

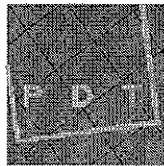


Project Manual
for
EYECARE MEDICAL GROUP
53 SEWALL STREET
PORTLAND, ME 04102

E.M.G. - Phase 2 Addition & Renovation

VOLUME 3

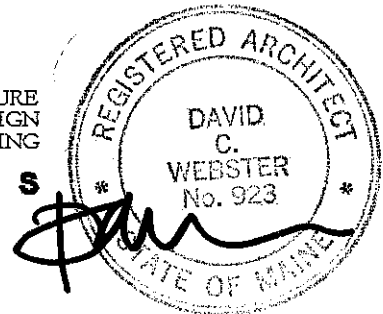
Construction Documents
July 11th, 2013



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ARCHITECTURE
INTERIOR DESIGN
PLANNING

ARCHITECTS



EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

SECTION 000110 - TABLE OF CONTENTS

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS No. of Pages

INTRODUCTORY INFORMATION

000101	Project Title Page (Volume 3)
000110	Table of Contents

PROCUREMENT AND CONTRACTING REQUIREMENTS

By Construction Manager

SPECIFICATIONS GROUP

GENERAL REQUIREMENTS SUBGROUP

DIVISION 01 - GENERAL REQUIREMENTS

011000	Summary (Vol. 1)
012100	Allowances (Vol. 1)
012500	Substitution Procedures (Vol. 1)
012600	Contract Modification Procedures (Vol. 1)
012900	Payment Procedures (Vol. 1)
013100	Project Management and Coordination (Vol. 1)
013200	Construction Progress Documentation (Vol. 1)
013300	Submittal Procedures (Vol. 1)
014000	Quality Requirements (Vol. 1)
014200	References (Vol. 1)
015000	Temporary Facilities and Controls (Vol. 1)
016000	Product Requirements (Vol. 1)
017300	Execution (Vol. 1)
017700	Closeout Procedures (Vol. 1)
017823	Operation and Maintenance Data (Vol. 1)
017839	Project Record Documents (Vol. 1)

FACILITY CONSTRUCTION SUBGROUP

DIVISION 02 - EXISTING CONDITIONS

023200	Geotechnical Investigation (Vol. 1 – Addendum 2)
024119	Selected Structure Demolition (Vol. 1)

DIVISION 03 - CONCRETE

033000	Cast-in-Place Concrete (Vol. 1)
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EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

DIVISION 04 - MASONRY

042000 **Unit Masonry**

DIVISION 05 - METALS

Structural by others

051200 Structural Steel (Vol. 2)
054000 **Cold-Formed Metal Framing**
055000 Metal Fabrications (Vol. 1)

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

061000 **Rough Carpentry**
061600 **Sheathing**
062023 **Interior Finish Carpentry**
064023 **Interior Architectural Woodwork**

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

071113 Bituminous Dampproofing (Vol. 1)
072100 Thermal Insulation (Vol. 1)
072616 Below-Grade Vapor Retarders (Vol. 1)
072713 **Modified Bituminous Sheet Air Barriers**
072726 **Fluid-Applied Membrane Air Barriers**
074213 **Metal Wall Panels**
075323 **EPDM Membrane Roofing**
076200 **Sheet Metal Flashing and Trim**
078100 **Applied Fireproofing**
078413 **Penetration Firestopping**
078446 **Fire-Resistive Joint Systems**
079200 **Joint Sealants**
079500 **Expansion Control**

DIVISION 08 - OPENINGS

081113 **Hollow Metal Doors and Frames**
081416 **Flush Wood Doors**
083113 **Access Doors and Frames**
084113 **Aluminum-Framed Entrances & Storefronts**
084229 **Automatic Entrances**
087100 **Door Hardware**
088000 **Glazing**

DIVISION 09 - FINISHES

092216 **Non-Structural Metal Framing**
092900 **Gypsum Board**
093000 **Tiling**
095113 **Acoustical Panel Ceilings**

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

096513	Resilient Base & Accessories
096516	Resilient Sheet Flooring
096813	Tile Carpeting
096816	Sheet Carpeting
099113	Exterior Painting
099123	Interior Painting
099300	Staining & Transparent Finishing

DIVISION 10 – SPECIALTIES

101100	Visual Display Surfaces
101400	Signs
102123	Cubicle Curtains and Tracks
102600	Wall and Door Protection
102800	Toilet, Bath and Laundry Accessories
104413	Fire Extinguisher Cabinets
104416	Fire Extinguishers

DIVISION 11 - EQUIPMENT

Not Used

DIVISION 12 - FURNISHINGS

122123	Roller Shades
124813	Entrance Floor Mats and Frames

DIVISION 13 - SPECIAL CONSTRUCTION

Not Used

DIVISION 14 - CONVEYING SYSTEMS

Not Used

DIVISIONS 15 – 19 - NOT USED

FACILITY SERVICES SUBGROUP

DIVISION 21 – FIRE SUPPRESSION

211100	FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING (Vol. 1)
211000	FIRE-SUPPRESSION SPRINKLERS

DIVISION 22 – PLUMBING

220500	COMMON WORK RESULTS FOR PLUMBING
220516	BRAIDED EXPANSION LOOPS AND FITTINGS FOR PLUMBING PIPING
220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
220553	IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

220700	PLUMBING INSULATION
221116	DOMESTIC WATER PIPING (Vol. 1)
221116	DOMESTIC WATER PIPING-SUPPLEMENTAL INFORMATION
221119	PLUMBING SPECIALTIES (Vol. 1)
221119	PLUMBING SPECIALTIES-SUPPLEMENTAL INFORMATION
221316	PLUMBING SANITARY AND STORM PIPING (Vol. 1)
221429	SUMP PUMPS (Vol. 1)
223500	INDIRECT-FIRED WATER HEATERS
224000	PLUMBING FIXTURES
226213	VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES
226313	GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

DIVISION 23 – HEATING, VENTILATION, AND AIR-CONDITIONING (HVAC)

230500	COMMON WORK RESULTS FOR MECHANICAL
230516	BRAIDED EXPANSION LOOPS AND FITTINGS
230519	THERMOMETERS AND PRESSURE GAUGES
230529	HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT
230548	MECHANICAL SEISMIC CONTROLS
230553	IDENTIFICATION FOR MECHANICAL
230593	TESTING, ADJUSTING, AND BALANCING
230700	MECHANICAL INSULATION (Vol. 1 – Addendum 1) VOID
230700	MECHANICAL INSULATION
230900	INSTRUMENTATION AND CONTROL FOR HVAC
230901	VARIABLE FREQUENCY DRIVES
230993	SEQUENCE OF OPERATIONS
231123	FACILITY FUEL GAS PIPING
232113	HYDRONIC HVAC PIPING
232123	HYDRONIC PUMPS
233113	DUCTWORK
233600	AIR TERMINALS
233713	DIFFUSERS, REGISTERS, AND GRILLES
235216	CONDENSING BOILERS
236426	ROTARY-SCREW WATER CHILLERS
237313	MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
237314	CUSTOM AIR-HANDLING UNITS
238413	HUMIDIFIERS

DIVISION 24 – NOT USED

Not Used

DIVISION 25 – INTEGRATED AUTOMATION

Not Used

DIVISION 26 – ELECTRICAL

260100	BASIC ELECTRICAL REQUIREMENTS (Vol. 1)
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (Vol. 1)

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

260523	CONTROL-VOLTAGE ELECTRICAL POWER CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (Vol. 1)
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS (Vol. 1)
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS (Vol. 1)
260573	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
260923	LIGHTING CONTROL DEVICES
260943	NETWORK LIGHTING CONTROLS
262200	LOW-VOLTAGE TRANSFORMERS
262416	PANELBOARDS
262726	WIRING DEVICES
262813	FUSES
262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
262913	ENCLOSED CONTROLLERS
263600	TRANSFER SWITCHES
265100	INTERIOR LIGHTING

DIVISION 27 – COMMUNICATIONS

270526	GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
270528	PATHWAYS FOR COMMUNICATIONS SYSTEMS
271500	COMMUNICATIONS HORIZONTAL CABLING

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

280513	CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY
283111	DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

DIVISION 29 – NOT USED

SITE AND INFRASTRUCTURE SUBGROUP

DIVISION 31 – EARTHWORK

311000	Site Clearing (Vol. 1)
312000	Earth Moving (Vol. 1)
312319	Dewatering (Vol. 1)
312513	Erosion Controls (Vol. 1)
312573	Dirtbag_ Specifications for Control of Sediment (Vol. 1)

DIVISION 32 – EXTERIOR IMPROVEMENTS

321100	Base Courses (Vol. 1)
321216	Asphaltic Paving (Vol. 1)
321600	Curbs and Sidewalks (Vol. 1)
321723.13	Painted Pavement Markings (Vol. 1)
323000	Site Improvements (Vol. 1)
323113	Chain Link Fence and Gates (Vol. 1)
324000	Signage (Vol. 1)

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

329200 Turf and Grasses (Vol. 1)
329300 Trees, Plants and Ground Cover (Vol. 1)

DIVISION 33 – UTILITIES

330500 Common Work Results for Utilities (Vol. 1)
331100 Water Distribution Systems (Vol. 1)
333100 Sanitary Sewer Collection/Conveyance Systems (Vol. 1)
333900 Sewer Appurtenances (Vol. 1)
334100 Storm Utility Drainage Piping (Vol. 1)
334600 Subdrainage (Vol. 1)

DIVISION 34 – TRANSPORTATION - NOT USED

DIVISION 35 – WATERWAY AND MARINE CONSTRUCTION - NOT USED

DIVISION 36 – 39 - NOT USED

PROCESS EQUIPMENT SUBGROUP – NOT USED

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry units (CMUs).
2. Face brick.
3. Mortar and grout.
4. Reinforcing steel.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Cavity-wall insulation.

- B. Products installed, but not furnished, under this Section include the following:

1. Steel lintels for unit masonry, furnished under Division 05 Section "Metal Fabrications."

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: For the following:

1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

- C. Samples for Selection: For the following:

1. Face brick, in the form of straps of five or more bricks.
2. Weep holes/vents.

- D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 4. Grout mixes. Include description of type and proportions of ingredients.
 5. Reinforcing bars.
 6. Joint reinforcement.
 7. Anchors, ties, and metal accessories.
- F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
 2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- G. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
- 1.4 QUALITY ASSURANCE
- A. Installer Qualifications: Company specializing in performing the work of this Section with minimum 5 years experience.
 - B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.
 - C. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
 - D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
 - E. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockups for typical exterior wall in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wall and accessories.
 - a. Include a sealant-filled joint at least 16 inches long in exterior wall mockup.
 - b. Include window opening in exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
 - c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include metal studs, sheathing, air barrier system, cavity insulation, veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.
 2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 3. Clean exposed faces of mockups with masonry cleaner as indicated.
 4. Protect accepted mockups from the elements with weather-resistant membrane.
 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
- G. Preinstallation Conferences: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1. At least 7 days prior to starting veneer masonry, conduct a meeting to review detailed requirements for mortar mixes and to determine procedures for satisfactory construction operations. Review requirements of submittals, status of coordinating work, and availability of materials. Review requirements tenting and heating. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with masonry construction to attend, including the following:
 - a. Contractor's superintendent.
 - b. Masonry foreman.
 - c. Architect.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 - 2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates or setting beds. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with the following requirements:
 - 1. Cold-Weather Construction: When the anticipated daytime low temperature is within the limits indicated, use the following procedures:
 - a. 40 to 32 deg F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F.
 - b. 32 to 25 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Heat masonry units to 40 deg F. Maintain mortar and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- grout above freezing until used in masonry. Use heat on both sides of walls under construction.
- c. 25 to 20 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F.
 - d. 20 deg F and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F.
2. Cold-Weather Protection: When the anticipated daytime low temperature is within the limits indicated, coordinate with the General Contractor to provide the following protection. This is in addition to construction procedures specified above:
 - a. 40 to 32 deg F: Cover masonry with insulating blankets for 48 hours after construction.
 - b. 32 deg F and Below: Provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 72 hours after construction.
 3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried out, but not less than 7 days after completion of cleaning.
- D. Hot-Weather Requirements: Coordinate with the General Contractor to protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners, unless otherwise indicated.
- B. Concrete Masonry Units: ASTM C 90.
1. Weight Classification: Normal weight.
 2. Curing: Allow masonry units to cure 28 days to permit drying shrinkage before laying.
 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
 4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

2.4 MASONRY LINTELS

- A. Masonry Lintels: Built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured.

2.5 BRICK

- A. General: Provide shapes indicated and as follows:
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Face Brick: ASTM C 216, Grade SW, Type FBS (extruded).
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 8000 psi.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Initial Rate of Absorption: Less than 18 g/30 sq. in. per minute when tested per ASTM C 67.
3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
4. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
5. Application: Use where brick is exposed, unless otherwise indicated.
6. Products:
 - a. Face Brick, Type 1: Academy Smooth Red by Morin Brick Company; contact: Paul LaChance; phone: (207) 784-9375.
 - b. Face Brick Type 2: Brown Brushed Velour by Morin Brick Company; contact: Paul LaChance; phone: (207) 784-9375.

2.6 MORTAR AND GROUT MATERIALS

- A. General: Mortar and grout may be provided in one of two options; field mix of Portland cement, lime and sand or with specified Portland Cement-Lime Mix.
- B. Portland Cement: ASTM C 150, Type I or II.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
 1. Available Products:
 - a. Blue Circle Cement, Inc.: Eaglebond High Strength Type "S".
 - b. Ciment Quebec, Inc.: Portland and Lime / Type S.
 - c. Dragon Cement and Concrete: Type S Masonry Cement.
- E. Aggregate for Mortar: ASTM C 144.
- F. Water: Potable.

2.7 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951.
 1. Exterior Walls: Hot-dip galvanized, carbon steel.
 2. Wire Size for Side Rods: 0.148-inch diameter for interior walls and W2.8 or 0.188-inch diameter for exterior walls.
 3. Wire Size for Cross Rods: 0.148-inch diameter.
 4. Wire Size for Veneer Ties: 0.148-inch diameter.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 6. Provide in lengths of not less than 10 feet.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

C. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
2. Available Products:
 - a. Duro-wall; D/A 360 Ladur-eye.
 - b. Hohmann & Barnard; Lox-All Adjustable Eye-Wire, #270.
 - c. Wire-Bond; Series 800, Composite Hook and Eye.

2.8 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
 2. Where wythes are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
 3. Wire: Fabricate from 3/16-inch- diameter, hot-dip galvanized steel wire.
- D. Adjustable Masonry-Veneer Anchors
1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
 2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch wide by 6 inches long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
 - b. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch-thick, steel sheet, galvanized after fabrication.
 - c. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch-diameter, hot-dip galvanized steel wire.
 - d. Product:
 - 1) Hohmann & Barnard, Inc.; X-Seal™ Anchor.
3. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
- a. Available Products:
 - 1) ITW Buildex; Teks Maxiseal with Climaseal finish.
 - 2) Textron Inc., Textron Fastening Systems; Elco Dril-Flex with Stalgard finish.

2.9 EMBEDDED FLASHING MATERIALS

- A. Metal Pan Flashing: Refer to Division 07 Section "Sheet Metal Flashing and Trim".
- B. Metal Drip Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, as follows:
 1. Metal Drip Edges: Fabricate from 26 gage stainless steel. Extend at least 4-1/2 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and back edge turned up 1-1/2 inch.
 2. Available Product: No. 1008 by Heckman Building Products Inc.
- C. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions with interlocking counterflashing on exterior face, of same metal as reglet.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fry Reglet Corporation; Fry Reglet MA-4 Masonry Reglet with SpringLok Counterflashing.
 2. Material: Stainless steel, 0.019 inch thick.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 4. Accessories:
 - a. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
 5. Finish: Mill.
- D. Flexible Flashing: For flashing not exposed to the exterior, use the following, unless otherwise indicated:
1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Advanced Building Products Inc.; Strip-N-Flash.
 - 2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
 - 3) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
 - 4) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
 - 5) Hohmann & Barnard, Inc.; Textroflash.
 - 6) W. R. Meadows, Inc.; Air-Shield Thru-Wall Flashing.
 - 7) Polyguard Products, Inc.; Polyguard 400.
 - 8) Sandell Manufacturing Co., Inc.; Sando-Seal.
 - b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
 2. Termination Seal: Provide one of the following:
 - a. Dow Corning Corporation; 790.
 - b. GE Construction Sealants; SCS2700 SilPruf LM.
 - c. Tremco Incorporated: Spectrem 1.
- E. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 2. Where flashing is fully concealed, use flexible flashing.
- F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.10 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.
1. Holmann & Barnard: #NS – Closed Cell Neoprene.
 2. Sandell: Closed Cell Neoprene.
 3. Wire Bond: 3000 Horizontal.
- B. Weep/Vent Products: Use the following, unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Available Products:
 - 1) Advanced Building Products Inc.; Mortar Maze weep vent.
 - 2) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
 - 3) Heckmann Building Products Inc.; No. 85 Cell Vent.
 - 4) Hohmann & Barnard, Inc.; Quadro-Vent.
 - 5) Sandell: Cell Vent.
 - 6) Wire-Bond; Cell Vent.
- C. Cavity Drainage Material: 1-inch- thick, free-draining mesh; made from polyethylene strands and shaped to avoid being clogged by mortar droppings.
1. Available Products:
 - a. Advanced Building Products; Mortar Break.
 - b. Mortar Net by Mortar Net USA, LTD.; Model MN 10-1.
- D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
1. Available Products:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
 - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
 - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
 - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.
- E. Grout Screen: Monofilament screen fabricated from high-strength, non-corrosive, polypropylene polymers.
1. Available Products: Subject to compliance with requirements, grout screen materials that may be incorporated into the Work include, but are not limited to, the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. AA3260; AA Wire Products.
- b. Dur-O-Stop; Dur-O-Wal, Inc.
- c. MGS; Hohmann and Barnard.

2.11 CAVITY-WALL INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, closed-cell product extruded with an integral skin.
 - 1. Available Products: Provide the following or approved substitute.
 - a. Dow Chemical Company; Sytrofoam Square Edge.
 - 1) Provide for gypsum sheathing walls.
 - 2) Provide 4 by 8 foot sheets with square edges, thickness as indicated on the drawings.
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.12 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate (Spic and Span) and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.
- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 1. Available Manufacturers:
 - a. 202V Vana-Stop; Diedrich Technologies, Inc.
 - b. Sure Klean Vana Trol; ProSoCo, Inc.

2.13 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime mortar unless otherwise indicated.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide type S mortar for all applications stated unless another type is indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. For masonry below grade or in contact with earth, use Type M.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. Verify that foundations are within tolerances specified.
 2. Verify that reinforcing dowels are properly placed.
 3. Examine wall framing and sheathing to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- D. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
1. Mix units from several pallets or cubes as they are placed.
- E. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Bracing Walls During Construction: It is the sole responsibility of the masonry contractor to design and provide temporary bracing of masonry walls during construction. Refer to NCMA Tek Bulletin 3-4B and applicable OSHA standards. Provide 3' vinyl construction fencing around Restricted Zones.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Where cutting and patching of existing masonry walls, tooth in new work where finished product will be exposed to view.
- F. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- G. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- I. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units or brick with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment is necessary, remove mortar and replace.

3.6 CAVITY WALLS

- A. Bond wythes of cavity walls together using the following method:
 - 1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement to allow for differential movement regardless of whether bed joints align.
 - 2. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Installing Cavity-Wall Insulation: At sheathing, place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose.
 - 1. Fill cracks and open gaps in insulation with foam insulation specified in Division 07 section “Thermal Insulation”.

3.7 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c., unless noted otherwise.
 - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.8 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to structural masonry back-up wythe with wire ties designed to engage pintle-eye assembly incorporated in joint reinforcement.
 - 1. Use individual adjustable metal ties installed in horizontal joints to bond wythes together. Provide ties shown, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally with not less than 1 anchor for each 1.77 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.
 - 2. Engage pintles form ties into eyes connected to joint reinforcement.
- B. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached anchors through insulation, air/vapor barrier, and sheathing to wall framing with metal fasteners of type indicated.
 - 2. Embed tie sections in masonry joints.
 - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally, with not less than 1 anchor for each 1.77 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

3.9 CONTROL AND EXPANSION JOINTS

- A. General: Install control joints in unit masonry where indicated. Provide control joints in masonry partitions at changes in wall heights, at control joints in the wall bottom support material, within 8' of wall corners or intersections for walls greater than 16', and at not less than 24' on center for straight walls. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
- B. Install control joints in veneer masonry as indicated on the drawings or, if not indicated, at a maximum spacing of 24 feet on center. Locate joints at door and window jambs inasmuch as possible.
 - 1. Provide joints at both sides of windows and doors 6 foot wide or wider.
- C. Form expansion joints in brick made from clay or shale as follows:
 - 1. Build in compressible joint fillers and set back from face of veneer to form open joint 3/4 inch deep and not less than 3/8 inch for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."

3.10 LINTELS

- A. Install steel lintels where indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install through-wall flashing as follows, unless otherwise indicated:
 - 1. Install metal drip flashing on top of foundation wall or lintel.
 - 2. At lintels and shelf angles, extend metal drip flashing a minimum of 8 inches into masonry at each end. At heads and sills, extend metal drip flashing 8 inches at ends and turn up not less than 2 inches to form end dams.
 - 3. Adhere flexible flashing to vertical leg of metal drip flashing.
 - 4. Extend flexible flashing across thickness of insulation, turned up a minimum of 8 inches and adhering to air barrier membrane. Seal top of through-wall flashings to air barrier with sealant.
- C. Install reglets as follows, unless otherwise indicated:
 - 1. Install reglet on top of masonry unit.
 - 2. Extend flexible flashing over metal reglet through outer wythe, across air space and insulation, turned up a minimum of 8 inches and adhering to air barrier membrane. Seal top of through-wall flashings to air barrier with an additional 6-inch- wide, flexible flashing strip.
 - 3. Provide springlock flashing for installation by roofing contractor.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
 - 1. Use specified weep/vent products to form weep holes.
 - 2. Space weep holes 24 inches o.c., unless otherwise indicated.
 - 3. Provide weep holes not more than 8 inches from end of lintels.
- E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
- F. Install vents in vertical head joints at the top of each continuous cavity. Use specified weep/vent product to form vents.
 - 1. Space vents 24 inches o.c.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.12 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than 60 inches.

3.13 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning for CMU: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water. Do not use pressure sprayers, garden hose type and pressure only.
 - 2. Clean concrete masonry with job-mixed detergent solution by cleaning method indicated in NCMA TEK 8-2A and as applicable to type of stain on exposed surfaces.
- E. Final Cleaning for Brick: After mortar is thoroughly set and cured for a minimum of 7 days, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water. Do not use pressure sprayers, garden hose type and pressure only.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20 Revised, and manufacturer's printed instructions.

3.14 MASONRY WASTE DISPOSAL

- A. Excess Masonry Waste: Remove excess clean masonry waste and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior non-load-bearing wall framing.
 - 2. Soffit framing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- B. Shop Drawings:
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
- C. Delegated-Design Submittal: For cold-formed steel framing.
 - 1. Include structural analysis calculations signed and sealed by the qualified professional engineer responsible for their preparation.
 - a. Review of structural analysis calculations is for general conformance with requirements and completeness. The responsibility for correctness rests solely with the designer. The Architect reserves the authority to require resubmittal for observed deficiencies, or incompleteness.
 - 2. Include complete details for all member connections at openings and other discontinuities of the wall system.
 - 3. Specify connections to supports at top and bottom of wall including spacings at jambs of openings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Expansion anchors.
 - 3. Power-actuated anchors.
 - 4. Mechanical fasteners.
 - 5. Vertical deflection clips.
 - 6. Horizontal drift deflection clips
 - 7. Miscellaneous structural clips and accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
 - 1. Provide seal of professional engineer on calculations and shop drawings.
 - 2. Same engineer shall provide on-site review of installation.
- C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
- D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.
- E. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
 - 1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."
- F. SSMA Section Properties: Provide cold-formed metal framing members with section properties that equal or exceed the properties indicated in SSMA's "Product Technical Information" publication.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
1. Dale/Incor.
 2. Dietrich Metal Framing; a Worthington Industries Company.
 3. MarinoWare; a division of Ware Industries.
 4. Super Stud Building Products, Inc.
 5. The Steel Network, Inc.
 6. United Metal Products, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: The contractor is required to provide the complete design and detailing of the wall and roof framing systems to resist specified loads within deflection limits specified where cold-formed metal framing is indicated. Where necessary or desirable, the contractor may substitute structural steel components for increased strength or stiffness. Such substitutions will be included in the design and detailing submittal and shall be provided at no additional cost to the Owner. Size limitations identified on the drawings pertain to both cold-formed metal framing and structural steel components. All design and detailing of structural steel and cold-formed metal framing is subject to approval by the Structural Engineer of record.
- B. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated on the structural drawings or otherwise approved.
 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Curtain-Wall Framing: Horizontal deflection of 1/360 of the wall height for siding, 1/600 of the wall height for masonry veneer.
 - b. Soffit/Ceiling Framing: Vertical deflection of 1/360 of the span.
 3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4 inch.
 5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Cold-Formed Steel Framing Design Standards:
 - 1. Floor and Roof Systems: AISI S210.
 - 2. Wall Studs: AISI S211.
 - 3. Headers: AISI S212.
 - 4. Lateral Design: AISI S213.
- D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.
- E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - 1. Grade: ST33H or ST50H as required by structural performance.
 - 2. Coating: G90.
- B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: 50, Class 1 or 2.
 - 2. Coating: G90.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 18 gage.
 - 2. Flange Width: 1-5/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure.
 - 1. Construction: Slotted galvanized steel angle with step bushing to prevent over tightening of fasteners.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Vertical Deflection: 1-1/2 inches total travel.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. VertiClip, by The Steel Network. Series: SL, SLT, SLB, AND SLS as required by attachment condition.
 - b. Fast Top Clips by Dietrich, with FastClip deflection screws.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: As required to resist design loads.
 2. Flange Width: 1 inch plus the design gap for 1-story structures and 1 inch plus twice the design gap for other applications.
- E. Approved alternates to double studs for openings: ASTM A653/A653M, Grade 50 (340), 50ksi (340MPa), minimum yield strength, 65ksi (450 MPa), minimum tensile strength, G-60 (Z180) hot-dipped galvanized coating.
1. JamStud™ by The Steel Network, Inc.
 - a. Approved engineered connections for openings: StiffClips® as manufactured by The Steel Network, Inc.
 2. HDS by Dietrich.

2.5 SOFFIT/CEILING JOIST FRAMING

- A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch.
 2. Flange Width: 1-5/8 inches, minimum.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
1. Supplementary framing.
 2. Bracing, bridging, and solid blocking.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
- C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
 - 2. Minimum size; No. 10-16 (D=0.19"), with length adequate for 3 threads to project through the connected members.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed metal framing is to be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Install field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw or bolt wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed metal framing members by screw fastening only. Wire tying of framing members is not permitted.
 - a. Power-actuated fasteners: In concrete, minimum spacing = 3", minimum edge distance = 3". In structural steel, minimum spacing = 1 1/2", minimum edge distance = 1/2".
 - b. Screws: Minimum spacing and edge distance = 1/2".
- E. Install framing members in one-piece lengths or multiple lengths as required by the design and load requirements.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- H. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings or as indicated in the shop drawings.
- I. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to bottom track, unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: As required by design, but not greater than 24 inches on center.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 - 3. Connect vertical deflection clips to bypassing studs and anchor to building structure.
 - 4. Connect drift clips to cold formed metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track.
 - 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space joists not more than 2 inches from abutting walls, and as follows:
 - 1. Joist Spacing: 16 inches.
- D. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.
 - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
- G. Secure joists to load-bearing interior walls as indicated in the shop drawings prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.6 FIELD QUALITY CONTROL

- A. Engineer of cold-form metal framing shall review on-site installation and provide written documentation that installation conforms to design intent. If corrective work is required, same engineer shall specify repair work necessary to provide conforming installation.
- B. Remove and replace work where test results indicate that it does not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Framing with dimension lumber.
 - 2. Rooftop equipment bases and support curbs.
 - 3. Wood blocking and nailers.
 - 4. Wood furring.
 - 5. Plywood backing panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Application: Treat items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Use treatment that does not promote corrosion of metal fasteners.
 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 3. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by testing agency.
- E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat items indicated on Drawings, and the following:
1. Plywood backing panels.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 DIMENSION LUMBER FRAMING

- A. Partitions, Joists, Rafters, and Other Framing: Construction or No. 2 grade.
 - 1. Species:
 - a. Spruce-pine-fir; NLGA.

2.5 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber and any of the following species:
 - 1. Spruce-pine-fir; NLGA.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.6 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.8 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- I. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Where wood-preserved-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

3.3 FLOOR JOIST FRAMING INSTALLATION

- A. General: Install floor joists with crown edge up and support ends of each member with not less than 1-1/2 inches of bearing on wood or metal, or 3 inches on masonry. Attach floor joists as follows:
 - 1. Where supported on wood members, by using metal framing anchors.
 - 2. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.
- B. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches.
- C. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than 1/3 depth of joist; do not locate closer than 2 inches from top or bottom.
- D. Provide solid blocking of 2-inch nominal thickness by depth of joist at ends of joists unless nailed to header or band.
- E. Provide bridging of type indicated below, at intervals of 96 inches o.c., between joists.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Diagonal wood bridging formed from bevel-cut, 1-by-3-inch nominal- size lumber, double-crossed and nailed at both ends to joists.
2. Steel bridging installed to comply with bridging manufacturer's written instructions.

END OF SECTION 061000

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Wall sheathing.
 - 2. Roof sheathing.

1.3 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS, GENERAL

- A. Plywood: DOC PS 1.
- B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- C. Factory mark panels to indicate compliance with applicable standard.

2.2 WALL SHEATHING

- A. Contractor has the option of providing glass-mat gypsum wall sheathing or cellulose fiber-reinforced gypsum wall sheathing.
- B. Gypsum Wall Sheathing:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GlasRoc Sheathing; CertainTeed (BPB America, Inc.)
 - 2) Dens-Glass Gold; Georgia-Pacific Corporation.
 - 3) E2XP Extended Exposure Sheathing; Gold Bond.
 - 4) Securock Sheathing; United States Gypsum Co.
 - b. Type and Thickness: Type X, 5/8 inch thick.
 - c. Size: 48 by 96 inches minimum.
2. Cellulose Fiber-Reinforced Gypsum Wall Sheathing: ASTM C 1278/C 1278M, gypsum sheathing.
 - a. Product: Subject to compliance with requirements, provide "Fiberock Sheathing with Aqua-Tough" by United States Gypsum Co.
 - b. Type and Thickness: Type X, 5/8 inch thick.
 - c. Size: 48 by 96 inches minimum.

2.3 ROOF SHEATHING

- A. Plywood Roof Sheathing (Roof Edge Blocking): Exposure 1, Structural I (CDX) sheathing.
 1. Span Rating: Not less than 24/0 or 32/16.
 2. Nominal Thickness: Not less than 1/2 inch.

2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
- F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
1. For steel framing less than 0.0329 inch thick, attach sheathing to comply with ASTM C 1002.
 2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing to comply with ASTM C 954.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 1. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
- D. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30S, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Wall and Roof Sheathing:
 - a. Nail to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.

3.3 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
 - 3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.
- C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
 - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
 - 2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- D. Seal sheathing joints according to sheathing manufacturer's written instructions.
 - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient quantity of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 - 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing board joints, and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.
 - 3. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

END OF SECTION 061600

SECTION 062023 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior standing and running trim.
 - 2. Shelving and clothes rods.
 - 3. Wood ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
- B. Samples for Selection:
 - 1. For each species and cut of lumber and panel products with non-factory-applied finish, with 1/2 of exposed surface finished, 50 sq. in. for lumber and 8 by 10 inches for panels.
 - 2. For each finish system and color of lumber and panel products with factory-applied finish, 50 sq. in. for lumber and 8 by 10 inches for panels.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and the following grading rules:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association, "Standard Grading Rules for Northeastern Lumber."
 - 2. NHLA: National Hardwood Lumber Association, "Rules for the Measurement and Inspection of Hardwood & Cypress."
 - 3. NLGA: National Lumber Grades Authority, "Standard Grading Rules for Canadian Lumber."
 - 4. SPIB: The Southern Pine Inspection Bureau, "Standard Grading Rules for Southern Pine Lumber."
 - 5. WCLIB: West Coast Lumber Inspection Bureau, Standard No. 17, "Grading Rules for West Coast Lumber."
 - 6. WWPA: Western Wood Products Association, "Western Lumber Grading Rules."
- B. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
 - 1. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
- C. Particleboard: ANSI A208.1, Grade M-2.

2.2 INTERIOR TRIM

- A. Lumber Trim for Opaque Finish (Painted):
 - 1. Species and Grade: Poplar; B finish; NHLA.
 - 2. Maximum Moisture Content: 10 percent.
 - 3. Finger Jointing: Allowed.
 - 4. Face Surface: Surfaced (smooth).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.3 OPEN WALL SHELVING

- A. Thermoset Decorative Overlay (melamine) shelves with 3 mm PVC edging, 3/4 inch thick unless noted otherwise.
- B. Wall Brackets: Knape & Vogt No. 182, twin slotted standards with No. 82 heavy-duty U-Brackets. Color as selected by Architect.

2.4 SHELVING AND CLOTHES RODS

- A. Thermoset Decorative Overlay (melamine) shelf with 3 mm PVC edging, 1 inch (25 mm) thick unless noted otherwise.
- B. Pole: Knape & Vogt No. KV2 ZC, extension closet rod with No. 29202 support bracket. Use bracket to limit pole length and shelf span to 42 inches.

2.5 WOOD CEILING

- A. Species and Grade: Clear VG (Vertical Grain) Heart western red cedar; NLGA, WCLIB, or WWPA.
- B. Pattern: V-edge, smooth-faced tongue-and-groove pattern with eased edges, actual face width (coverage) and thickness of 3-1/8 by 23/32 inch, measured at 19 percent moisture content.

2.6 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- B. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
 - 1. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FABRICATION

- A. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.
- B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
 - 3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.2 STANDING AND RUNNING TRIM INSTALLATION

- A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
 - 1. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
 - 2. Install trim after gypsum board joint finishing operations are completed.

3.3 SHELVING AND CLOTHES ROD INSTALLATION

- A. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 32 inches o.c. and within 6 inches of end of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
- B. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.
 - 1. Fasten shelves to cleats with finish nails or trim screws, set flush.
 - 2. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 ADJUSTING

- A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.5 CLEANING

- A. Clean interior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.6 PROTECTION

- A. Protect installed products from damage from weather and other causes during remainder of the construction period.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate cabinets.
 - 2. Plastic-laminate countertops.
 - 3. Solid-surfacing-material countertops.
 - 4. Wood chair rails.

1.3 ACTION SUBMITTALS

- A. Product Data: For panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, solid-surfacing material, cabinet hardware and accessories.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for plumbing fixtures and other items installed in architectural woodwork.
- C. Samples for Initial Selection:
 - 1. Plastic laminates.
 - 2. Thermoset decorative panels.
 - 3. Solid-surfacing materials.
- D. Samples for Verification:
 - 1. Lumber and panel products with shop-applied opaque finish, 50 sq. in. for lumber and 8 by 10 inches for panels, for each finish system and color, with 1/2 of exposed surface finished.
 - 2. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish.
 - 3. Thermoset decorative-panels, 8 by 10 inches, for each type, color, pattern, and surface finish.
 - 4. Solid-surfacing materials, 6 inches square.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

5. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.4 QUALITY ASSURANCE

- A. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
 1. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with such selections and requirements in addition to the quality standard.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Species and Cut for Transparent Finish: Red oak, plain sawn or sliced.
- C. Wood Products: Comply with the following:
 - 1. Particleboard: ANSI A208.1, Grade M-2.
- D. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
 - 1. Colors: Provide full color options available from Panolam or Panval not just standard white, putty, almond, and grey.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
 - a. Formica Corporation.
 - b. Lamin-Art, Inc.
 - c. Nevamar Company, LLC; Decorative Products Div.
 - d. Panolam Industries International Incorporated. (Pionite)
 - e. Westinghouse Electric Corp.; Specialty Products Div.
 - f. Wilsonart International; Div. of Premark International, Inc.
- F. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avonite, Inc.
 - b. E. I. du Pont de Nemours and Company.
 - c. Formica Corporation.
 - d. Nevamar Company, LLC; Decorative Products Div.
 - e. Swan Corporation (The).
 - f. Wilsonart International; Div. of Premark International, Inc.
 - 2. Type: Standard type, unless Special Purpose type is indicated.
 - 3. Colors and Patterns: As selected by Architect from manufacturer's full range.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, 3.0 mm thick, unless otherwise indicated.

2.2 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening, self-closing.
 - 1. Available Products:
 - a. Blum: BH75T1550.
 - b. Grass: GHA3703M.
 - c. MEPLA: CS04 (MH146304550015).
- C. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
- D. Shelf Rests: BHMA A156.9, B04013; plastic, two-pin type with shelf hold-down clip.
 - 1. Plastic double pin shelf clip: Provide 1/4 inch diameter hole, clear or white color as selected by the Architect.
 - a. Available Products:
 - 1) Hardware Concepts, Inc.: Series 5033.
 - 2) AllenField: No. 55 Double Pin.
- E. Drawer Slides: BHMA A156.9, B05091; Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
 - 1. Available Products:
 - a. Grass 6610.
 - b. Mepla-Alfit: AL 5300.
 - c. KV 8417.
 - d. Blum 430E Series.
- F. Counter Support Brackets: Provide one of the following
 - 1. Heavy gage aluminum angle, MIG welded corners, 5/16 inch holes for mounting, and primed finish for field painting. Provide Rakks Counter Support, Model No. EH-1818, by Ragine Corporation (800-826-6006) or approved substitution.
 - 2. 1/8 inch thick steel bracket with powder coat finish. Provide Work Station Brackets by A & M Hardware, Inc. (888-647-0200) or approved substitute.
 - 3. 18-1/8 inch Inter-Arc Work Support, model SWS2 by Doug Mockett, Manhattan Beach, California. Matte Black or Metallic Silver finish.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Short Run Pro, 18 by 18 countertop bracket (LBRKT-7CRS 4802-50036 or 18 by 24 countertop bracket (LBRKT 7CRS 4802-56037. Provide white powder coat finish.
- G. Aluminum Slides for Sliding Glass Doors: Provide EKU Clipo 35 GK system by Hafele. Complete assemblies, each consisting of one upper channel, two shoes, two carriers and one lower track.
- H. Sliding Door Locks: Knappe & Vogt #963 CHR, or approved substitute, ratchet lock for 1/4" glass, laps 3/4" to 3-3/8". May be keyed alike or with up to twelve key changes. Polished chrome finish.
- I. Grommets for Cable Passage through Countertops: 3-inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
 1. Product: Provide No. 35-3" by Outwater Plastics, Woodridge, NJ, (800) 631-8375.
- J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
 2. Satin Stainless Steel: BHMA 630.
- K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.3 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- C. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- D. Adhesive for Bonding Plastic Laminate: Contact cement.
 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.4 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.
- E. Install glass to comply with applicable requirements in Division 08 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

2.5 PLASTIC-LAMINATE CABINETS

- A. Grade: Custom, unless noted otherwise.
- B. AWI Type of Cabinet Construction: Flush overlay without face frame.
- C. Component Materials:
 - 1. Body members - ends, bottom, divisions, rails and tops: .028" exterior laminate over 3/4 inch thick particleboard, interior Thermoset Decorative Overlay (melamine) with 3 mm PVC edging, all exposed and semi-exposed sides. Provide Type B or C flush joint for underside of wall cabinets as required by AWI 400-G-7.
 - 2. Shelves: Minimum 3/4 inch thick particleboard, Thermoset Decorative Overlay (melamine) each side with 3 mm PVC edging. Provide material and thickness required to meet AWI 400-G-8.
 - 3. Backs: 1/4 inch thick particleboard, Thermoset Decorative Overlay (melamine) each side.
 - 4. Drawer sides, backs and subfronts: 1/2" hardwood plywood or solid lumber.
 - 5. Drawer Bottoms: 1/4" hardwood plywood.
 - 6. Drawer Fronts: .028" exterior laminate over 3/4 inch thick particleboard, interior Thermoset Decorative Overlay (melamine) with 3 mm PVC edging.
 - 7. Cabinet Doors: .028" exterior laminate over 3/4 inch thick particleboard, interior Thermoset Decorative Overlay (melamine) with 3 mm PVC edging.
 - 8. Edging: Band all exposed edges with 3 mm PVC.
 - 9. Base Toe Kick: Hardwood plywood.
- D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Solid colors, matte finish.
 - b. Patterns, matte finish.

2.6 POST-FORMED COUNTERTOPS

- A. Post-formed Countertops: HGP, nominal thickness .038" (1.0 mm), phenolic resin particleboard with .020" phenolic backer sheet. Provide contemporary design with 1-1/4 inch bullnose edges and 3/16 inch radius coves.

2.7 SOLID-SURFACING-MATERIAL COUNTERTOPS

- A. Grade: Premium.
- B. Solid-Surfacing-Material Thickness: 3/4 inch.
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
 1. As selected by Architect from manufacturer's full range.
- D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
 1. Fabricate tops with shop-applied edges of materials and configuration indicated.
 2. Fabricate tops with loose backsplashes for field application.
- E. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips.
- G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 3. Secure backsplashes to walls with adhesive.
 - 4. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- H. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.2 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064023

SECTION 072713 - MODIFIED BITUMINOUS SHEET AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes self-adhering, vapor-retarding, modified bituminous sheet air barriers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 2. Include details of interfaces with other materials that form part of air barrier.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.
- B. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to set quality standards for materials and execution.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Build integrated mockups of exterior wall as part of masonry veneer mockup to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
 - b. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
 1. Protect substrates from environmental conditions that affect air-barrier performance.
 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E 283, ASTM E 783 or ASTM E 2357.

2.3 SELF-ADHERING SHEET AIR BARRIER

- A. Modified Bituminous Sheet: 40-mil- thick, self-adhering sheet consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick, cross-laminated polyethylene film with release liner on adhesive side and formulated for application with primer that complies with VOC limits of authorities having jurisdiction.

- 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Carlisle Coatings & Waterproofing Inc.; CCW-705.
- b. Grace, W. R. & Co. - Conn.; Perm-A-Barrier Wall Membrane.
- c. Henry Company; Blueskin SA.
- d. Meadows, W. R., Inc.; SealTight Air-Shield.
- e. Tremco Incorporated, an RPM company; ExoAir 110/110LT.

- 2. Physical and Performance Properties:

- a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
- b. Tensile Strength: Minimum 250 psi; ASTM D 412, Die C.
- c. Ultimate Elongation: Minimum 200 percent; ASTM D 412, Die C.
- d. Puncture Resistance: Minimum 40 lbf; ASTM E 154.
- e. Water Absorption: Maximum 0.15 percent weight gain after 48-hour immersion at 70 deg F; ASTM D 570.
- f. Vapor Permeance: Maximum 0.05 perm; ASTM E 96/E 96M, Water Method.

2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier membrane.
- B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.
- C. Counterflashing Strip: Modified bituminous 40-mil- thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil- thick, cross-laminated polyethylene film with release liner backing.
- D. Modified Bituminous Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick, cross-laminated polyethylene film with release liner backing.
- E. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.
- F. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- H. Sprayed Foam Sealant: Refer to Division 07 Section “Thermal Insulation” for spray foam insulation applied at doors and windows.
- I. Modified Bituminous Transition Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
- J. Expansion/Seismic Joint: Provide Elastomeric Flashing Sheet; ASTM D 2000, minimum 50- to 65-mil- thick, cured sheet neoprene with manufacturer-recommended contact adhesives and lap sealant with stainless-steel termination bars and fasteners.
- K. Joint Sealant: Provide one of the following:
 - 1. Dow Corning Corporation; 790.
 - 2. GE Construction Sealants; SCS2700 SilPruf LM.
 - 3. Tremco Incorporated: Spectrem 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
 - 1. Install modified bituminous strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.
- G. Expansion/Seismic Joints: Install elastomeric flashing sheet loosely over joint to form bellows. Install lap sealant and termination bars to complete wall seal. Provide mineral wool insulation between air barrier expansion joint and exterior wall expansion joint cover system.
- H. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- I. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 INSTALLATION

- A. Apply modified bituminous sheet air-barrier membrane over gypsum sheathing only.
- B. General: Install modified bituminous sheets and accessory materials according to air-barrier manufacturer's written instructions and according to recommendations in ASTM D 6135.
 - 1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous air-barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F.
- C. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
 - 1. Install modified bituminous strips centered over vertical inside corners. Install 3/4-inch fillets of termination mastic on horizontal inside corners.
- D. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations with termination mastic and according to ASTM D 6135.
- E. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.
 - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- F. Apply and firmly adhere modified bituminous sheets horizontally over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
 - 1. Apply sheets in a shingled manner to shed water without interception by any exposed sheet edges.
 - 2. Roll sheets firmly to enhance adhesion to substrate.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Apply continuous modified bituminous sheets over modified bituminous strips bridging substrate cracks, construction, and contraction joints.
- H. Seal top of through-wall flashings to air-barrier sheet with an additional 6-inch- wide, modified bituminous strip.
- I. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- J. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.
 - 1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- K. Connect and seal exterior wall air-barrier membrane continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- L. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact. Roll firmly to enhance adhesion.
- M. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier membrane with foam sealant.
- N. At end of each working day, seal top edge of air-barrier material to substrate with liquid membrane.
- O. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- P. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.
- Q. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- R. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
 - 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 072713

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes fluid-applied, vapor-retarding membrane air barriers.

1.3 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 2. Include details of interfaces with other materials that form part of air barrier.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
- B. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
 - 1. Protect substrates from environmental conditions that affect air-barrier performance.
 - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor- permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Air-Barrier Assembly Air Leakage: Maximum 0.0008 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E 2357.

2.3 VAPOR-RETARDING MEMBRANE AIR BARRIER

- A. Fluid-Applied, Vapor-Retarding Membrane Air Barrier: Elastomeric, modified bituminous or synthetic polymer membrane.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Elastomeric, Modified Bituminous Membrane:
 - 1) Henry Company; Air-Bloc 06.
 - 2) Meadows, W. R., Inc.; Air-Shield LM.
 - 3) Tremco Incorporated, an RPM company; ExoAir 120SP.
 - b. Synthetic Polymer Membrane:
 - 1) Grace, W. R., & Co. - Conn.; Perm-A-Barrier Liquid.
 - 2) Henry Company; Air-Bloc 32MR.
 - 3) Rubber Polymer Corporation, Inc.; Rub-R-Wall Airtight.
 - 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
 - b. Vapor Permeance: Maximum 0.08 perm; ASTM E 96/E 96M.
 - c. Ultimate Elongation: Minimum 500 percent; ASTM D 412, Die C.

2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.
- B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.
- C. Counterflashing Strip: Modified bituminous, 40-mil- thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil- thick, cross-laminated polyethylene film with release liner backing.
- D. Modified Bituminous Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
- E. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.
- F. Sprayed Foam Sealant: Refer to Division 07 Section "Thermal Insulation" for spray foam insulation applied at doors and windows.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Modified Bituminous Transition Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
- H. Expansion/Seismic Joint: Provide Elastomeric Flashing Sheet; ASTM D 2000, minimum 50- to 65-mil- thick, cured sheet neoprene with manufacturer-recommended contact adhesives and lap sealant with stainless-steel termination bars and fasteners.
- I. Joint Sealant: Provide one of the following:
 - 1. Dow Corning Corporation; 790.
 - 2. GE Construction Sealants; SCS2700 SilPruf LM.
 - 3. Tremco Incorporated: Spectrem 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
 - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
 - 1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of 3 inches (75 mm) along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.
- B. Expansion/Seismic Joints: Install elastomeric flashing sheet loosely over joint to form bellows. Install lap sealant and termination bars to complete wall seal. Provide mineral wool insulation between air barrier expansion joint and exterior wall expansion joint cover system.

3.4 TRANSITION STRIP INSTALLATION

- A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact. Roll firmly to enhance adhesion.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- H. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- I. Seal top of through-wall flashings to air barrier with an additional 6-inch- wide, modified bituminous strip.
- J. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- K. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

- A. Apply fluid air-barrier membrane over concrete masonry walls only.
- B. General: Spray-apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges. Roller application is not acceptable.
 - 1. Apply primer to substrates at required rate and allow it to dry.
 - 2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 3. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
 - 1. Vapor-Retarding Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil dry film thickness, applied in one or more equal coats.
- D. Apply strip and transition strip a minimum of 1 inch onto cured air-barrier material or strip and transition strip over cured air-barrier material overlapping 3 inches onto each surface according to air-barrier manufacturer's written instructions.
- E. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform inspections.
- B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2. Continuous structural support of air-barrier system has been provided.
 - 3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
 - 4. Site conditions for application temperature and dryness of substrates have been maintained.
 - 5. Maximum exposure time of materials to UV deterioration has not been exceeded.
 - 6. Surfaces have been primed, if applicable.
 - 7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 - 8. Termination mastic has been applied on cut edges.
 - 9. Strips and transition strips have been firmly adhered to substrate.
 - 10. Compatible materials have been used.
 - 11. Transitions at changes in direction and structural support at gaps have been provided.
 - 12. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 - 13. All penetrations have been sealed.
- C. Air barriers will be considered defective if they do not pass tests and inspections.
 - 1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.7 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 6 months, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION 072726

SECTION 074213 - METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Metal soffit panels.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop- and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
 - a. Flashing and trim.
 - b. Anchorage systems.
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
 - 2. Include manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each sealant exposed to view.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Soffit Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.
 - 2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
 - 3. Accessories: 12-inch- long Samples for each type of accessory.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and soffit-mounted items. Show the following:
 - 1. Soffit panels and attachments.
 - 2. Penetrations of soffit by fixtures.
- F. Maintenance Data: For metal panels to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- C. Source Limitations: Obtain each type of metal panel from single source from single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panel for period of metal panel installation.

1.6 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of structural members and opening dimensions by field measurements before metal panel fabrication, and indicate measurements on Shop Drawings.

1.7 WARRANTY

- A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
 2. Surface: Smooth, flat finish.
 3. Exposed Coil-Coated Finish:
 - a. 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 MISCELLANEOUS MATERIALS

- A. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.3 METAL SOFFIT PANELS

- A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and flat pan between panel edges; with flush joint between panels.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Artisan Series L-8 by Metl-Span or comparable product by one of the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. AEP-Span.
 - b. ATAS International, Inc.
 - c. Firestone Metal Products.
 - d. Metecno-Morin.
2. Material: Zinc-coated (galvanized) steel sheet, 24 gage nominal thickness.
 - a. Exterior Finish: 2-coat fluoropolymer.
 - b. Color: As selected by Architect from manufacturer's full range.
 3. Panel Coverage: 8 inches.
 4. Panel Height: 1.0 inch.

2.4 ACCESSORIES

- A. Soffit Panel Accessories: Provide components required for a complete metal panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels, unless otherwise indicated.
 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from same material and thickness as panel. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal soffit panels.

2.5 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Fabricate metal panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, and that will minimize noise from movements within panel assembly.
- E. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application but not less than thickness of metal being secured.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of work.
 - 1. Examine soffit framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before metal panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 METAL SOFFIT PANEL INSTALLATION

- A. In addition to complying with requirements of "Metal Wall Panel Installation, General" Article, install metal soffit panels to comply with the requirements of this article.
- B. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
 1. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.

3.3 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 1. Install components required for a complete metal soffit panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213

SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Adhered EPDM membrane roofing system.
2. Roof insulation.
3. Walkway pads.
4. Fascia system.
5. Expansion joints.

B. Products installed, but not furnished, under this Section include the following:

1. Roof drains furnished under Division 22 Section "Plumbing".

1.3 DEFINITIONS

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened membrane roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
5. Fascia system.

- C. Samples for Verification: For the following products, in manufacturer's standard color options:

1. Fascia system.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer.
- B. Manufacturer's installation rating of the roofing contractor.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
- D. Warranties: Sample of special warranties.
- E. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For membrane roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for membrane roofing system identical to that used for this Project.
- B. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing roofing similar to that required for this Project and who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product. Contractor shall have installed a minimum of 500,000 square feet and have a manufacturer's installation rating of 9.0 or better.
 - 1. Installer for GAF products shall be a Master Select or Master Certified Contractor.
 - 2. Work associated with single-ply membrane roofing, including (but not limited to) insulation, flashing, and membrane sheet joint sealers, shall be performed by Installer of this Work.
- C. Preinstallation Roofing Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Review governing regulations and requirements for insurance and certificates if applicable.
 8. Review temporary protection requirements for roofing system during and after installation.
 9. Review roof observation and repair procedures after roofing installation.
- D. Upon completion of the installation, an inspection shall be made by the system manufacturer to ascertain that the roofing system has been installed according to the applicable manufacturer's specifications and details. No "early bird" warranty will be accepted. The results of the warranty inspection shall be submitted in writing to Owner for their review and records.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.9 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

- A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. A manufacturer's sole source 20-year written Total Roofing System Warranty shall be provided with a peak gust wind speed limitation of 90 mph (measured 30 feet above the ground). Warranty shall cover both labor and materials with no dollar limitation and shall state that the Total roofing System will remain in a watertight condition. The contractor shall provide as part

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

of the shop drawing submittal process, certification indicating that the manufacturer has reviewed and has agreed to such wind coverage indicated.

1. Total Roofing System is defined as the following materials and provided by the roof system manufacturer: membrane, flashings, counterflashings, adhesives, sealants, insulation, overlayment, fasteners, fastener plates, fastener strips, hard rubber, metal edging, preformed fascia system. Metal termination anchor bars, roof drain flashing and sealants, and any other product utilized in this system installation.
2. The warranty shall be for twenty (20) years starting after final acceptance of the total roofing system by the roof system manufacturer. Defective materials or installation shall be removed, properly disposed of, and replaced at the manufacturer's expense.
3. The warranty shall provide that if within the warranty period the roofing system becomes non-watertight or if the elastomeric sheet splits, tears, or separates at the seams because of defective materials and/or materials and cost thereof shall be the responsibility of the manufacturer. Should the manufacturer or his approve applicator fail to perform repairs within 72 hours of notification, the warranty will not be voided because of work being performed by others to repair the roofing regardless of the manufacturer's warranty to the contrary.
4. The total Roofing System shall be applied by a roofing Contractor approved by the system manufacturer. After inspection and acceptance of the installed roof system, the warranty will be issued.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist wind speed of 90 mph (measured 30 feet above the ground).

2.2 EPDM MEMBRANE ROOFING

- A. EPDM: ASTM D 4637, Type I, non-reinforced, uniform, flexible EPDM sheet.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- c. GAF Materials Corporation.
 - d. Versico Incorporated.
- 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: Black.

2.3 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
 - 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Single-Ply Roof Membrane Adhesives: 250 g/L.
 - f. Single-Ply Roof Membrane Sealants: 450 g/L.
 - g. Nonmembrane Roof Sealants: 300 g/L.
 - h. Sealant Primers for Nonporous Substrates: 250 g/L.
 - i. Sealant Primers for Porous Substrates: 775 g/L.
 - j. Other Adhesives and Sealants: 250 g/L.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.
- C. Protection Sheet: Epichlorohydrin or neoprene non-reinforced flexible sheet, 55- to 60-mil-thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
- D. Bonding Adhesive: Manufacturer's standard, State of Maine VOC Compliant.
- E. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 6-inch- wide minimum, butyl splice tape with release film.
- F. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.
- G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- H. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.4 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation.
- B. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. minimum density, square edged.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.
 - d. Pactiv Corporation.
 - 2. Thickness: As indicated on the drawings.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.5 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Full-spread spray-applied, low-rise, two-component urethane adhesive.
- D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick, factory primed.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Georgia-Pacific Corporation; Dens Deck Prime.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

2.7 FASCIA SYSTEM

- A. Provide fasciae in shapes and sizes indicated. Include anchor plates; cleats or other attachment devices; concealed splice plates; and trim and other accessories indicated or required for complete installation, with no exposed fasteners.
 - 1. Provide scupper components where indicated on the drawings.
- B. Provide exposed fascia components fabricated from the following metal:
 - 1. Extruded aluminum in thickness indicated, but not less than 0.040 inch.
 - 2. Finish: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 1402, Test Method 7. Color as selected by the Architect.
 - 3. Product:
 - a. Hickman: Extruded TerminEdge Roof Edging.
 - b. Metal-Era: Anchor-Tite Fascia System.
 - c. Provide face size as indicated on the drawings.

2.8 EXPANSION JOINTS

- A. Deck-To-Wall Expansion Joints: Provide manufacturers standard joint system consisting of expansion joint support or support sponge and EPDM flashing.
- B. Product: C/S Model BrJW-300 WC with SSF-300 and RFX-3F or approved substitute.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- G. Loosely Laid Insulation: Loosely lay insulation units over substrate.
- H. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft., and allow primer to dry.
 2. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- I. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together.
- J. Metal Roof Decks:
1. Fasten cover boards through insulation according to requirements of manufacturer for specified warranty and performance.
- K. Concrete Roof Decks:
1. Set cover board on layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.4 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere membrane roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
- B. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
- D. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
- E. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
- F. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
- G. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
- H. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.5 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings.

3.6 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
- B. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches of space between adjacent roof pavers.

3.7 ROOF DRAIN INSTALLATION

- A. Install roof drain and accessories in strict accordance with manufacturer's written instructions, providing a permanent weather tight installation.
 - 1. Inspect and determine substrate to be in satisfactory condition, with deck fully anchored and aligned at proper location and elevation. All surfaces shall be smooth, dry, clean, free of sharp edges, and other irregularities.
 - 2. Attach deck flange securely to substrate.
 - 3. Assemble and flash gravel stop flange into roof system per roof system and roof drain manufacturer requirements.
 - 4. Securely attach strainer basket.

3.8 FASCIA SYSTEM INSTALLATION

- A. Comply with manufacturer's written installation instructions. Anchor products securely to structural substrates to withstand lateral and thermal stresses and inward and outward loading pressures.
- B. Expansion Provisions: Install running lengths to allow controlled expansion for movement of metal components in relation not only to one another but also to adjoining dissimilar materials,

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

including flashing and roofing membrane materials, in a manner sufficient to prevent water leakage, deformation, or damage.

3.9 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
 - 1. Notify Architect or Owner 48 hours in advance of the date and time of inspection.
- B. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
- C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075323

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Formed Products:
 - a. Formed wall sheet metal fabrications.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
 - 1. Identification of material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details of connections to adjoining work.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Engage an experience Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.
 - 1. Finish: 2D (dull, cold rolled).
 - 2. Surface: Smooth, flat.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal unless otherwise indicated.
- B. Solder:
 - 1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
 - 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 2. Obtain field measurements for accurate fit before shop fabrication.
 - 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
- B. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

2.5 WALL SHEET METAL FABRICATIONS

- A. Opening Flashings in Frame Construction: Fabricate sill pan flashings to extend 8 inches beyond wall openings. Form sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
 - 1. Stainless Steel: 0.019 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Set sheet metal flashing and trim and other components of the Work securely in place. Use solder and other miscellaneous items as required to complete sheet metal flashing and trim system.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3.3 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous sill pan flashings to extend 8 inches beyond wall openings.

3.4 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 078100 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes sprayed fire-resistive materials (SFRM).

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Framing plans, schedules, or both, indicating the following:
 - 1. Extent of fireproofing for each construction and fire-resistance rating.
 - 2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
 - 3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
 - 4. Treatment of fireproofing after application.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fireproofing.
- B. Evaluation Reports: For fireproofing, from ICC-ES.
- C. Preconstruction Test Reports: For fireproofing.
- D. Field quality-control reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
- B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 or UL 263 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. Asbestos: Provide products containing no detectable asbestos.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

- A. Concealed SFRM: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carbolite Company, subsidiary of RPM International, Fireproofing Products Div.; AD Southwest Fireproofing Type 5GP.
 - b. Grace, W. R. & Co. - Conn.; Grace Construction Products; Monokote MK-6 Series.
 - c. Isolatek International; Cafco 300.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Bond Strength: Minimum 150-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
2. Density: Not less than 15 lb/cu. ft. and as specified in the approved fire-resistance design, according to ASTM E 605.
3. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.375 inch.
4. Combustion Characteristics: ASTM E 136.
5. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 10 or less.
 - b. Smoke-Developed Index: 0.
6. Compressive Strength: Minimum 1,200 lbf/sq. in. according to ASTM E 761.
7. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
8. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
9. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
10. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. in 24 hours according to ASTM E 859.
11. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G 21.
12. Finish: Spray-textured finish.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
 1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.
- C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fireproofing.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:
 - 1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
 - 2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
 - 3. Substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.
- B. Verify that concrete work on steel deck has been completed before beginning fireproofing work.
- C. Verify that roof construction, installation of roof-top HVAC equipment, and other related work is complete before beginning fireproofing work.
- D. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.
- B. Clean substrates of substances that could impair bond of fireproofing.
- C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

- A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.
- B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.
 - 1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
 - 2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.
- D. Metal Decks:
 - 1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, has been completed.
 - 2. Do not apply fireproofing to underside of metal roof deck until roofing has been completed; prohibit roof traffic during application and drying of fireproofing.
- E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.
- F. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.
- G. Extend fireproofing in full thickness over entire area of each substrate to be protected.
- H. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.
- I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fireproofing that differs in color from that of encapsulant over which it is applied.
- J. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- K. Cure fireproofing according to fireproofing manufacturer's written recommendations.
- L. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.
- M. Finishes: Where indicated, apply fireproofing to produce the following finishes:
 - 1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Test and inspect as required by the IBC, 1704.10.
- B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- C. Fireproofing will be considered defective if it does not pass tests and inspections.
 - 1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
 - 2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.
- D. Prepare test and inspection reports.

3.5 CLEANING, PROTECTING, AND REPAIRING

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
- B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.
- C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.
- D. Repair fireproofing damaged by other work before concealing it with other construction.
- E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078100

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in smoke barriers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
 - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

requirements. Manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

- B. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
 - b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
- C. Special Inspections: Allow for 1 of each type of firestopping system to be removed and inspected for conformance with approved submittals. All firestopping shall be inspected prior to the installation of ceilings.
- D. Above Ceiling review: Prior to the installation of ceilings, a review of construction completion shall be conducted for firestopping and other items that will not be visible when the ceilings have been installed.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include those systems indicated that are produced by one of the following manufacturers:
 - 1. Grace, W. R. & Co. - Conn.
 - 2. Hilti, Inc.
 - 3. Nelson Firestop Products.
 - 4. RectorSeal Corporation (The).
 - 5. Specified Technologies Inc.
 - 6. 3M; Fire Protection Products Division.
 - 7. Tremco; Sealant/Weatherproofing Division.
 - 8. USG Corporation.

2.2 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.
- D. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.3 FILL MATERIALS

- A. General: Provide through-penetration firestop systems containing the types of fill materials as required by UL approved Through-Penetration Firestop System. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- D. Elastomeric Spray: Single component, water-based elastomeric compound.
- E. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- F. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- H. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- I. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- J. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
- K. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- L. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
- M. Unfaced, Slag-Wool-/Rock-Wool-Fiber Board Insulation: ASTM C 612, maximum flame-spread and smoke-developed indices of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics; and of the following density, type, thermal resistivity, and fiber color:
 - 1. Nominal density of 4 lb/cu. ft., Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F.
 - 2. Color: Natural.
 - 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fibrex Insulations Inc.
 - b. Owens Corning.
 - c. Thermafiber.

2.4 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Through-penetration firestop system designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Through-penetration firestop system manufacturer's name.
 6. Installer's name.
- B. Do not install identification on exposed finished wall locations.

3.5 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
- C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. Reinstall firestopping materials that have been removed for inspection.

3.6 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Joints in or between fire-resistance-rated constructions.
 - 2. Joints in smoke barriers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
 - 1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

- B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
 - 1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
 - a. Fire-resistive joint system products bear classification marking of qualified testing agency.
 - b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
- C. Special Inspections: Allow for 1 of each type of firestopping system to be removed and inspected for conformance with approved submittals. All firestopping shall be inspected prior to the installation of ceilings.
- D. Above Ceiling review: Prior to the installation of ceilings, a review of construction completion shall be conducted for firestopping and other items that will not be visible when the ceilings have been installed.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.
- C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:
 - 1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 - 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Grace Construction Products.
 - b. Hilti, Inc.
 - c. Nelson Firestop Products.
 - d. RectorSeal Corporation.
 - e. Specified Technologies Inc.
 - f. 3M Fire Protection Products.
 - g. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - h. USG Corporation.
- C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.
 - 1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Grace Construction Products.
 - b. Hilti, Inc.
 - c. Nelson Firestop Products.
 - d. RectorSeal Corporation.
 - e. Specified Technologies Inc.
 - f. 3M Fire Protection Products.
 - g. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - h. USG Corporation.
- D. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. VOC Content: Fire-resistive joint system sealants shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply fill materials so they contact and adhere to substrates formed by joints.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.
- B. Do not install identification on exposed finished wall locations.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
- C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.
- D. Reinstall firestopping materials that have been removed for inspection.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.6 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Latex joint sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- C. Warranties: Sample of special warranties.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
 1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Sealant Type 1: Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant; ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 790 (VOC 43); 756 SMS (VOC 87) for cold applications.
 - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - c. Pecora Corporation; 890 (VOC na).
 - d. Sika Corporation, Construction Products Division; SikaSil-C990.
 - e. Tremco Incorporated; Spectrem 1 (VOC 1).
- B. Sealant Type 2: Not Used.
- C. Sealant Type 3: Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant; ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; 301 NS (VOC 50).
 - b. Tremco Incorporated; Spectrem 800 (VOC 1).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Sealant Type 4: Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 786(VOC 33) (Food)
 - b. GE Advanced Materials - Silicones; Sanitary SCS1700.
 - c. Tremco Incorporated; Tremsil 200 Sanitary (VOC 1).

2.3 LATEX JOINT SEALANTS

- A. Sealant Type 5: Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems; Sonolac (VOC 41).
 - b. Bostik, Inc.; Chem-Calk 600.
 - c. Pecora Corporation; AC-20 (VOC 31).
 - d. Tremco Incorporated; Tremflex 834.

2.4 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - 1. Use Type O (open cell material) at metal-to-metal joints.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Exterior Isolation and Contraction Joints in Cast-in-place Concrete Slabs.
 - 1. Silicone Joint Sealant: Sealant Type 3.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Exterior Control, Expansion, and Soft Joints in Masonry and Between Masonry and Adjacent Work.
 - 1. Silicone Joint Sealant: Sealant Type 1.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Exterior Control, Expansion, and Soft Joints Between Masonry and Metal Door Frames, Windows, Storefronts and Curtain Walls.
 - 1. Silicone Joint Sealant: Sealant Type 1.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Under Exterior Door Thresholds.
 - 1. Silicone Joint Sealant: Sealant Type 1.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Exterior Joints for Which No Other Sealant Type is Indicated.
 - 1. Silicone Joint Sealant: Sealant Type 1.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Interior Isolation and Contraction Joints in Cast-In-Place Concrete Slabs.
 - 1. Silicone Joint Sealant: Sealant Type 3.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Concealed Interior Perimeter Joints of Exterior Openings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Silicone Joint Sealant: Sealant Type 1.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- H. Exposed Interior Perimeter Joints of Exterior Openings.
1. Silicone Joint Sealant: Sealant Type 1.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- I. Perimeter Joints Between Interior Wall Surfaces and Frames of Interior Doors and Windows.
1. Latex Joint Sealant: Sealant Type 5.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- J. Joints between Plumbing Fixtures and Walls and Floors and Between Countertops and Walls.
1. Silicone Joint Sealant: Sealant Type 4.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- K. Interior Joints for Which No Other Sealant is Indicated.
1. Latex Joint Sealant: Sealant Type 5.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 079500 - EXPANSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Architectural joint systems for building interiors.
 - 2. Architectural joint systems for building exteriors.

1.3 DEFINITIONS

- A. Maximum Joint Width: Widest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
- B. Minimum Joint Width: Narrowest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
- C. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (mm or inches) or a percentage (plus or minus) of nominal value of joint width.
- D. Nominal Joint Width: The width of the linear opening specified in practice and in which the joint system is installed.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blackout requirement, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- B. Samples: For each exposed expansion control system and for each color and texture specified, full width by 6 inches long in size.
- C. Samples for Initial Selection: For each type of expansion control system indicated.
 - 1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Samples for Verification: For each type of expansion control system indicated, full width by 6 inches long in size.
- E. Product Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - 1. Manufacturer and model number for each expansion control system.
 - 2. Expansion control system location cross-referenced to Drawings.
 - 3. Nominal joint width.
 - 4. Movement capability.
 - 5. Classification as thermal or seismic.
 - 6. Materials, colors, and finishes.
 - 7. Product options.
 - 8. Fire-resistance ratings.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each fire barrier provided as part of an expansion control system, for tests performed by a qualified testing agency.

1.6 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of architectural joint systems and are based on the specific systems indicated. Refer to Division 01 Section "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.7 COORDINATION

- A. Coordinate installation of exterior wall joint systems with roof expansion assemblies to ensure that wall transitions are watertight. Roof expansion assemblies are specified in Division 07.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum: ASTM B 221, Alloy 6063-T5 for extrusions; ASTM B 209, Alloy 6061-T6 for sheet and plate.
 - 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
 - 2. Mill Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Elastomeric Seals: Preformed elastomeric membranes or extrusions to be installed in metal frames.
- C. Moisture Barrier: Flexible elastomeric material, Santoprene.
- D. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.2 ARCHITECTURAL JOINT SYSTEMS, GENERAL

- A. General: Provide architectural joint systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
 - 1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where joint changes direction or abuts other materials.
 - 2. Include factory-fabricated closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint systems.
- B. Design architectural joint systems for the following size and movement characteristics:
 - 1. Nominal Joint Width: As indicated.
 - 2. Maximum Joint Width: As indicated.
 - 3. Minimum Joint Width: As indicated.
 - 4. Movement Capability: As indicated.
 - 5. Type of Movement: As indicated.

2.3 ARCHITECTURAL JOINT SYSTEMS FOR BUILDING INTERIORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the products specified in individual subparagraphs below as basis-of-design products or a comparable product by one of the following:
 - 1. Architectural Art Mfg., Inc.
 - 2. Construction Specialties, Inc.
 - 3. JointMaster/InPro Corporation.
 - 4. MM Systems Corporation.
- B. Wall-to-Wall Joint Systems:
 - 1. Basis-of-Design Product: Balco type WD-2 for flat wall conditions and Balco type WDC-2 for corner wall conditions or a comparable product.
 - 2. Nominal Joint Width: 2 inches.
 - 3. Movement Capability: Plus or minus 2 inches.
 - 4. Type of Movement Capability: Expansion and contraction.
 - 5. Exposed Cover Material: Primed paint finish aluminum for field painting.
 - 6. Frame Material: Mill finish aluminum.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

C. Wall-to-Ceiling Joint Systems:

1. Basis-of-Design Product: Balco type AC-30 or a comparable product.
2. Nominal Joint Width: 3 inches.
3. Movement Capability: Plus or minus 3 inches.
4. Type of Movement Capability: Expansion and contraction.
5. Retainer Material: Mill finish aluminum.
6. Preformed Seal Material: Santoprene.
 - a. Seal Color: White.

2.4 ARCHITECTURAL JOINT SYSTEMS FOR BUILDING EXTERIORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the products specified in individual subparagraphs below as basis-of-design products or a comparable product by one of the following:

1. Architectural Art Mfg., Inc.
2. Construction Specialties, Inc.
3. JointMaster/InPro Corporation.
4. MM Systems Corporation.

B. Architectural Joint Systems for Exterior Walls:

1. Basis-of-Design Product: Balco type FCVS-2 or a comparable product.
2. Nominal Joint Width: 2 inches.
3. Movement Capability: Plus 2 inches and minus 1 inches.
4. Type of Movement Capability: Expansion and contraction.
5. Cyclic-Movement-Test-Response Characteristics: No evidence of visual fatigue, inability to cycle between designated joint widths, or other types of failure as determined by testing products identical to those indicated per ASTM E 1399 including Appendix X3.
6. Preformed Seal Material: Santoprene.
 - a. Seal Color: As selected by Architect.
7. Moisture Barrier: Provide manufacturer's standard unit.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces where architectural joint systems will be installed for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to architectural joint system manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing joint systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of joint systems.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing architectural joint assemblies and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install joint systems.
 - 1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 - 2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper joint installation and performance.
 - 3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
 - 4. Locate in continuous contact with adjacent surfaces.
 - 5. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.
- C. Seals in Metal Frames: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
 - 1. Provide in continuous lengths for straight sections.
 - 2. Seal transitions according to manufacturer's written instructions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
 - 3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- D. Terminate exposed ends of joint assemblies with field- or factory-fabricated termination devices.
- E. Water Barrier: Provide water barrier at exterior joints and where called for on Drawings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over joints. Reinstall cover plates or seals prior to Substantial Completion of the Work.

END OF SECTION 079500

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes hollow-metal work.

1.3 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. General: Submittals for Sections 081113, 081416 and 087100 shall be made concurrently.
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.
- C. Shop Drawings: Include the following:
 - 1. Elevations of each door design.
 - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
- D. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Standard Steel Doors and Frames:
 - a. Ceco Door Products; an Assa Abloy Group company.
 - b. Curries Company.
 - c. Steelcraft; a division of Ingersoll-Rand.
- B. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.3 INTERIOR DOORS AND FRAMES

- A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2..
 - 1. Physical Performance: Level B according to SDI A250.4.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch.
 - d. Edge Construction: Model 2, Seamless.
 - a. Core: Kraft-paper honeycomb.
 - 3. Frames:
 - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
 - b. Construction: Face welded Full profile welded.
 - 4. Exposed Finish: Factory primed.

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.
 - 1. Physical Performance: Level B according to SDI A250.4.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A60 coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
 - 1) Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 10.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 - 3. Frames:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
 - b. Construction: Face welded.
4. Exposed Finish: Factory primed.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A60 metallic coating.

1. Wipe Coat Galvanneal materials will not be considered acceptable.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

H. Glazing: Comply with requirements in Division 08 Section "Glazing."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

- B. Hollow Metal Doors:

1. Fire Door Cores: As required to provide fire-protection ratings indicated.
2. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches.
3. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
4. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
5. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
6. Full hinge cut-outs for non-handed doors will not be acceptable.

- C. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.
 - b. Compression Type: Not applicable.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. Head Anchors: Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
 7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- D. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 4. Provide loose stops and moldings on inside of hollow-metal work.
 5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.9 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
- C. At exterior walls and masonry walls, coat inside of frame profile with bituminous coating to a thickness of 1/16 inch.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames. Fill exterior frames with foam insulation.
 4. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
 - c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
 - d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 3. Smoke-Control Doors: Install doors according to NFPA 105.
- D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.
4. Factory glazing of wood doors.

1.3 ACTION SUBMITTALS

- A. General: Submittals for Sections 081113, 081416 and 087100 shall be made concurrently.
- B. Product Data: For each type of door indicated. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 1. Indicate dimensions and locations of mortises and holes for hardware.
 2. Indicate dimensions and locations of cutouts.
 3. Indicate requirements for veneer matching.
 4. Indicate doors to be factory finished and finish requirements.
 5. Indicate fire-protection ratings for fire-rated doors.

D. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of warranty.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products to match existing by the following:
 - 1. Flush Wood Doors:
 - a. Graham Wood Doors; an Assa Abloy Group company.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
- B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 and UL 10C.
 - 1. Include all requirements as part of the door construction per Category “A” guidelines.”
 - 2. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 - 3. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
- D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.
- E. Particleboard-Core Doors:
 - 1. Particleboard: ANSI A208.1, Grade LD-2, 32 lbs/ft² density.
 - 2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
- F. Structural-Composite-Lumber-Core Doors:
 - 1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf.
 - b. Screw Withdrawal, Edge: 400 lbf.
 - 2. Provide doors with structural-composite-lumber cores instead of particleboard cores for the following doors:
 - a. Doors indicated to receive exit devices.
 - b. Doors where oversized glass lites exceed more than 40 percent of the door surface area.
 - c. Doors where louvers exceed more than 40 percent of the door surface area.
- G. Mineral-Core Doors:
 - 1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 - 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
 - 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - a. Screw-Holding Capability: 550 lbf per WDMA T.M.-10.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Grade: Premium, with Grade A faces.
2. Species: Red oak.
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Pair and Set Match: Provide for doors hung in same opening.
7. Exposed Vertical Edges: Same species as faces - edge Type A.
8. Core: Particleboard except where structural composite lumber is required.
9. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.

2.4 LIGHT FRAMES

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
1. Wood Species: Same species as door faces.
 2. Profile: Flush rectangular beads.
 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.
1. Color: As selected by Architect.

2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
1. Comply with requirements in NFPA 80 for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- C. Openings: Cut and trim openings through doors in factory.
1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Finish doors at factory.
- C. Transparent Finish:
 - 1. Grade: Premium.
 - 2. Finish: WDMA TR-4 conversion varnish or TR-6 catalyzed polyurethane.
 - 3. Staining: Graham, #600 Wheat.
 - 4. Effect: Open-grain finish.
 - 5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Division 08 Section "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
 - 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
 - 2. Install smoke- and draft-control doors according to NFPA 105.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Access doors and frames for ceilings, unless specified elsewhere.
 - 2. Floor access doors and frames.

1.3 SUBMITTALS

- A. Product Data: For each type of access door and frame indicated. Include construction details, materials, individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.
- C. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.
- D. Ceiling Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim are shown and coordinated with each other.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain access doors and frames through one source from a single manufacturer.
- B. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, electrical or other concealed work, and indicate in the schedule specified in "Submittals" Article.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Where access doors are required for access to electrical junction boxes or panels located above non-accessible ceilings, the subcontractor installing the boxes or panels will be responsible for furnishing access doors, or relocate boxes and panels to accessible locations.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR CEILINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Acudor Products, Inc.
 2. Babcock-Davis.
 3. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
 4. Karp Associates, Inc.
 5. Larsen's Manufacturing Company.
 6. Milcor Inc.
 7. Nystrom, Inc.
 8. Williams Bros. Corporation of America (The).
- B. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Ceiling surfaces.
 3. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage.
 - a. Finish: Factory prime.
 4. Frame Material: Same material, thickness, and finish as door.
 5. Hinges: Manufacturer's standard.
 6. Latch: Cam latch operated by screwdriver with interior release.

2.2 FLOOR ACCESS DOORS AND FRAMES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Bilco K-1 or comparable product by one of the following:
1. Acudor Products, Inc.
 2. Babcock-Davis.
 3. Dur-Red Products.
 4. Karp Associates, Inc.
 5. Milcor Inc.
 6. Nystrom, Inc.
 7. Williams Bros. Corporation of America (The).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Floor Doors, General: Equip each door with adjustable counterbalancing springs, heavy-duty hold-open arm that automatically locks door open at 90 degrees, release handle with red vinyl grip that allows for one-handed closure, and recessed lift handle.
- C. Aluminum Floor Door: Single-leaf opening. Extruded-aluminum angle frame with 1/4-inch-thick, diamond-pattern, aluminum tread plate door; nonwatertight; loading capacity to support 150-lbf/sq. ft. pedestrian live load.
- D. Hardware: Provide the following:
 - 1. Hinges: Heavy-duty, zinc-coated steel butt hinges with stainless-steel pins.
 - 2. Latch: Stainless-steel slam latch with removable handle.
 - 3. Hardware Material: Manufacturer's standard.

2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.
- D. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- E. Frame Anchors: Same type as door face.
- F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
 - 1. Exposed Flanges: Nominal 1 to 1-1/2 inches wide around perimeter of frame.
 - 2. Provide mounting holes in frames for attachment of units to metal or wood framing.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel and Metallic-Coated-Steel Finishes:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
- E. Aluminum Finishes:
 - 1. Mill finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

3.3 SCHEDULE

- A. Ceilings: 24 by 24 inch door, unless noted otherwise.

END OF SECTION 083113

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Storefront framing for punched openings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of aluminum-framed systems.
 - 2. Include design calculations.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.4 INFORMATIONAL SUBMITTALS

- A. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.
- C. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
 - 1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- D. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
- E. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures including, but not limited to, excessive deflection.
- b. Noise or vibration caused by thermal movements.
- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- d. Water leakage through fixed glazing and framing areas.
- e. Failure of operating components.

2. Warranty Period: Two years from date of Substantial Completion.

- B. Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

- B. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
2. Dimensional tolerances of building frame and other adjacent construction.
3. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Noise or vibration created by wind and by thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Sealant failure.
 - g. Failure of operating units.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below them to less than 1/8 inch and clearance between members and operable units directly below them to less than 1/16 inch.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.
- E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft..

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
- H. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- I. Energy Performance: Certify and label energy performance according to NFRC as follows:
 - 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
 - 2. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than the following values as determined according to NFRC 500.
 - a. Frame: 62.
 - b. Glass: 68.
- J. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 - 2. Interior Ambient-Air Temperature: 75 deg F.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide indicated products by one of the following:
 - 1. EFCO Corporation.
 - 2. Kawneer North America; an Alcoa company.
 - 3. Tubelite.
 - 4. Oldcastle Building Envelope company.
 - 5. YKK AP America Inc.
- B. Products:
 - 1. Exterior Aluminum Windows:
 - a. Kawneer: Trifab VG 451 T.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. EFCO: System 403.
- c. Tubelite: 4500 series.
- d. Oldcastle: 3000 Thermal MultiPlane.
- e. YKK AP: YES 45 TU.

2.3 FRAMING

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction:
 - a. Exterior: Thermally broken
 - 2. Glazing System: Retained mechanically with gaskets on four sides.
 - 3. Glazing Plane: Front.
 - 4. Exterior Jambs and Head Framing: Provide manufacturer's standard extruded aluminum continuous flat filler for use at jambs and head framing. This extrusion provides the necessary profile for sealing with the building air barrier system. Channel type jamb components will not be acceptable.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Subsills for Exterior Storefronts: Manufacturer's standard thermally broken extruded aluminum sill flashing, color to match framing. Provide .060 inch thick break metal sill where indicated.
- E. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 - 2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from stainless steel.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
 - 1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."
 - 1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.6 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from exterior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Storefront Framing: Fabricate framing in profiles indicated for flush glazing (without projecting stops). Provide subframes and reinforcing of types indicated or, if not indicated, as required for a complete system. Factory assemble components to greatest extent possible. Disassemble components only as necessary for shipment and installation.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

- A. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 08 Section "Glazing."

G. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
2. Alignment:
 - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

END OF SECTION 084113

SECTION 084229 - AUTOMATIC ENTRANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Exterior and interior, sliding, power-operated automatic entrances.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design automatic entrances, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Automatic entrances shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Operating Temperature Range: Provide automatic entrances that operate within minus 20 to plus 122 deg F.
- E. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 1.25 cfm/sq. ft. of fixed entrance system area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft..
- F. Opening-Force Requirements:
 - 1. Power-Operated Doors: Not more than 50 lbf required to manually set door in motion if power fails, and not more than 15 lbf required to open door to minimum required width.
 - 2. Breakaway Device for Power-Operated Doors: Not more than 50 lbf required for a breakaway door or panel to open.
 - 3. Accessible Interior Doors: Not more than 5 lbf to fully open door.
- G. Entrapment Force Requirements:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Power-Operated Sliding Doors: Not more than 30 lbf required to prevent stopped door from closing.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include activation and safety devices, components and finishes.
- B. Shop Drawings: For automatic entrances. Include plans, elevations, sections, details, hardware mounting heights, and attachments to other work.
 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Wiring Diagrams: For power, signal, and control wiring.
 3. Activation and safety devices.
 4. Include hardware schedule and indicate hardware types, functions, quantities, and locations.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Delegated-Design Submittal: For automatic entrances indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design Calculations: Calculate requirements for seismic restraints.
- E. Product Certificates: For each type of emergency-exit automatic entrance, from manufacturer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for automatic entrances.
- G. Field quality-control reports.
- H. Maintenance Data: For automatic entrances, safety devices, and control systems to include in maintenance manuals.
- I. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer with company certificate issued by AAADM.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project and who employs a certified inspector.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- C. Certified Inspector Qualifications: Certified by AAADM.
- D. Source Limitations for Automatic Entrances: Obtain automatic entrances from single source from single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Power-Operated Door Standard: BHMA A156.10.
- G. Emergency-Exit Door Requirements: Comply with requirements of authorities having jurisdiction for automatic entrances serving as a required means of egress.
- H. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to automatic entrances including, but not limited to, the following:
 - a. Structural load limitations.
 - b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Coordination with electrical, glazing, and other trades.
 - d. Required testing, inspecting, and certifying procedures.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings to receive automatic entrances by field measurements before fabrication.

1.7 COORDINATION

- A. Templates: Obtain templates for doors, frames, and other work specified to be factory prepared for installing automatic entrances, and distribute to parties involved. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic entrances to comply with indicated requirements.
- B. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.
- C. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Faulty operation of operators, controls, and hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 2. Sheet and Plate: ASTM B 209.
- B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
- C. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.
- D. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Glazing: As specified in Division 08 Section "Glazing."
- F. Sealants and Joint Fillers: As specified in Division 07 Section "Joint Sealants."
- G. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos; formulated for 30-mil thickness per coat.
- H. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.2 SLIDING AUTOMATIC ENTRANCES

- A. General: Provide manufacturer's standard automatic entrances including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, activation and safety devices, and accessories required for a complete installation.
- B. Sliding Automatic Entrance: Subject to compliance with requirements, provide products by one of the following:
 - 1. Products:
 - a. Besam Automated Entrance Systems, Inc.; an ASSA ABLOY Group Company; Unislide Model US23-3000-31.
 - b. Horton Automatics; Div. of Overhead Door Corporation; ProSlide Series 2003, Type 310, Model SO-SX-SX-SO.
 - c. Stanley Access Technologies: Dura-Glide 200 Series.
 - 2. Configuration: Biparting- sliding doors, with sidelites.
 - a. Traffic Pattern: Two way.
 - b. Emergency Breakaway Capability: Sliding leaves and sidelites.
 - c. Mounting: Between jambs with swing-out sidelites installed to exterior of swing-slide panels.
 - 3. Operator Features:
 - a. Power opening and closing.
 - b. Drive System: Belt.
 - c. Adjustable opening and closing speeds.
 - d. Adjustable hold-open time between 0 and 30 seconds.
 - e. Obstruction recycle.
 - f. On-off/hold-open switch to control electric power to operator.
 - g. Spring to reclose sliding doors and swinging sidelites if panels are pushed open.
 - h. Switch in sidelites that shall stop operation of automatic sliding panels when the sidelite is open.
 - 4. Sliding Door Carrier Assemblies and Overhead Roller Tracks: Manufacturer's standard carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

Support doors from carrier assembly by cantilever and pivot assembly. Anti-derailing shall be by a separate adjustable roller. Track shall be replaceable with having to remove operator.

- a. Rollers: Minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.
5. Sliding Door Threshold: Manufacturer's standard threshold members and bottom-guide track system, with stainless-steel, ball-bearing-center roller wheels.
- a. Configuration: Saddle-type or recessed threshold as indicated across door opening and guide track system at sidelites. At saddle-type installations, provide vertical square edge where threshold butts entrance matting.
6. Combination Activation and Safety Device: Combination motion/presence sensor.
7. Sidelite Safety Device: Presence sensor, mounted above each sidelite on side of door opening through which doors travel, to detect obstructions and to prevent door from opening.

2.3 ENTRANCE COMPONENTS

- A. Framing Members: Manufacturer's standard extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
1. Nominal Size: 1-3/4 by 4-1/2 inches.
 2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch wall thickness.
- B. Stile and Rail Doors: Manufacturer's standard 1-3/4-inch- thick, glazed doors with minimum 0.125-inch- thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.
1. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and manufacturer's standard preformed gaskets.
 2. Stile Design: Thin stile, less than 1-3/4-inch nominal width.
 3. Rail Design: 5-inch nominal height.
 4. Muntin Bars: Horizontal tubular rail member for each door; match stile design and finish.
- C. Sidelite(s): Manufacturer's standard 1-3/4-inch- deep sidelite(s) with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members matching door design and finish.
1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
 2. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and manufacturer's standard preformed gaskets.
 3. Muntin Bars: Horizontal tubular rail members for each sidelite; match stile design.
- D. Headers: Fabricated from minimum 0.125-inch- thick, extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.

1. Mounting: Surface mounted.
 2. Capacity: Capable of supporting doors up to 175 lb per leaf over spans up to 14 feet without intermediate supports.
- E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- F. Signage: Affixed to both sides of each door as required by BHMA A156.10 and BHMA A156.19 for type of door and its operation.
1. Application Process: Door manufacturer's standard process.
 2. Provide sign materials with instructions for field application after glazing is installed.

2.4 DOOR OPERATORS AND ACTIVATION AND SAFETY DEVICES

- A. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.
1. Door Operator Performance: Provide door operators that will open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
 2. Electromechanical Operators: Concealed, self-contained, overhead unit powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; UL 325; and with manual operation with power off.
 3. Microprocessor master controller shall provide the following:
 - a. Programmable speed values for Open Speed, Close Speed, Open Check, Close Check, and Open Cushion; Close Speed shall not exceed 12 inches per second.
 - b. Programmable time values for Full-Open Time Delay and Partial-Open Time Delay. Partial-Opening shall be adjustable in 1 inch increments.
 - c. Modes of Operation: Auto-Seal mode (self-close approximately every 11 seconds), Self-Cycle Test mode (operates door during tune-in process), Night mode power fail operation, Day mode autolock prevention, Day 1-Way, Day 2-Way, Night 2-Way, and Night 1-Way.
 - 1) In Day 1-Way mode, all sensors shall be enabled throughout the hold-open and closing modes for maximum safety in accordance with ANSI A156.10.
 - d. Auxiliary Override Input: Dedicated security input for opening doors under any mode condition.
 - e. Provide winter/summer limiting switch.
 - f. Digital display for diagnostic evaluation of electrical and mechanical functions.
 - g. Full digital adjustment capabilities providing precise door control and braking.
 - h. Dedicated interface connection.
 4. Revolution Encoder: Instructs master control on sliding panels speed and position.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

5. Adjustable Reversing Circuit: Operator shall reopen door unit if closing path is obstructed; maximum force required to prevent sliding panel from closing shall be 28 lbf.
 6. Finger Safety: When unit slide open, strike rail of sliding panel will stop short of adjacent sidelite; resulting opening is net slide.
 7. Power ON/OFF Switch: Located in header. When switched OFF or when there is an electrical power failure, unit shall revert to free manual operation.
- B. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units with metal or plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10; with relay hold time of not less than 2 to 10 seconds.
1. Provide capability for switching between bidirectional and unidirectional detection.
 2. For one-way-traffic entrances, sensor on egress side shall not be active when doors are fully closed.
- C. Presence Sensors: Self-contained, infrared-scanner units with metal or plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10; with relay hold time of not less than 2 to 10 seconds. Sensors shall remain active at all times.
- D. Combination Motion/Presence Sensors: Self-contained units; consisting of both motion and presence sensors in a single metal or plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.
1. Motion Sensor: K-band-frequency, microwave-scanner units; with relay hold time of not less than 2 to 10 seconds.
 - a. Provide capability for switching between bidirectional and unidirectional detection.
 - b. For one-way-traffic entrances, sensor on egress side shall not be active when doors are fully closed.
 2. Presence Sensor: Infrared-scanner units; with relay hold time of not less than 2 to 10 seconds. Sensors shall remain active at all times.
- E. Photoelectric Beams (In addition to presence sensors) (for sliding doors): Provide two pulsed infrared, sender-receiver assemblies for recessed mounting. Beams shall parallel door opening and shall serve a hold-open when interrupted. Beams shall not be active when doors are fully closed.
- F. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.
- G. Opening-Width Control: Two-position switch that in the normal position allows sliding doors to travel to full opening width and in the alternate position reduces opening to a selected partial opening width.

2.5 HARDWARE

- A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Breakaway Device for Power-Operated Doors: Provide breakaway device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Maximum force to open door shall be 50 lbf according to BHMA A156.10. Interrupt powered operation of door operator while in breakaway mode.
- C. Automatic Locking for Sliding Door: Electrically controlled device mounted in header that automatically locks door against sliding when in closed position. Provide fail secure operation if power fails.
 - 1. Include concealed, vertical-rod exit devices, UL 305, with latching into threshold and overhead carrier assembly and released by full-width panic bar; and that prevent emergency breakaway doors from swinging and that permit emergency egress.
 - 2. Include locking devices for sidelites, to prevent manual break out.
- D. Thresholds: BHMA A156.21, extruded-aluminum raised thresholds; with beveled edges with a slope of not more than 1:2 and a maximum height of 1/2 inch. Provide cutouts as required for door operating hardware.
- E. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
 - 2. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
 - 3. Weather Sweeps: Manufacturer's standard nylon brush sweep mounted to underside of door bottom.

2.6 FABRICATION

- A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
 - 1. Form aluminum shapes before finishing.
 - 2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
 - 3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing.
 - a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - b. Reinforce members as required to receive fastener threads.
 - 4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Fabricate tubular and channel frame assemblies with manufacturer's standard welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
 2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 3. Form profiles that are sharp, straight, and free of defects or deformations.
 4. Provide components with concealed fasteners and anchor and connection devices.
 5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
 6. Fabricate exterior components to drain water passing joints and condensation and moisture occurring or migrating within system to the exterior.
 7. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
 8. Allow for thermal expansion of exterior units.
- C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
- D. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.
- E. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."
- F. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.
1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors and breakaway sidelites.
 2. Provide compression-type weather stripping at fixed stops of exterior doors. At locations without fixed stops, provide sliding-type weather stripping retained in adjustable strip mortised into door edge.
 3. Provide weather sweeps mounted to underside of door bottoms of exterior doors.
- G. Activation and Safety Devices:
1. General: Factory install devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.
 2. Install photoelectric beams in vertical jambs of sidelites, with dimension above finished floor as follows:
 - a. Top Beam: 48 inches.
 - b. Bottom Beam: 24 inches.

2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
 - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
 - 3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
 - 4. Provide thresholds at exterior doors.
- C. Door Operators: Connect door operators to electrical power distribution system as specified in Division 26 Sections.
- D. Access-Control Devices: Connect access-control devices to access-control system as specified in Division 28 Sections.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Activation and Safety Devices: Install and adjust devices to provide detection field and functions indicated.
- F. Glazing: Install glazing as specified in Division 08 Section "Glazing."
- G. Sealants: Comply with requirements specified in Division 07 Section "Joint Sealants" to provide weathertight installation.
 - 1. Set bottom-guide track system, framing members and flashings in full sealant bed.
 - 2. Seal perimeter of framing members with sealant.
- H. Signage: Apply signage on both sides of each door and breakaway sidelight as required by referenced door standards.
- I. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 FIELD QUALITY CONTROL

- A. Inspection: Engage Installer's certified inspector to test and inspect automatic entrances and prepare test and inspection reports.
 - 1. Certified inspector shall test and inspect each automatic entrance to determine compliance of installed systems with applicable BHMA standards.
 - 2. Inspection Report: Certified inspector shall submit report in writing to Architect and Contractor within 24 hours after inspection.
- B. Work will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING

- A. Adjust door operators, controls, and hardware for smooth and safe operation and for weathertight closure; comply with requirements in BHMA A156.10 and BHMA A156.19.
- B. Lubricate operating hardware and other moving parts as recommended by manufacturer.
- C. Readjust door operators and controls after repeated operation of completed installation equivalent to 3 days' use by normal traffic (100 to 300 cycles). Lubricate hardware, operating equipment, and other moving parts.

3.5 CLEANING AND PROTECTION

- A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
 - 1. Comply with requirements in Division 08 Section "Glazing" for cleaning and maintaining glass.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.6 DEMONSTRATION

- A. Engage a certified inspector to train Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION 084229

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Non-fire-rated sliding doors.
 - c. Non-fire-rated folding doors.
 - d. Other doors to the extent indicated.
 - 2. Cylinders for doors specified in other Sections.

1.3 ACTION SUBMITTALS

- A. General: Submittals for Sections 081113, 081416 and 087100 shall be made concurrently.
- B. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Samples for Verification: Submit minimum 2-by-4-inch plate Samples of each type of finish required, except primed finish.
- D. Other Action Submittals:
 - 1. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
 - b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - c. Content: Include the following information:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- 1) Identification number, location, hand, fire rating, and material of each door and frame.
 - 2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
 - 3) Complete designations of every item required for each door or opening including name and manufacturer.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - 6) Explanation of abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for door hardware.
 - 8) Door and frame sizes and materials.
 - 9) List of related door devices specified in other Sections for each door and frame.
- d. Submittal Sequence: Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in Project construction schedule. Submit the final door hardware sets after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.
2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For electrified door hardware, signed by product manufacturer.
1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches and closers.
- C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
- C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
- D. Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.
 - 1. Door Hardware: Provide hardware as required by accessibility regulations and requirements of authorities having jurisdiction. These include, but are not limited to, the following:
 - a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
 - b. Door Closers: Comply with the following maximum opening-force requirements indicated:
 - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
 - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.
 - 2. NFPA 101: Comply with the following for means of egress doors:
 - a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
 - b. Door Closers: Not more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.
 - c. Thresholds: Not more than 1/2 inch high.
- E. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.
- F. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.
- G. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Address for delivery of keys.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to electrified door hardware including, but not limited to, the following:

1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review required testing, inspecting, and certifying procedures.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to Owner by registered mail or overnight package service.

1.8 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Existing Openings: Where new hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide for proper operation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: One year from date of Substantial Completion, except as follows:
 - a. Exit Devices: Two years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements.
- C. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 HINGES, GENERAL

- A. Quantity: Provide the following, unless otherwise indicated:
 - 1. Two Hinges: For doors with heights up to 60 inches.
 - 2. Three Hinges: For doors with heights 61 to 90 inches.
 - 3. Four Hinges: For doors with heights 91 to 120 inches.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
- B. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
 - C. Hinge Weight: Unless otherwise indicated, provide the following:
 1. Entrance Doors: Heavy-weight hinges.
 2. Doors with Closers: Antifriction-bearing hinges.
 3. Interior Doors: Antifriction-bearing hinges.
 - D. Hinge Base Metal: Unless otherwise indicated, provide the following:
 1. Exterior Hinges: Stainless steel, with stainless-steel pin.
 2. Interior Hinges: Steel, with steel pin.
 3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.
 - E. Hinge Options: Where indicated in door hardware sets or on Drawings:
 1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors and outswinging corridor doors with locks.
 2. Corners: Square.
 - F. Fasteners: Comply with the following:
 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 2. Wood Screws: For wood doors and frames.
 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
 4. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors and wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

2.3 HINGES

- A. Butts and Hinges: BHMA A156.1.
- B. Template Hinge Dimensions: BHMA A156.7.
- C. Available Manufacturers:
 1. Hager Companies (HAG).
 2. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 3. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
- D. The following is a guide for hinge size and type required for this project.

EYECARE MEDICAL GROUP
 PHASE 2 – ADDITION & RENOVATION

	Manufacturer	Interior:	Exterior
1-3/4" Doors up to 3'-0" wide	Stanley	FBB179-4 1/2"	FBB191-4 1/2"
	Hager	BB1279-4 1/2"	BB1191-4 1/2"
	McKinney	TA-TB2714-4 1/2"	TA-TB2314-4 1/2"
1-3/4" Doors over 3'-0" wide	Stanley	FBB168-4 1/2"	FBB199-4 1/2"
	Hager	BB1168-4 1/2"	BB1199-4 1/2"
	McKinney	T4A-T4B3786-4 1/2"	T4A-T4B3386-4 1/2"

2.4 LOCKS AND LATCHES, GENERAL

- A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
- B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- C. Lock Trim:
 - 1. Levers: Cast.
 - 2. Escutcheons (Roses): Forged.
 - 3. Dummy Trim: Match lever lock trim and escutcheons.
- D. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Bored Locks: Minimum 1/2-inch latchbolt throw.
 - 2. Mortise Locks: Minimum 3/4-inch latchbolt throw.
- E. Backset: 2-3/4 inches, unless otherwise indicated.
- F. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
 - 1. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 2. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 3. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2.5 MORTISED LOCKS AND LATCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

EYECARE MEDICAL GROUP
 PHASE 2 – ADDITION & RENOVATION

1. Mechanical Locks and Latches:

- a. Best Lock Corporation (BLC).
- b. Corbin Russwin Architectural Hardware; Div. of Yale Security Inc. (CR).
- c. Sargent Manufacturing Company; an Assa Abloy Group company (SGT).
- d. Schlage Lock Company; an Ingersoll-Rand Company (SCH).

B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA Grade 1; Series 1000.

1. Provide one of the following manufacturers and designs:

- a. Best 40H Series
- b. Corbin/Russwin ML2000 Series
- c. Sargent 8200 Series
- d. Schlage L9000 Series

C. Lock Trim: Comply with the following:

1. Lockset Designs: Provide the lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:

- a. Best, 14 design
- b. Corbin/Russwin, Newport design
- c. Sargent, LNL design
- d. Schlage, 06A design

D. Lock Functions: Lock functions as indicated in the hardware schedule shall be as follows:

FUNCTION	SARGENT	SCHLAGE	CORBIN/RUSSWIN	BEST
A (utility)	04	80	57	EW
B (office)	05	50	51	E
C (passage)	15	10	10	N
D (classroom)	37	70	55	J
E (entrance)	16	60	42	F
F (privacy)	65	40	30	LF

2.6 BORED LOCKS AND LATCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mechanical Locks and Latches:

- a. Best Lock Corporation (BLC).
- b. Corbin Russwin Architectural Hardware; Div. of Yale Security Inc. (CR).
- c. Sargent Manufacturing Company; an Assa Abloy Group company (SGT).
- d. Schlage Lock Company; an Ingersoll-Rand Company (SCH).

B. Bored Locks: BHMA Grade 1; Series 4000.

EYECARE MEDICAL GROUP
 PHASE 2 – ADDITION & RENOVATION

1. Provide one of the following manufacturers and designs:

- a. Best: 9K Series
- b. Corbin Russwin: CL3300 Series.
- c. Sargent: 10 Line
- d. Schlage: ND Series

C. Auxiliary Locks: BHMA Grade 1.

D. Lock Trim: Comply with the following:

1. Lockset Designs: Provide the lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:

- a. Best: 15 C
- b. Corbin Russwin: NZD
- c. Sargent: LL
- d. Schlage: Rhodes

E. Lock Functions: Lock functions as indicated in the hardware schedule shall be as follows:

FUNCTION	SARGENT	SCHLAGE	CORBIN/RUSWIN	BEST
(1) (utility)	04	80	57	D
(2) (office)	05	53	51	AB
(3) (passage)	15	10	10	N
(4) (classroom)	37	70	55	R
(5) (entrance)	16	60	72	C
(6) (privacy)	65	40	20	L

2.7 EXIT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Precision Hardware, Inc. (PH).
- 2. Sargent Manufacturing Company; an Assa Abloy Group company (SGT).
- 3. Von Duprin; an Ingersoll-Rand Company (VD).

B. Products: All exit devices for this project shall be one of the following:

- 1. Precision Olympian Series
- 2. The 80 Series exit device by Sargent & Co.
- 3. 98 Series by Von Duprin Division

C. Exit Devices: BHMA A156.3, Grade 1.

D. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural &

EYECARE MEDICAL GROUP
 PHASE 2 – ADDITION & RENOVATION

Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
- E. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- F. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
- G. Outside Trim: Pull with cylinder; material and finish to match locksets, unless otherwise indicated.
- H. Top and Bottom Strikes: Where vertical rod exit devices are indicated for interior doors, provide standard surface-mounted top strike and flush or recessed bottom strike.
- I. The following functions shall be required where specified:

FUNCTION	VON DUPRIN	SARGENT	PRECISION
A	CD99NL-OP	16-8804	1103CD x 1123-38

2.8 LOCK CYLINDERS

- A. Standard Lock Cylinders: BHMA A156.5, Grade 1.
- B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
 1. Number of Pins: Six.
 2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 4. Bored-Lock Type: Cylinders with tailpieces to suit locks.
- C. Construction Keying: Comply with the following:
 1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
 2. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.
 - a. Replace construction cores with permanent cores as indicated in keying schedule.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Cylinders: Same manufacturer as for locks and latches.

2.9 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:
 1. Existing System: Master key or grand master key locks to Owner's existing system.
 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver.
 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: Information to be furnished by Owner.
 2. Quantity: In addition to one extra key blank for each lock, provide the following:
 - a. Cylinder Change Keys: Three.
 - b. Master Keys: Five.

2.10 OPERATING TRIM

- A. Standard: BHMA A156.6.
- B. Materials: Fabricate from stainless steel, unless otherwise indicated.
- C. Available Manufacturers:
 1. Burns Manufacturing Incorporated (BM).
 2. Don-Jo Mfg., Inc. (DJO).
 3. Hager Companies (HAG).
 4. IVES Hardware; an Ingersoll-Rand Company (IVS).
 5. Rockwood Manufacturing Company (RM).
- D. Door Pulls, 1 inch diameter.
 1. Size: ADA compliant, unless indicated otherwise, provide 10 inches center to center, with 3 1/2 inch projection and 2 1/2 inch clearance.
 2. Available Products:
 - a. Hager Companies, H4J.
 - b. IVES Hardware; an Ingersoll-Rand Company; 8103EZ.
- E. Push Bars, 1 inch diameter.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.11 CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Surface-Mounted Closers:
 - a. LCN Closers; an Ingersoll-Rand Company (LCN).
 - b. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
- C. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 - 1. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
- D. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.
- E. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. LCN:
 - a. Exterior: 4040 Series
 - b. Interior: 4040 Series
 - 2. Sargent:
 - a. Exterior: 281
 - b. Interior: 281

2.12 PROTECTIVE TRIM UNITS

- A. Size: 1-1/2 inches less than door width on push side and 1/2 inch less than door width on pull side, by height specified in door hardware sets.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Fasteners: Manufacturer's standard machine or self-tapping screws.
- C. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides; fabricated from the following material:
 - 1. Material: 0.050-inch- thick stainless steel.
 - 2. Available Manufacturers:
 - a. Burns Manufacturing Incorporated (BM).
 - b. Don-Jo Mfg., Inc. (DJO).
 - c. Hager Companies (HAG).
 - d. IVES Hardware; an Ingersoll-Rand Company (IVS).
 - e. Rockwood Manufacturing Company (RM).
- D. Fabricate protection plates as follows:
 - 1. Kick Plates: 10" high by 1-1/2" less than door width for single doors and 1" less than door width for pairs of doors. Kick plates shall be applied to push side of all doors where noted.

2.13 STOPS AND HOLDERS

- A. Stops and Bumpers: BHMA A156.16, Grade 1.
 - 1. Provide wall stops for doors unless floor or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.
 - 2. Provide matching finishes for hardware units at each door or opening, to the greatest extent possible, and except as otherwise indicated. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of hardware exposed at the same door or opening. In general, match items to the manufacturer's standard finish for the latch and lock set (or push-pull units if no latch-lock sets) for color and texture.
- B. Wall Stops: Wall type bumpers with concealed type flange shall be used where ever possible.
 - 1. Available Products:
 - a. Ives - 407 1/2
 - b. Door Controls - 3211T
 - c. Rockwood - 409
- C. Floor Stops: Where wall type bumpers cannot be used, provide dome type, floor mounted stops of the proper height as follows:
 - 1. Available Products:
 - a. Ives - 436, 438
 - b. Door Controls - 3310X, 3320X
 - c. Rockwood - 440, 442

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Exterior doors striking masonry and doors specified to have door stops and holders, shall have cast bronze wall or floor type door stops with hook or staple type holders to selectively hold doors in open position. The following will be acceptable:
 - 1. Available Products:
 - a. Ives - 445, 446
 - b. Door Controls - 3237X, 3347X
 - c. Rockwood - 473, 477
- E. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

2.14 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
- B. Weatherstripping:
 - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame. Basis-of-Design Product, No. A626A by National Guard Products or approved substitute.
 - 2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed. Basis-of-Design Product, No. 600A by National Guard Products or approved substitute.
 - 3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed. Basis-of-Design Product, No. 95WH by National Guard Products or approved substitute.
- C. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke-labeled gasketing on fire-rated doors and on smoke-labeled doors. Basis-of-Design Product, No. 5050 by National Guard Products or approved substitute.
- D. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

2.15 THRESHOLDS

- A. Standard: BHMA A156.21.
- B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
- C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch high.
- D. Manufacturers:
 1. Provide No. 896 with door bottom sweep No. 95WH by National Guard Products or approved substitute.

2.16 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 2. Steel Machine or Wood Screws: For the following fire-rated applications:
 - a. Mortise hinges to doors.
 - b. Strike plates to frames.
 - c. Closers to doors and frames.
 3. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:
 - a. Surface hinges to doors.
 - b. Closers to doors and frames.
 - c. Surface-mounted exit devices.
 4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

5. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.17 FINISHES

- A. Standard: BHMA A156.18, as indicated in door hardware sets.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide the following finishes:
 1. Butts and Hinges: 26D
 2. Locks & Lock Trim: 26D
 3. Exit Devices: 32D
 4. Door Controls - Closers: Sprayed Alum. Finish
 5. Mortise Locks & Latches: 26D
 6. Door Stops 26D/32D
 7. Weatherstripping Aluminum
 8. Threshold Aluminum
 9. Kickplates 32D
 10. Pulls 32D

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.7 DOOR HARDWARE SETS

- A. The hardware sets listed below indicate the items of hardware required for each opening. It is the bidder's responsibility to accurately furnish the proper quantities, items, sizes, weights and functions as required by the plans and specifications. If an opening has, through error, been omitted from the following hardware sets, it shall be the bidder's responsibility to supply hardware of equivalent quality and quantity, as that which is specified for a comparable opening.

SINGLE OUTSIDE DOOR

HW1

Doors B116.B

Continuous gear hinge
Exit Device (function A)
Closer
Weatherstripping
Door Bottom Sweep
Kickplate
Threshold

SINGLE OUTSIDE DOOR (with lockset)

HW2

Doors A117

Continuous gear hinge
Lockset (function E)
Closer
Weatherstripping
Door Bottom Sweep
Kickplate
Threshold

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

VESTIBULE DOOR

HW3

Doors B116.A

Hinges
Exit Device (function A)
Closer
Kickplate
Wall stop
Silencers

PRIVATE TOILET - NON-RATED

HW4

Doors A107, A114, A115, B110, C154

Hinges
Lockset (function F) (function 6)
Wall Stop
Silencers

EXAM ROOM / OR

HW5

Doors A104, A105, A110, A111, A112, B117, B119.A, B119.B, B120

Hinges
Locksets (passage function 3)
Door Stop
Silencers

OFFICE OR STORAGE

HW6

Doors AS1, A106, A113, A116, A127, B102, B103, B111, B118.A, B118.B, C128

Hinges
Locksets (classroom function 4)
Door Stop
Silencers

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

CORRIDOR OR RATED

HW7

Doors A103, A123, B101, B104, B107,

Hinges

Locksets (classroom function 4)

Closer

Door Stop

Smoke gasketing

MECHANICAL RATED

HW8

Doors A125

Hinges

Locksets (classroom function 1)

Closer

Door Stop

Smoke gasketing

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Storefront framing.
 - 4. Glazed entrances.
 - 5. Interior borrowed lites.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Design glass, including comprehensive engineering analysis according to ICC's 2009 International Building Code by a qualified professional engineer, using the following design criteria:
 - 1. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
 - 2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
 - 3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
 - 4. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.4 ACTION SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glass Samples: For each type of the following products; 12 inches square.
 - 1. Insulating glass.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass and glazing products, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulating glass.
- C. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
- B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Source Limitations for Glass: Obtain insulating glass from single source from single manufacturer for each glass type.
- E. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
- F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- H. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.

1.9 WARRANTY

- A. Manufacturer's Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 2. For uncoated glass, comply with requirements for Condition A.
 3. For coated vision glass, comply with requirements for Condition C (other coated glass).

2.3 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
1. Sealing System: Dual seal, with silicone primary seal and butyl secondary seal.
 2. Spacer: Aluminum with mill or clear anodic finish.
 3. Desiccant: Molecular sieve or silica gel, or blend of both.
- B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies.
- B. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, clear float glass; with intumescent interlayers; complying with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. InterEdge, Inc., a subsidiary of AFG Industries, Inc.; Pyrobel.
 - b. Pilkington Group Limited (distributed by Technical Glass Products); PyroStop.
 - c. Vetrotech Saint-Gobain; SGG Contraflam N2.

2.5 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 - 1. Neoprene complying with ASTM C 864.
 - 2. EPDM complying with ASTM C 864.
 - 3. Silicone complying with ASTM C 1115.
 - 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM, silicone, or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 - 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
 - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 790.
 - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - c. May National Associates, Inc.; Bondaflex Sil 290.
 - d. Pecora Corporation; 890.
 - e. Sika Corporation, Construction Products Division; SikaSil-C990.
 - f. Tremco Incorporated; Spectrem 1.
- C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

2.10 MONOLITHIC-GLASS TYPES

- A. Tempered Glass: Clear fully tempered float glass.
 - 1. Thickness: 6.0 mm.
 - 2. Provide safety glazing labeling.

2.11 INSULATING-GLASS TYPES

- A. Insulated Glass: Clear insulating glass.
 - 1. Overall Unit Thickness: 5/8 inch.
 - 2. Thickness of Each Glass Lite: 6.0 mm.
 - 3. Outdoor Lite: Float glass.
 - 4. Interspace Content: Air.
 - 5. Indoor Lite: Float glass.
 - 6. Provide tempered glass and safety glazing labeling where required by code.
 - 7. Application: Exterior hollow metal doors.
- B. Low-E Insulated Glass: Low-e-coated, clear insulating glass.
 - 1. Overall Unit Thickness: 1 inch.
 - 2. Thickness of Each Glass Lite: 6.0 mm.
 - 3. Outdoor Lite: Float glass.
 - 4. Interspace Content: Air.
 - 5. Indoor Lite: Float glass.
 - 6. Low-E Coating: Pyrolytic or sputtered on second or third surface.
 - 7. Provide tempered glass and safety glazing labeling where required by code.
 - 8. Application: Automatic entrances and sidelites.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.12 FIRE-PROTECTION-RATED GLAZING TYPES

- A. Fire Rated Glass: 60-minute and 90-minute fire-rated glazing; laminated glass with intumescent interlayers.
 - 1. Provide safety glazing labeling.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes non-load-bearing steel framing members for the following applications:
 - 1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
 - 2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized.
- B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
 - 1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.018 inch for furring and framing for soffits, 0.027 inch for wall framing and 0.033 inch for fire fire-rated wall framing.
 - b. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide one of the following:
 - 1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
 - 2) MBA Building Supplies; FlatSteel Deflection Track or Slotted Deflecto Track.
 - 3) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
 - 4) Superior Metal Trim; Superior Flex Track System (SFT).
 - 5) Telling Industries; Vertical Slip Track or Vertical Slip Track II.

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Available Product: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dietrich: SLP-TRK Slotted Track.
 - b. Fire Trak Corp.; Fire Trak.
 - c. Metal-Lite, Inc.; The System.
 - d. The Steel Network, Inc.; VertiClip SLD or VertiTrack VTD.

E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: 0.018 inch.
2. Depth: As indicated on Drawings.

2.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
- C. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
 1. Depth: 1-1/2 inches.
- E. Furring Channels (Furring Members):

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Cold-Rolled Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
 2. Steel Studs: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.018 inch.
 - b. Depth: As indicated on Drawings.
- F. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Corporation; Drywall Suspension System.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two 0.312 inch (0.79 mm) (20 gage) studs at each jamb, unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.4 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
 - 3. Furring Channels (Furring Members): 16 inches o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not attach hangers to steel roof deck.
 - 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 - 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 - 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

- 1. Interior gypsum board.
- 2. Tile backing panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.
- C. Drawings: Submit drawings indicating locations of control joints.

1.4 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Gypsum.
 2. CertainTeed Corp.
 3. Georgia-Pacific Gypsum LLC.
 4. Lafarge North America Inc.
 5. National Gypsum Company.
 6. PABCO Gypsum.
 7. Temple-Inland.
 8. USG Corporation.
- B. Type X:
 1. Thickness: 5/8 inch.
 2. Long Edges: Tapered.
- C. Moisture- and Mold-Resistant Type: Complying with ASTM C1177/C 1177M, moisture- and mold-resistant core and surfaces.
 1. Core: 5/8 inch, Type X.
 2. Long Edges: Tapered.
 3. Basis of design Product: "DensArmor Plus" as manufactured by G-P Gypsum.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; GlasRoc Tile Backer.
 - b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
 - 2. Core: 5/8 inch, Type X.
 - 3. Mold Resistance: ASTM D 3273, score of 10.

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material:
 - a. Galvanized or aluminum-coated steel sheet or rolled zinc.
 - b. Trim-Tex, Super Seal Tear Away™ L Bead where abutting exterior metal doors and windows.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. Expansion (control) joint.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purpose compound.
 - a. Use setting-type taping with mold-resistant gypsum wallboard.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: Not required.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Roxul Inc.; Roxul AFB.
 - b. USG Corporation; ThermaFiber SAFB.

D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; AC-20 FTR or AIS-919.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.
2. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Fire-Resistive Joint Systems: As specified in Division 07 Section "Fire-Resistive Joint Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Fire-Resistance-Rated Gypsum Board Assemblies: Provide fire-resistive joint system at the top of fire-resistance-rated gypsum board assemblies. Provide firestop system around any structural penetration of wall assembly.
- K. Smoke-Rated Gypsum Board Assemblies: Provide a tight, taped joint at the top of smoke-rated assemblies and around any penetrations to assemblies at both side of the assembly. The use of acoustical sealant will be acceptable to fill gaps up to 3/8 inch wide.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: Vertical and horizontal surfaces, unless otherwise indicated.
 - 2. Moisture- and Mold-Resistant Type: As indicated on Drawings.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
 - 1. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 2. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panel: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings or according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners, unless otherwise indicated.
 - 2. LC-Bead: Use at exposed panel edges.
 - 3. L-Bead: Use where indicated.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Where indicated on Drawings.
 - 3. Level 3: Where indicated on Drawings.
 - 4. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
 - 5. Level 5: Not required.
- E. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
 - 1. Complete the following in areas to receive gypsum board ceilings:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Installation, insulation, and leak and pressure testing of water piping systems.
- b. Installation of air-duct systems.
- c. Installation of air devices.
- d. Installation of mechanical system control-air tubing.
- e. Installation of ceiling support framing.
- f. Installation of Penetration Firestopping and Fire-Resistive Joint Systems.

3.8 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093000 - TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ceramic tile.
 - 2. Waterproof and crack isolation membrane.
 - 3. Metal edge strips.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Selection:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Full-size units of each type of trim and accessory for each color and finish required.
 - 3. Metal edge strips in 6-inch lengths.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of product, signed by product manufacturer.
- B. Material Test Reports: For each tile-setting and -grouting product.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
 - 1. Waterproof and crack isolation membrane.
 - 2. Joint sealants.
 - 3. Metal edge strips.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.2 TILE PRODUCTS

- A. Ceramic Floor Tile: Factory-mounted unglazed ceramic mosaic tile.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Daltile; Division of Dal-Tile International Inc.; Keystones.
 2. Composition: Porcelain.
 3. Module Size: 2 by 2 inches.
 4. Thickness: 1/4 inch.
 5. Face: Plain with cushion edges.
 6. Surface: Smooth, without abrasive admixture.
 7. Finish: Mat, opaque glaze.
 8. Tile Color and Pattern: Uptown Taupe Speckle, D202.
 9. Grout Color: As selected by Architect from manufacturer's full range.
 10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cove: Cove, module size 2 by 2 inch, built-up base MB-5A.
 - b. External Corners for Thin-Set Mortar Installations: Surface bullnose, module size 2 by 2 inches.
 - c. Internal Corners: Cove, module size 2 by 1 inch.
- B. Ceramic Wall Tile: Provide flat tile complying with the following requirements:
1. Tile Type/Products: Available products include the following:
 - a. Dal-Tile: Matte.
 2. Module Size: 4-1/4 by 4-1/4 inches.
 3. Thickness: 5/16 inch.
 4. Face: Plain with cushion edges.
 5. Tile Color and Pattern: Urban Putty, 0761.
 6. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 2 by 6 inches.

2.3 WATERPROOF AND CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and ANSI A118.12, and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane. (2.39 g/L)
 - b. MAPEI Corporation; Mapelastastic HPG with MAPEI Fiberglass Mesh. (31 g/L)

2.4 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bonsal American; an Oldcastle company.
 - b. Bostik, Inc.
 - c. C-Cure.
 - d. Custom Building Products.
 - e. Laticrete International, Inc.
 - f. MAPEI Corporation.
 - 2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - 3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.5 GROUT MATERIALS

- A. Polymer-Modified Tile Grout: ANSI A118.7.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bonsal American; an Oldcastle company.
 - b. Bostik, Inc.
 - c. C-Cure.
 - d. Custom Building Products.
 - e. Laticrete International, Inc.
 - f. MAPEI Corporation.
 - 2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

2.6 ELASTOMERIC SEALANTS

- A. General: Provide manufacturer's standard sanded acrylic caulking containing a mildew-cide or antimicrobial protection.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
- C. Products: Available products include the following:
 - 1. Keracaulk™ S by Mapei
 - 2. CeramaSeal by Bostik Findley

2.7 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
 - 1. Provide Schiene by Schluter or approved substitute.

2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 TILE INSTALLATION

- A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors composed of tiles 8 by 8 inches or larger.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

E. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Ceramic Mosaic Tile: 1/16 inch.
2. Ceramic Wall Tile: 1/16 inch.

F. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

G. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

3.4 WATERPROOFING/CRACK ISOLATION MEMBRANE INSTALLATION

A. Install waterproofing to comply with manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over waterproofing until waterproofing/crack isolation membrane has cured.

C. Locations:

1. Toilet Rooms slabs receiving tile flooring. Turn membrane up 2 inches minimum at perimeter walls to keep water from traveling under partitions.
2. Install over all cracks, control and construction joints in concrete floor.

3.5 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove latex-portland cement grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.6 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Tile Installation F125A: Thin-set mortar on crack isolation membrane; TCA F125A.
 - a. Tile Type: Ceramic floor tile.
 - b. Thin-Set Mortar: Latex portland cement mortar.
 - c. Grout: Polymer-modified unsanded grout.
- B. Interior Wall Installations, Metal Studs or Furring:
 - 1. Tile Installation W245: Thin-set mortar on coated glass-mat, water-resistant gypsum backer board; TCA W245.
 - a. Tile Type: Ceramic wall tile.
 - b. Thin-Set Mortar: Latex portland cement mortar.
 - c. Grout: Polymer-modified unsanded grout.

END OF SECTION 093000

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes acoustical panels and exposed suspension systems for ceilings.

1.3 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- long Samples of each type, finish, and color.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed.
2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.
3. Hold-Down Clips: Equal to 2.0 percent of quantity installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 2. Smoke-Developed Index: 50 or less.
- C. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL

A. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
2. Suspension System: Obtain each type through one source from a single manufacturer.

B. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.

C. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Where indicated, provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.3 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Products: Subject to compliance with requirements, provide one of the following:

1. CertainTeed; Performa Symphony® , No. 1222-IOF-1.

B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:

1. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face.
2. Pattern: E (lightly textured).

C. Color: White.

D. LR: Not less than 0.90.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. NRC: Not less than 0.70.
- F. CAC: Not less than 33.
- G. Edge/Joint Detail: Reveal.
- H. Thickness: 3/4 inch.
- I. Modular Size: 24 by 24 inches.
- J. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
 - 1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- E. Hanger Rods or Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- I. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.
- J. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
 - 1. Available Products: UHDC by Armstrong or L15 by USG.

2.5 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Prelude 15/16" Exposed Tee System (7300 Series); Armstrong World Industries, Inc.
 - 2. S11 System; Celotex Corporation.
 - 3. 1200 System; Chicago Metallic Corporation.
 - 4. DX 24 System; USG Interiors, Inc.
- B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished 15/16-inch- wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: Override (stepped) or butt-edge type, as standard with manufacturer.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Steel cold-rolled sheet.
 - 5. Cap Finish: Painted white.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
 - 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
 - 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

- B. Suspend ceiling hangers from building's structural members and as follows:

1. Hangers shall be single lengths of wire without splices; coordinate lengths in deep ceiling cavities.
2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
3. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
4. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
5. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
6. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
7. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
8. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 9. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 10. Do not attach hangers to steel deck tabs.
 11. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 12. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 13. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Suspension system shall be reinforced to support diffusers, light fixtures and any additional members. Install hanger wires to grid at each corner of light fixtures. Coordinate location with electrical and other trades.
1. Each individual fixture and attachment with combined weight of 56 pounds or less shall have two 12-gage wire hangers attached at diagonal corners of the fixture. These wires shall be slack. Fixtures and attachments with a combined weight of greater than 56 pounds shall be independently supported from the structure at all four corners.
- E. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- F. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- G. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - b. Install panels with pattern running in one direction parallel to long axis of space.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
4. Install hold-down clips in areas within 10 feet of exterior doors or vestibule doors; space as recommended by panel manufacturer's written instructions, unless otherwise indicated or required.

3.4 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs acoustical panel ceilings, conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of acoustical panels until deficiencies have been corrected.
 1. Complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of Penetration Firestopping and Fire-Resistive Joint Systems.

3.5 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Resilient base.
 - 2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of product indicated.
- C. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.
- D. Product Schedule: For resilient products.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.7 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - 1. Johnsonite; A Tarkett Company.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient flooring.
- C. Thickness: 0.125 inch.
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed or preformed.
- G. Inside Corners: Job formed or preformed.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

H. Colors: 80 Fawn.

2.2 VINYL MOLDING ACCESSORY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong World Industries, Inc.
2. Burke Mercer Flooring Products, Division of Burke Industries Inc.
3. Flexco.
4. Johnsonite; A Tarkett Company.
5. Musson Rubber Company.
6. Roppe Corporation, USA.

B. Colors and Patterns: As selected by Architect from full range of industry colors.

C. Profile and Dimensions:

1. Transition Strip between Sheet Flooring and Carpet: CE-XX-A by Johnsonite or approved substitute.
2. Transition Strip between Sheet Flooring and VCT: CD-XX-C by Johnsonite or approved substitute.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Cove Base Adhesives: Not more than 50 g/L.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are same temperature as the space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- D. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: If selected by contractor, install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet and resilient floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- B. Perform the following operations immediately after completing resilient product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products until Substantial Completion.

END OF SECTION 096513

SECTION 096516 - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vinyl sheet floor covering, with backing.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples for Initial Selection: For each type of floor covering indicated.
- D. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch sections of each different color and pattern of floor covering required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.
- E. Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch Sample applied to a rigid backing and prepared by Installer for this Project.
- F. Product Schedule: For floor coverings. Use same designations indicated on Drawings.
- G. Maintenance Data: For each type of floor covering to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation [**and seaming method**] indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Engage an installer who employs workers for this Project who are trained or certified by floor covering manufacturer for installation techniques required.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- C. Preinstallation Conference: Conduct conference at Project site.
 1. At least 7 days prior to starting installation of flooring, conduct a meeting to review detailed requirements for materials and to determine procedures for a satisfactory installation of flooring materials.
 2. Review methods and procedures related to curing and protection of concrete substrate.
 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store rolls upright.

1.6 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive floor coverings during the following time periods:
 1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 48 hours after floor covering installation.
- E. Install floor coverings after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Floor Covering: Furnish quantity not less than 10 linear feet for every 500 linear feet or fraction thereof, in roll form and in full roll width for each color, pattern, and type of floor covering installed.

PART 2 - PRODUCTS

2.1 VINYL SHEET FLOOR COVERING

- A. Products: Subject to compliance with requirements, provide the following:

1. Armstrong World Industries, Inc.; Medintech.

- B. Vinyl Sheet Floor Covering with Backing: ASTM F 1303.

1. Type (Binder Content): Type II, minimum binder content of 34 percent.
2. Wear-Layer Thickness: Grade 1.
3. Overall Thickness: 0.080 inch.
4. Interlayer Material: None.
5. Backing Class: Class A (fibrous).

- C. Wearing Surface: Smooth.

- D. Sheet Width: 6 feet.

- E. Seaming Method: Heat welded.

- F. Colors and Patterns: As indicated in the finish schedule.

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

- B. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.

1. Use adhesives that have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. Seamless-Installation Accessories:

1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Color: Match floor covering.

- D. Integral-Flash-Cove-Base Accessories:

1. Cove Strip: 1-inch radius provided or approved by manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Cap Strip: Square metal, vinyl, or rubber cap provided or approved by manufacturer.
 3. Corners: Metal inside and outside corners and end stops provided or approved by manufacturer.
- E. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor coverings until they are same temperature as space where they are to be installed.
 1. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.3 FLOOR COVERING INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor coverings.
- B. Unroll floor coverings and allow them to stabilize before cutting and fitting.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Lay out floor coverings as follows:
 - 1. Maintain uniformity of floor covering direction.
 - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates.
 - 3. Match edges of floor coverings for color shading at seams.
 - 4. Avoid cross seams.
- D. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
- E. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
- F. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor coverings on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of floor coverings installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
- J. Integral-Flash-Cove Base: Cove floor coverings 6 inches up vertical surfaces. Support floor coverings at horizontal and vertical junction by cove strip. Butt at top against cap strip.
 - 1. Install metal corners at inside and outside corners.
 - 2. Install in Operating Rooms, unless noted otherwise.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
- B. Perform the following operations immediately after completing floor covering installation:
 - 1. Remove adhesive and other blemishes from floor covering surfaces.
 - 2. Sweep and vacuum floor coverings thoroughly.
 - 3. Damp-mop floor coverings to remove marks and soil.
- C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

D. Cover floor coverings until Substantial Completion.

END OF SECTION 096516

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes modular carpet tile.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.
- B. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- long Samples.
- C. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- E. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.
- F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.6 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.7 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Mohawk Commercial; Character Lines Modular.
 - a. Color: As selected by Architect from manufacturer's full range.
- B. Fiber Type: Duracolor® Premium Nylon with Antron® Legacy
- C. Pile Characteristic: Level Multi Colored Patterned Loop pile.
- D. Density: 4675 oz./cu. yd.
- E. Pile Thickness: .154 inch.
- F. Stitches: 11.5 per inch.
- G. Gage: 1/12.
- H. Surface Pile Weight: 20 oz./sq. yd.
- I. Backing System: EcoFlex ICT.
- J. Size: 24 by 24 inches.
- K. Applied Soil-Resistance Treatment: Manufacturer's standard material.
- L. Antimicrobial Treatment: Manufacturer's standard material.
- M. Performance Characteristics: As follows:
 - 1. Flooring Radiant Panel: ASTM E648 Direct Glue Down Mode – Class 1
 - 2. NBS Smoke Chamber: ASTM E662 Flaming Mode – 450 or less
 - 3. Electrostatic Propensity: Less than 3.0 kV per AATCC 134.
 - 4. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.
- H. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 096816 - SHEET CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Tufted carpet.
- B. Related Sections include the following:
 - 1. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following, including installation recommendations for each type of substrate:
 - 1. Carpet: For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
- B. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet: 12-inch- square Sample.
 - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- long Samples.
 - 3. Carpet Seam: 6-inch Sample.
- C. Product Schedule: For carpet Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- B. Warranties: Special warranties specified in this Section.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet: Full-width rolls equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced Installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.
- B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Mockups: Before installing carpet, build mockups to verify seam construction and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.9 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.10 WARRANTY

- A. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, excess static discharge, and delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Tandus, Grama 44025
 - a. Color: Ashland Slate.
- B. Fiber Type: Dynex SD nylon.
- C. Pile Characteristic: Tufted textured loop pile.
- D. Pile Thickness: 0.177 inch.
- E. Stitches: 12 per inch.
- F. Gage: 1/10.
- G. Face Weight: 22 oz./sq. yd..
- H. Total Weight: 60.2 oz./sq. yd. for finished carpet.
- I. Primary Backing: Manufacturer's standard material.
- J. Secondary Backing: Super-Lok® enriched latex backing.
- K. Width: 12 feet.
- L. Applied Soil-Resistance Treatment: Manufacturer's standard material.
- M. Antimicrobial Treatment: Manufacturer's standard material.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

N. Performance Characteristics: As follows:

1. Flooring Radiant Panel: ASTM E648 Direct Glue Down Mode – Class 1
2. NBS Smoke Chamber: ASTM E662 Flaming Mode – 450 or less
3. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer.
 1. VOC Limits: Provide adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
- C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
- D. Seam Sealer: Edge of carpet sealer product recommended by carpet manufacturer for sealing and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet manufacturer.
 2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet.
 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

- A. Comply with CRI 104 and carpet manufacturer's written installation instructions for the following:
 - 1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
- B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
 - 1. Level adjoining border edges.
- C. Do not bridge building expansion joints with carpet.
- D. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- E. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.

3.4 CLEANING AND PROTECTING

- A. Perform the following operations immediately after installing carpet:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 2. Remove yarns that protrude from carpet surface.
 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer and carpet adhesive manufacturer.

END OF SECTION 096816

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Steel.
- B. This Section includes exposed exterior items and surfaces with low VOC coatings complying with ME DEP regulations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. VOC content.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced Applicator who has completed painting system applications similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.7 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Benjamin Moore & Co.
 - 2. California Paints.
 - 3. PPG Architectural Finishes, Inc. (Pittsburgh Paints, Glidden Professional, Flood Stains)
 - 4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. VOC Compliance for Exterior Paints and Coatings: Provide the manufacturer's formulation for the products specified below that are VOC compliant with the State of Maine Department of Environmental Protection Regulation, "Chapter 151: Architectural and Industrial Maintenance (AIM) Coatings" and the following chemical restrictions expressed in grams per liter:
1. Flat Paints and Coatings: VOC content of not more than 100 g/L.
 2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
 3. Non-Flat Paints and Coatings - High Gloss: VOC content of not more than 250 g/L.
 4. Anticorrosive (Rust Preventative) Coatings: VOC content of not more than 400 g/L.
 5. Fire Resistive Coatings: VOC content of not more than 350 g/L.
 6. Industrial Maintenance Coatings (IMC): VOC content of not more than 340 g/L.
 7. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 8. Quick-Dry Enamels: VOC content of not more than 250 g/L.
 9. Quick-Dry Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 10. Specialty Primers, Sealers, and Undercoaters: VOC content of not more than 350 g/L.
 11. Wood Preservatives: VOC content of not more than 350 g/L.
- C. Colors: Provide color selections made by the Architect. Allow for up to 5 different color selections.

2.3 METAL PRIMERS

- A. Ferrous-Metal and Galvanized-Metal Primer: Factory-formulated rust-inhibitive metal primer for exterior application.
1. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04.
 2. California; Rust Stop DTM 100% Acrylic Latex Metal Primer.
 3. Devoe Coatings: 4020-1000 Devflex 4020PF DTM Primer & Flat Finish. (91 g/L)
 4. Pittsburgh Paints: 90-712 Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel. (123 g/L)
 5. Sherwin-Williams; IMC DTM Acrylic Primer/Finish, B66W1. (150 g/L)

2.4 EXTERIOR LATEX PAINTS

- A. Exterior Semi-Gloss Acrylic Enamel: Factory-formulated semi-gloss acrylic enamel for exterior application.
1. Benjamin Moore; DTM Acrylic Semi-Gloss Enamel M29: Applied at a dry film thickness of not less than 2.0 mils.
 2. California Paints; Rust Stop DTM 100% Acrylic Semi-Gloss, 10XX.
 3. Devoe Coatings; 4216-XXXX, High Performance Waterborne Acrylic Semi-Gloss Enamel.
 4. Pittsburgh Paints: 6-900XI Speedhide Exterior Semi-Gloss Latex: Applied at a dry film thickness of not less than 1.5 mils.
 5. Sherwin-Williams; IMC DTM Acrylic Coating Semi-Gloss (Waterborne) B66W200 Series. (250 g/L)

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
- E. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints. Uniformly abrade galvanized surfaces with a palm sander and 60 grit aluminum oxide so surface is free of oil and surface contaminants.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 4. Paint entire exposed surface of window frames and sashes.
 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 6. Apply an additional coat of primer on metal surfaces that have been shop primed.
- B. Tinting: Tint primer of colors such as reds, yellows, and oranges with a gray basecoat system designed to help provide color coverage.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces. When using colors such as red, yellow or orange, an extra coat of finish may be necessary. Notify Architect when additional coats do not fix the problem.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in paragraph 2.02.C of this Section.
- B. Steel and Galvanized-Metal Substrates: Provide the following finish systems over exterior ferrous metal including, but not limited to, hollow metal doors and frames, steel lintels. Primer is required on shop-primed items.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Semi-Gloss Acrylic-Enamel Finish: Two finish coats over a rust-inhibitive primer.
 - a. Primer: Exterior ferrous-metal primer.
 - b. Finish Coats: Exterior semi-gloss acrylic enamel.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Steel.
 - 2. Wood.
 - 3. Gypsum board.
 - 4. Cotton or canvas insulation covering.
- B. This Section includes exposed interior items and surfaces with low VOC coatings complying with ME DEP regulations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. VOC content.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced Applicator who has completed painting system applications similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- C. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
 3. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.
 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.7 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Benjamin Moore & Co.
 2. California Paints.
 3. PPG Architectural Finishes, Inc. (Pittsburgh Paints, Glidden Professional, Flood Stains)
 4. Samuel Cabot, Inc. (Cabot).
 5. Sherwin-Williams Company (The).
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated.

2.2 PAINT, GENERAL

- A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. VOC Compliance for Interior Paints and Coatings: Provide the manufacturer's formulation for the products specified below that are VOC compliant with the State of Maine Department of Environmental Protection Regulation, "Chapter 151: Architectural and Industrial Maintenance (AIM) Coatings" and the following chemical restrictions expressed in grams per liter:
1. Flat Paints and Coatings: VOC content of not more than 100 g/L.
 2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
 3. Non-Flat Paints and Coatings - High Gloss: VOC content of not more than 250 g/L.
 4. Anticorrosive (Rust Preventative) Coatings: VOC content of not more than 400 g/L.
 5. Fire Resistive Coatings: VOC content of not more than 350 g/L.
 6. Industrial Maintenance Coatings (IMC): VOC content of not more than 340 g/L.
 7. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 8. Quick-Dry Enamels: VOC content of not more than 250 g/L.
 9. Quick-Dry Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 10. Specialty Primers, Sealers, and Undercoaters: VOC content of not more than 350 g/L.
 11. Stains: VOC content of not more than 250 g/L.
 12. Wood Preservatives: VOC content of not more than 350 g/L.
- C. Colors: Provide color selections made by the Architect. Allow for up to 10 different color selections.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.3 PRIMERS/SEALERS

A. Low-VOC Latex Primer/Sealer:

1. Cal: Envirotech Zero VOC Interior Latex Primer/Sealer, 64600.
2. Moore: Pristine Eco Spec Interior Latex Primer Sealer, No. 231
3. Glidden Professional: 9116-1200 LifeMaster No VOC Interior Primer. (0 g/L)
4. PPG: Pure Performance Interior Latex Primer, 9-900 Series. (0 g/L)
5. SW: ProMar 200 Zero VOC Interior Latex Primer B28W02600 Series. (0 g/L)]

B. High-Build Primer/Sealer:

1. Cal: Hide-A-Spray, 91-20. (VOC 76 g/L)
2. Glidden Professional: 1040-1200, High Build Surfacer Interior Primer Sealer. (100g/L)
3. PPG: 6-1 Speedhide Interior MaxBuild High Build Surfacer. (<50 g/L)
4. SW: PrepRite High Build Interior Latex Primer/Surfacer B28W601 (VOC 74 g/L).
5. Moore: Super Spec Satin-Fil 172 (VOC 31g/L)

2.4 METAL PRIMERS

A. Rust-Inhibitive Primer (Water Based):

1. Cal: Rust Stop DTM 100% Acrylic Semi-Gloss, 10XX.
2. Devco Coatings: 4020-1000 Devflex 4020PF DTM Primer & Flat Finish. (91 g/L)
3. Moore: IMC Acrylic Metal Primer M04. (51 g/L)
4. Pittsburgh Paints; 90-712 Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel. (123 g/L)
5. S-W: IMC Pro-Cryl Universal Primer, B66-310 Series. (100 g/L)

2.5 WOOD PRIMERS

A. Latex-Based Wood Primer:

1. Cal: ASAP “30” 50300.
2. Glidden Professional: 3210-1200 Gripper Interior/Exterior Primer Sealer. (100 g/L)
3. Moore: Super Spec Latex Enamel Undercoater & Primer Sealer #253.
4. PPG: Seal Grip Interior Primer/Finish, 17-951. (45 g/L)
5. S-W: PrepRite Classic Latex Primer B28W101 Series.

B. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

2.6 LATEX PAINTS

A. Low-VOC Latex (Flat):

1. California Paints: Rust Stop DTM 100% Acrylic Semi-Gloss, 633XX.
2. Glidden Professional: 1209-XXXXN Ultra-hide No VOC Interior Flat Paint (0 g/L)

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Moore: Eco Spec Interior Latex Flat, No. 219.
4. PPG: 6-4110XI Series, Speedhide zero Interior Zero VOC Interior Flat Latex. (0 g/L)
5. SW: ProMar 200 Zero VOC Interior Latex Flat B30-2600 Series. (0 g/L)]

B. Low-VOC Latex (Low Luster):

1. California Paints: Rust Stop DTM 100% Acrylic Semi-Gloss, 631XX.
2. Glidden Professional: 1411-XXXX Ultra-hide No VOC Interior Eggshell Paint (0 g/L)
3. Moore: Pristine Eco Spec Interior Latex Eggshell, No. 223
4. PPG: 6-4310XI Series, Speedhide zero Interior Zero VOC Latex Eggshell Interior. (0 g/L)
5. SW: ProMar 200 Zero VOC Interior Latex Eg-Shell B20-2600 Series. (0 g/L)]

C. Low-VOC Latex (Semi-gloss):

1. California Paints: Rust Stop DTM 100% Acrylic Semi-Gloss, 663XX.
2. Glidden Professional: 1415-XXXXN Ultra-hide No VOC Interior Semi-Gloss Paint (0 g/L)
3. Moore: Pristine Acrylic Semi-Gloss, No. 214
4. PPG: 6-4510XI Series, Speedhide zero Interior Zero VOC Latex Semi-Gloss. (0 g/L)
5. SW: ProMar 200 Zero VOC Interior Latex Semi-Gloss B31-2600 Series. (0 g/L)]

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Wood: 15 percent.
 2. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints. Uniformly abrade galvanized surfaces with a palm sander and 60 grit aluminum oxide so surface is free of oil and surface contaminants.
- G. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- H. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
- I. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Apply an additional coat of primer on metal surfaces that have been shop primed.
- B. Tinting: Tint primer of colors such as reds, yellows, and oranges with a gray basecoat system designed to help provide color coverage.
1. Do not tint prime or base coat for multi-colored finishes.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces. When using colors such as red, yellow or orange, an extra coat of finish may be necessary. Notify Architect when additional coats do not fix the problem.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms: Not applicable.
 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.
- F. Rated Partition Labeling: Partitions in the construction area that are shown to have a fire or smoke rating shall be labeled. Label each side of each partition between 6 and 18 inches above the ceiling. Labels shall consist of 4 inch high letters painted in bright orange color. Place labels approximately 5 feet on center on both sides of wall. Label schedule shall be as follows:
1. For smoke walls: "Smoke Rated Wall"
 2. For 1 hour walls: "One Hour Rated Wall"
 3. For 2 hour walls: "Two Hour Rated Wall"
 4. For 3 hour walls: "Three Hour Rated Wall"

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in paragraph 2.2 of this Section.
- B. Steel Substrates: Including, but not limited to steel doors and frames, steel stairs (including risers and stringers), handrails and guardrails, lintel plates and angles, wood door glass lite kits and astragals, access panels (both sides), metal fabrications; see Division 05 Section "Metal Fabrications", and miscellaneous metal items.
 - 1. Low-VOC Latex Over DTM Primer System:
 - a. Prime Coat: DTM anticorrosive metal primer.
 - b. Intermediate Coat: Low-VOC latex paint matching topcoat.
 - c. Topcoat: Low-VOC latex semi-gloss paint.
- C. Galvanized-Metal Substrates:
 - 1. Low-VOC Latex Over DTM Primer System:
 - a. Prime Coat: DTM anticorrosive metal primer.
 - b. Intermediate Coat: Low-VOC latex paint matching topcoat.
 - c. Topcoat: Low-VOC latex semi-gloss paint.
- D. Wood Substrates: Including wood trim.
 - 1. Low-VOC Latex System:
 - a. Prime Coat: Interior latex-based wood primer.
 - b. Intermediate Coat: Low-VOC latex paint matching topcoat.
 - c. Topcoat: Low-VOC latex (semigloss) paint.
- E. Gypsum Board Substrates:
 - 1. Low-VOC Latex System:
 - a. Prime Coat: Low-VOC latex primer/sealer.
 - b. Intermediate Coat: Low-VOC latex paint matching topcoat.
 - c. Topcoat: Low-VOC latex (flat) paint for ceilings and (eggshell) paint for walls.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Fiberglass-Faced Gypsum Board Substrates:
 - 1. Low-VOC Latex System:
 - a. Prime Coat: High-Build Primer/Sealer.
 - b. Intermediate Coat: Low-VOC latex paint matching topcoat.
 - c. Topcoat: Low-VOC latex (eggshell) paint.

- G. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.
 - 1. Low-VOC Latex System:
 - a. Prime Coat: Low-VOC latex primer/sealer.
 - b. Intermediate Coat: Low-VOC latex paint matching topcoat.
 - c. Topcoat: Low-VOC latex (flat) paint.

- H. Fire-Rating Identification: Identify all 1- and 2-hour fire-rated partitions by stenciling rating on each side of rated walls above ceiling line with 4 inch high letters in red or orange semigloss paint; each rated wall shall be identified at least once and at a spacing not greater than 12 feet o.c.
 - 1. One Coat: Latex semi-gloss paint.

END OF SECTION 099123

SECTION 099300 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and the application of wood finishes on the following substrates:
 - 1. Exterior Substrates:
 - a. Dressed lumber (wood soffit).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of finish system and in each color and gloss of finish indicated.
 - 1. Submit Samples on representative samples of actual wood substrates, 8 inches long.
 - 2. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
 - 1. Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. VOC content.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced Applicator who has completed painting system applications similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain sealer materials for each coating system from the same manufacturer as the finish coats.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

- A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply exterior finishes in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Benjamin Moore & Co.
 - 2. California Paints.
 - 3. PPG Architectural Finishes, Inc. (Pittsburgh Paints, Glidden Professional, Flood Stains, Sikkens)
 - 4. Samuel Cabot Incorporated.
 - 5. Sherwin-Williams Company (The)
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the category indicated.

2.2 MATERIALS, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.
- B. VOC Compliance for Interior Paints and Coatings: Provide the manufacturer's formulation for the products specified below that are VOC compliant with the State of Maine Department of

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

Environmental Protection Regulation, "Chapter 151: Architectural and Industrial Maintenance (AIM) Coatings" and the following chemical restrictions expressed in grams per liter:

1. Flat Paints and Coatings: VOC content of not more than 100 g/L.
2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
3. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
4. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
5. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
6. Floor Coatings: VOC not more than 100 g/L.
7. Shellacs, Clear: VOC not more than 730 g/L.
8. Stains: VOC not more than 250 g/L.

2.3 WOOD FILLERS

- A. Wood Filler Paste: MPI #91.
 1. VOC Content: E Range of [E1] [E2] [E3].

2.4 CLEAR WOOD SEALERS

- A. Clear Wood Finish: Clear penetrating, oil-based wood preservative finish.
 1. Moore: Moorwood Alkyd Clear Deck and Siding Finish C076.
 2. Cabot: Clear Solutions 9200 Series.
 3. Flood: CWF Clear Wood Finish
 4. PPG: Pittsburgh Paints Sun Proof 77-1900 Acrylic/Oil Clear

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with finish application only after unsatisfactory conditions have been corrected.
 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be finished. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 - 1. After completing finishing operations, reinstall items that were removed; use workers skilled in the trades involved. Remove surface-applied protection if any.
- C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 - 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
- D. Exterior Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Prime edges, ends, faces, undersides, and backsides of wood.
 - a. For solid hide stained wood, stain edges and ends after priming.
 - b. For varnish coated stained wood, stain edges and ends and prime with varnish. Prime undersides and backsides with varnish.
 - 3. Countersink steel nails, if used, and fill with putty or plastic wood filler tinted to final color. Sand smooth when dried.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for finish and substrate indicated.
 - 2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
 - 3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 EXTERIOR WOOD-FINISH-SYSTEM SCHEDULE

- A. Finish Carpentry Substrates: Including wood soffits (ceilings).
 - 1. Clear Wood Finish:
 - a. Two Coats: Exterior, clear wood finish.

END OF SECTION 099300

SECTION 101100 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Tackboards.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.
- B. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of panel joints.
 - 2. Include sections of typical trim members.
- C. Samples for Selection: For each type of visual display surface indicated, for units with factory-applied color finishes, and as follows:
 - 1. Actual sections of porcelain-enamel face sheet and tackboard assembly.
- D. Product Schedule: For visual display surfaces. Use same designations indicated on Drawings.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
- F. Maintenance Data: For visual display surfaces to include in maintenance manuals.
- G. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display surfaces vertically with packing materials between each unit.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.

1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish.

B. Fiberboard: ASTM C 208.

C. Extruded Aluminum: ASTM B 221, Alloy 6063.

2.2 TACKBOARD ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AARCO Products, Inc.
 - b. ADP Lemco, Inc.
 - c. Claridge Products and Equipment, Inc.
 - d. Ghent Manufacturing, Inc.
 - e. Newline Products, Inc.
 - f. PolyVision Corporation; a Steelcase company.

- B. Natural-Cork Tackboard: 1/8-inch- thick, natural cork sheet factory laminated to 3/8-inch-thick fiberboard backing.

2.3 TACKBOARD ACCESSORIES

- A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; standard size and shape.
 1. Factory-Applied Trim: Manufacturer's standard.
- B. Chalktray: Manufacturer's standard, continuous.
 1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
- C. Map Rail: Provide the following accessories:
 1. Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches wide.
 2. End Stops: Located at each end of map rail.

2.4 FABRICATION

- A. Visual Display Boards: Factory assemble visual display boards unless otherwise indicated.
 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
- B. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing for visual display surfaces.
- C. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.

3.3 INSTALLATION, GENERAL

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES

- A. Visual Display Boards: Attach visual display boards to wall surfaces with egg-size adhesive gobs at 16 inches o.c., horizontally and vertically.

3.5 CLEANING AND PROTECTION

- A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 101100

SECTION 101400 - SIGNS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of signs:

- 1. Panel signs.
- 2. Dimensional letters and numbers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- B. Shop Drawings: Show fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components.
 - 1. Provide message list for each sign required, including large-scale details of wording and lettering layout.
 - 2. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as a unit of Work in other Sections.
 - 3. Templates: Furnish full-size spacing templates for individually mounted dimensional letters and numbers.
- C. Samples for Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available.

1.4 INFORMATION SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 QUALITY ASSURANCE

- A. Sign Fabricator Qualifications: Firm experienced in producing signs similar to those indicated for this Project, with a record of successful in-service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.
- B. Single-Source Responsibility: For each separate sign type required, obtain signs from one source of a single manufacturer.
- C. Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.
- D. Design Concept: The Drawings indicate sizes, profiles, and dimensional requirements of signs and are based on the specific types and models indicated. Sign units by other manufacturers may be considered provided deviations in dimensions and profiles do not change the design concept as judged by the Architect. The burden of proof of equality is on the proposer.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

1.8 COORDINATION

- A. Coordinate placement of anchorage devices with templates for installing signs.

1.9 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of metal and polymer finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image colors and sign lamination.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Aluminum Castings: Provide aluminum castings of alloy and temper recommended by the sign manufacturer for the casting process used and for the use and finish indicated.
- C. Fasteners: Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.
- D. Anchors and Inserts: Use nonferrous metal or stainless steel anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.2 PANEL SIGNS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Mohawk Sign Systems.
 - 2. Welch Architectural Signage.
- B. Substrate: Fabricate signs from 1/8 inch thick matte clear acrylic with edges mechanically and smoothly finished to eliminate cut marks. Background color to be subsurface.
 - 1. Background Color: As selected by the Architect from manufacturer's standard colors.
 - 2. Edge Condition: Straight.
 - 3. Corner Condition: Rounded to 3/8 inch radius.
 - 4. Size: 6 by 6 inch, unless noted otherwise.
- C. Copy: Helvetica.
- D. Letterform: Route copy into face of substrate 1/32 inch deep. Chemically weld (inlay) computer precision cut tactile copy into routed letter openings so that tactile copy is embedded in substrate and remains at least 1/32" above surface of substrate.
 - 1. Height: 5/8 inch minimum letter height.
- E. Braille: Use engrave process for all Braille areas. Engrave Braille dots into surface of clear material.
- F. Symbols of Accessibility:
 - 1. Accessible elements: Provide international symbol of accessibility.
 - a. Provide male and female symbols as required for toilets.
- G. Provide characters complying with ADA Accessibility Guidelines and ICC/ANSI A117.1. Text shall be accompanied by Grade 2 braille.

2.3 DIMENSIONAL LETTERS AND NUMBERS

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. A.R.K. Ramos Manufacturing Company, Inc.
 - 2. ASI Sign Systems, Inc.
 - 3. Gemini, Inc.
 - 4. Metal Arts.
 - 5. Spanjer Brothers, Inc.
 - 6. Vomar Products, Inc.

- B. Cast Letters and Numbers: Form individual letters and numbers by casting. Produce characters with smooth, flat faces, sharp corners, and precisely formed lines and profiles, free from pits, scale, sand holes, or other defects. Cast lugs into the back of characters and tap to receive threaded mounting studs. Comply with requirements indicated for finish, style, and size.
 - 1. Metal: Aluminum.
 - 2. Plastic Sheet: Not less than 0.125 inch thick.
 - 3. Letter Height: 12 inches.
 - 4. Letter Thickness: 2 inches.
 - 5. Letter Style: As selected by the Architect.

2.4 FINISHES

- A. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related to appearance, provide color matches indicated, or if not indicated, as selected by the Architect from the manufacturer's standards.

- B. Metal Finishes: Comply with NAAMM "Metal Finishes Manual" for finish designations and applications recommendations.

- C. Aluminum Finishes: Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
 - 1. Class II Clear Anodized Fine Satin Finish: AA-M31C21A31 (Mechanical Finish: Fine satin directional textured; Chemical Finish: Fine matte etched finish; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil).

2.5 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Verify that items are sized and located to accommodate signs.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
 - 1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.
 - 2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.
- B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
 - 1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
 - 2. Signs Mounted on Glass: Provide matching opaque plate on opposite side of glass to conceal mounting materials.
- C. Dimensional Letters and Numbers: Mount letters and numbers using standard fastening methods recommended by the manufacturer for letter form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish letter spacing and to locate holes for fasteners.
 - 1. Projected Mounting: Mount aluminum letters and numbers at the projection distance from the wall surface indicated.

3.3 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 PANEL SIGN SCHEDULE

- | A. | Types: | Sizes: | Quantity: |
|----|--------|-----------------|-------------------|
| | Toilet | Provide 8" x 6" | one for each room |
| | Exit | Provide 6" x 6" | one for each exit |
- B. Allow for 12 informational signs, 6 by 6 inch, with minimum of 15 characters each and room number.

END OF SECTION 101400

SECTION 102123 – CUBICLE CURTAINS AND TRACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Cubicle curtains.
- 2. Cubicle tracks.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For cubicle curtains and tracks. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For each type of curtain indicated.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Curtain Fabric: 12-inch- square swatch or larger as required to show complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with shower and dressing compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221.

2.2 CUBICLE CURTAINS

- A. Architex Cubicle Curtain: 100 percent Trevira CS, flame resistant cloth, NFPA 701. 1-1/2 inch hems top and bottom; rustproof grommets 6 inches on center; number 40 open mesh with 1 -1/4 inch cotton tape hem at top. Color as selected by Architect.

2.3 CUBICLE CURTAIN TRACKS

- A. Imperial IFC-98 with IFC-100 roller carriers or approved substitute. Provide one hook for each 6 inches of track length. Configuration as shown on the plans.
- B. Anchorages and Fasteners: Manufacturer's standard, exposed fasteners of stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions.
- B. Install track rigid and level. Secure tracks in position with manufacturer's recommended anchoring devices.
- C. Curtains: Install curtains to specified length and verify that they hang vertically without stress points or diagonal folds.

3.2 ADJUSTING

- A. Curtain Adjustment: After hanging curtains, test and adjust each track or rod to produce unencumbered, smooth operation. Steam and dress down curtains as required to produce crease- and wrinkle-free installation. Remove and replace curtains that are stained or soiled or that have stress points or diagonal folds.

END OF SECTION 102123

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Corner guards.
 - 2. Impact-resistant wall coverings.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide handrails capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform load of 50 lbf/ft. applied in any direction.
 - 2. Concentrated load of 200 lbf applied in any direction.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.

1.4 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, impact strength, fire-test-response characteristics, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.
- B. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Initial Selection: For each type of impact-resistant wall protection unit indicated.
 - 1. Include similar Samples of accent strips and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Corner Guards: 12 inches long. Include examples of joinery, corners, end caps, top caps, and field splices.
 2. Impact-Resistant Wall Covering: 6 by 6 inches square.
- E. Material Certificates: For each impact-resistant plastic material, from manufacturer.
- F. Material Test Reports: For each impact-resistant plastic material.
- G. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.
1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.
- H. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated. Refer to Division 01 Section "Quality Requirements."
1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Surface-Burning Characteristics: Provide impact-resistant, plastic wall protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 2. Keep plastic sheet material out of direct sunlight.
 3. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Store corner-guard covers in a vertical position.
- b. Store wall-guard covers in a horizontal position.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Deterioration of plastic and other materials beyond normal use.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PVC Plastic: ASTM D 1784, Class 1, textured, chemical- and stain-resistant, high-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout; extruded and sheet material, thickness as indicated.
 1. Impact Resistance: Minimum 25.4 ft-lbf/in. of notch when tested according to ASTM D 256, Test Method A.
 2. Chemical and Stain Resistance: Tested according to ASTM D 543 or ASTM D 1308.
 3. Self-extinguishing when tested according to ASTM D 635.
 4. Flame-Spread Index: 25 or less.
 5. Smoke-Developed Index: 450 or less.
- B. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 for Alloy 6063-T5.
- C. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 CORNER GUARDS (CG)

- A. Surface-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with 90-degree turn to match wall condition.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. InPro Corporation; No 160 (2") Surface Mount.
 - 2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; as follows:
 - a. Profile: Nominal 2-inch- long leg and 1/4-inch corner radius.
 - b. Height: Full wall height.
 - c. Color and Texture: As selected by Architect from manufacturer's full range.
 - 3. Retainer: Minimum 0.060-inch- thick, one-piece, extruded aluminum.
 - 4. Retainer Clips: Manufacturer's standard impact-absorbing clips.
 - 5. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2.3 IMPACT-RESISTANT WALL COVERINGS (WP)

- A. Impact-Resistant Sheet Wall Covering: Fabricated from plastic sheet wall-covering material.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. IPC Door and Wall Protection Systems; Division of InPro Corporation.
 - 2. Size: As indicated.
 - 3. Sheet Thickness: 0.080 inch.
 - 4. Color and Texture: As selected by Architect from manufacturer's full range.
 - 5. Height: As indicated.
 - 6. Trim and Joint Moldings: Extruded rigid plastic that matches sheet wall covering color.
 - 7. Mounting: Adhesive.

2.4 FABRICATION

- A. Fabricate impact-resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Preform curved semirigid, impact-resistant sheet wall covering in factory for radius and sheet thickness as follows:
 - 1. Sheet Thickness of 0.040 Inch: 24-inch radius.
 - 2. Sheet Thickness of 0.060 Inch: 36-inch radius.
- C. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- D. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
- E. Miter corners and ends of wood handrails for returns.

2.5 METAL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 3. Run grain of directional finishes with long dimension of each piece.
 - 4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of work.
- B. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For impact-resistant wall protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
 - 1. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
 - a. Provide anchoring devices to withstand imposed loads.
 - b. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches.
- B. Impact-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Toilet accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:

- 1. Construction details and dimensions.
- 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- 3. Material and finish descriptions.
- 4. Features that will be included for Project.
- 5. Manufacturer's warranty.

- B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.

- 1. Approved full-size Samples will be returned and may be used in the Work.

- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

- 1. Identify locations using room designations indicated.
- 2. Identify products using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.8 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- C. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- D. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 TOILET ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated in this section or substitute product by one of the following:
 - 1. A & J Washroom Accessories, Inc.
 - 2. American Specialties, Inc.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Bradley Corporation.
4. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.

B. Toilet Tissue (Roll) Dispenser:

1. Basis-of-Design Product: Bobrick No. B-2888.
2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
3. Mounting: Surface mounted.
4. Operation: Noncontrol delivery with standard spindle.
5. Capacity: Designed for 4-1/2- or 5-inch- diameter tissue rolls.
6. Material and Finish: Stainless steel, No. 4 finish (satin).

C. Paper Towel (Folded) Dispenser:

1. Basis-of-Design Product: Bobrick No. B-262.
2. Mounting: Surface mounted.
3. Minimum Capacity: 400 C-fold or 525 multifold towels.
4. Material and Finish: Stainless steel, No. 4 finish (satin).
5. Lockset: Tumbler type.
6. Refill Indicators: Pierced slots at sides or front.

D. Liquid-Soap Dispenser:

1. Basis-of-Design Product: Bobrick No. B-2112.
2. Description: Designed for dispensing soap in liquid or lotion form.
3. Mounting: Horizontally oriented, surface mounted.
4. Capacity: 40 oz.
5. Materials: Stainless-steel piston, springs, and internal parts designed to dispense soap in measured quantity by pump action; and stainless-steel cover with unbreakable window-type refill indicator.
6. Lockset: Tumbler type.
7. Refill Indicator: Window type.

E. Grab Bar:

1. Basis-of-Design Product: Bobrick No. B-5806 Series.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/4 inches.
5. Configuration and Length: As indicated on Drawings.

F. Sanitary-Napkin Disposal Unit:

1. Basis-of-Design Product: Bobrick No. B-254.
2. Mounting: Surface mounted.
3. Door or Cover: Self-closing, disposal-opening cover.
4. Receptacle: Removable.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

G. Mirror Unit:

1. Basis-of-Design Product: Bobrick No. B-165.
2. Frame: Stainless-steel channel.
 - a. Corners: Welded and ground smooth.
3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
4. Size: 24 by 36 inches.

H. Coat Hook: Provide two hooks on doors where indicated.

1. Basis-of-Design Product: Bobrick B-212.
2. Description: Double-prong unit.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

2.3 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

3.3 SCHEDULE FOR DOOR HOOKS

- A. Provide door hooks for the following rooms: A104, A105, A106, A110, A111, A112, A113, A114, A115, A116, B103, B105, B106, B110, B132.
- B. Provide 4 extra hooks for Owner.

END OF SECTION 102800

SECTION 104413 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire protection cabinets for the following:
 - a. Portable fire extinguishers.
- B. Related Sections:
 - 1. Division 10 Section "Fire Extinguishers."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
 - 1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
 - 2. Show location of knockouts for hose valves.
- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 QUALITY ASSURANCE

- A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

1.6 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.
- C. Coordinate sizes and locations of fire protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Stainless-Steel Sheet: ASTM A 666, Type 304.
- C. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following.
 - 1. J.L. Industries: Cosmopolitan Series C8137F17.
 - 2. Larsen's: Architectural Series SS 2409-6R.
 - 3. Potter-Roemer: Alta Series 7062-A-4.
- C. Cabinet Construction: Nonrated.
- D. Cabinet Material: Enameled steel sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- E. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- F. Cabinet Trim Material: Stainless-steel sheet.
- G. Door Material: Stainless-steel sheet.
- H. Door Style: Fully glazed panel with frame.
- I. Door Glazing: Clear tempered glass, 3 mm.
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 1. Provide projecting door pull and friction latch.
 2. Provide manufacturer's standard hinge permitting door to open 180 degrees.
- K. Finishes:
 1. Manufacturer's standard baked-enamel paint for the following:
 - a. Interior of cabinet and door.
 2. Stainless Steel: No. 4.

2.3 IDENTIFICATION

- A. Identification: Projecting sign with lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
 1. Available Products:
 - a. PTD-182 by Larsen.
 - b. PTD109 by J.L. Industries.
 2. Location: Applied to wall above extinguisher.
 3. Application Process: Pressure-sensitive tape or screw fasteners.
 4. Lettering Color: White on red background with graphic of fire extinguisher and arrow pointing down.

2.4 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 1. Weld joints and grind smooth.
 2. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Fabricate door frames of one-piece construction with edges flanged.
 3. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.7 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 1. Run grain of directional finishes with long dimension of each piece.
 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 3. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for hose and cabinets to verify actual locations of piping connections before cabinet installation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
 - 1. Fire Protection Cabinets: 54 inches above finished floor to top of cabinet.
- B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Sections:
 - 1. Division 10 Section "Fire Extinguisher Cabinets."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FMG.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.7 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - f. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
 - g. Larsen's Manufacturing Company.
 - h. Potter Roemer LLC.
 - 2. Valves: Manufacturer's standard.
 - 3. Handles and Levers: Manufacturer's standard.
 - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install fire extinguishers in cabinets.

END OF SECTION 104416

SECTION 122413 - ROLLER SHADES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Manually operated light-filtering roller shades.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
- B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
- C. Samples for Initial Selection: For each colored component of each type of roller shade indicated.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: Not less than 3 inches square, with specified treatments applied. Mark face of material.
- E. Window Treatment Schedule: For roller shades. List the room numbers indicated on Drawings.
- F. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining roller shades and finishes.
 - 2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
 - 3. Operating hardware.
 - 4. Motorized shade operator.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed installation of roller shades similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain roller shades through one source from a single manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

- 1. Flame-Resistance Ratings: Passes NFPA 701.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.6 WARRANTY

- A. Roller Shade Hardware and Chain: Manufacturer's standard non-depreciating twenty-five year limited warranty.
- B. Shade Cloth: Standard non-depreciating 10-year limited warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade by MechoShade Systems, Inc. or an approved substitute.

2.2 ROLLER SHADES

- A. Light-Filtering Shade Cloth: EcoVeil group, 1550 Series, fabricated from TPO for both core yarn and jacket, single thickness, non-raveling 0.030 inch (0.762 mm) thick fabric.
 - 1. Fabric Width: As required for windows.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Weave: 3 percent open 2 x 2 basket weave.
 3. Colors: As selected by Architect from manufacturer's full range
 4. Bottom Hem: Straight.
- B. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material. Provide capacity for one roller shade band per roller, unless otherwise indicated on Drawings.
- C. Direction of Roll: Regular, from back of roller.
- D. Mounting Brackets: Galvanized or zinc-plated steel.
- E. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated on Drawings; removable design for access.
- F. Top/Back Cover: L shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.
- G. Manual Shade Operation: Provide with continuous loop bead chain, clutch, and cord tensioner and bracket.
1. Position of Clutch Operator: Right side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings.
 2. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
 3. Bead Chain: Nickel-plated metal.
 4. Operating Function: Stop and hold shade at any position in ascending or descending travel.
- H. Mounting: Wall type mounting on gypsum sidewalls permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

2.3 FABRICATION

- A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.
- B. Concealed Components: Non-corrodible or corrosion-resistant-coated materials.
1. Lifting Mechanism: With permanently lubricated moving parts.
- C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
- D. Installation Fasteners: Not fewer than two fasteners per bracket, fabricated from metal non-corrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.
- E. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.5 SCHEDULE

- A. Provide Shade Type 1 (light-filtering shades) in all perimeter windows, unless noted otherwise.

END OF SECTION 122123

SECTION 124813 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Carpet-type mats.

1.3 SUBMITTALS

- A. Product Data: Include manufacturer's specifications and installation instructions, construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of floor mat.
- B. Samples for Selection: For each type of floor mat and frame indicated.
- C. Maintenance Data: For cleaning and maintaining floor mats to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain floor mats and frames through one source from a single manufacturer.
- B. Accessibility Requirements: In addition to requirements of authorities having jurisdiction, provide installed floor mats that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carpet-Type Mats:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Mats Incorporated.

2.2 FLOOR MATS

- A. General: Provide colors, patterns, and profiles of materials, including metals and metal finishes indicated or specified. If not indicated, provide colors, patterns, and profiles selected by Architect from manufacturer's standards.
- B. Carpet-Type Mats: Polypropylene carpet tile bonded to 1/8- to 1/4-inch- thick, flexible vinyl backing to form mats 3/8 or 7/16 inch thick with nonraveling edges.
 1. Available Products: Products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mannington Recourse Tile.

2.3 FABRICATION

- A. General: Where possible, verify sizes by field measurement before shop fabrication.
- B. Floor Mats: Shop fabricate units to greatest extent possible in sizes as indicated. If not otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install surface-type units to comply with manufacturer's written instructions at locations indicated; coordinate with entrance locations and traffic patterns.

3.2 PROTECTION

- A. Defer installation of floor mats until Project is near Substantial Completion.

END OF SECTION 124813

SECTION 211000 - FIRE-SUPPRESSION SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The fire protection system shall revise and add to the existing wet pipe sprinkler riser currently serving the facility to extend sprinkler coverage throughout the renovation and addition areas in accordance with NFPA 13 requirements.
- B. This Section includes fire-suppression sprinklers, piping, and equipment.
- C. The Sprinkler Contractor shall place the sprinkler system in service and hand over the sprinkler system to the General Contractor for care and maintenance.
- D. Performance and Design Criteria: Provide products and systems complying with specific performance and design criteria indicated.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Design sprinklers and obtain approval from authorities having jurisdiction. The design of the automatic sprinkler system shall be complete with all necessary accessories for proper operation.
- B. The system shall be hydraulically calculated in accordance with all provisions of the Contract Documents and any authority having jurisdiction.
- C. Design sprinkler piping according to the following and obtain approval from authorities having jurisdiction:
 - 1. Include a 5 percent margin of safety for available water flow and pressure.
 - 2. Include losses through water-service piping, valves, and backflow preventers.
- D. Sprinkler Occupancy Hazard Classifications:
 - 1. Light Hazard:
 - a. Office and Public Areas
 - 2. Ordinary Hazard, Group 1:
 - a. General Storage Areas

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Mechanical Equipment Rooms
 - c. Building Service Areas.
 - d. Electrical Equipment Rooms
- E. Minimum Density for Automatic-Sprinkler Piping Design shall be in accordance with NFPA 13. Maximum Protection Area per Sprinkler shall be in accordance with NFPA 13.

1.4 GENERAL REQUIREMENTS

- A. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.
- B. Protect all systems from freezing. Provide freeze protection for sprinklers in unheated areas with glycol or dry pipe system.
- C. Bundled/Grouped wired in concealed spaces: Non-combustible spaces having 15 or more non-plenum-rated wires grouped together shall be fully sprinklered.
- D. Seismic Performance: If required by the authority with jurisdiction, fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.
- E. Elevators: Provide sprinkler protection in accordance with authority with jurisdiction requirements.
- F. Coordinate fire department connection type and location with local fire department.
- G. The sprinkler contract starts inside the sprinkler valve room with a connection to the existing riser.
- H. Contractor shall obtain and pay for required permits.

1.5 SUBMITTALS

- A. Shop Drawings: Submit working plans, prepared according to NFPA 13, and hydraulic calculations with cross reference to applicable drawings, water supply data, and equipment schedule with ratings for the system to the Owner's Representative, Insurance Underwriter, and other authorities having jurisdiction.
- B. Product Data: Catalog sheets, specifications, and installation instructions. Indicate UL or FM approval for each product. Include the following additional information:
 - 1. Pipe and fitting materials and methods of joining for sprinkler piping.
 - 2. Pipe hangers and supports.
 - 3. Piping seismic restraints.
 - 4. Valves, including specialty valves, accessories, and devices.
 - 5. Alarm devices. Include electrical data.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. Electrical Devices: Complete description of intended use, wiring diagrams, data plate information and, in the case of switching devices, whether normally on or normally off. Include motor test data.
 7. Mechanical Devices: Complete description of intended use, including normal operating capacities and working pressures.
 8. Enclosures: Dimensions, materials, gages of metals; type of door hinges and locks, and methods of securing the enclosure members to the building construction.
 9. Hose Threads: Verify that hose threads on fire department connections match threads on equipment used by the local or servicing fire department.
- C. Design Data: The portions of the sprinkler system not sized on the Contract Drawings shall be sized in accordance with NFPA requirements for Hydraulically Designed Systems. Submit drawings and hydraulic calculations for approval.
- D. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible sprinkler system design professional. Indicate that products and systems comply with performance and design criteria in the Contract Documents.
1. Certification: Submit Contractor's NICET certification and number or PE license number.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Maintenance Data: For each type of sprinkler specialty to include in maintenance manuals specified in Division 1.

1.6 QUALITY ASSURANCE

A. Sprinkler Contractor

1. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.
2. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified sprinkler designer. Base calculations on results of fire hydrant flow test. Sprinkler designer shall be legally qualified and licensed to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.
3. Contractor shall be a licensed fire sprinkler contractor.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Manufacturer Qualifications:
 - 1. Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.
 - 2. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.
 - 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
 - 4. Factory Mutual Engineering Corporation (FM) Approval Guide
- C. NFPA Requirements: <http://www.maine.gov/dps/fmo/laws/nfpa.html>
 - 1. NFPA#1 Fire Prevention Code, 2007 edition.
 - 2. NFPA #13 "Standard for the Installation of Sprinkler Systems" 2007 edition.
 - 3. NFPA 291: Recommend Practice for Flow Testing and Marking of Hydrants

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 PIPING

- A. Pipe and fittings shall conform to the requirements of NFPA 13. Pipe shall be listed by UL and be FM approved, and installed per its listing and approval.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.2 Sprinkler piping shall be black steel schedule 40, 2 inch and smaller, and thinwall 2 ½ inch and larger. C factor 120.

- A. System piping shall be substantially supported to the building structure. The installation of hangers and supports shall adhere to the requirements set forth in N.F.P.A. 13. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application.

2.3 JOINING MATERIALS

- A. Furnish in accordance with NFPA 13.
- B. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.4 SPRINKLERS

- A. Fire sprinklers shall be of one manufacturer throughout the building. No mixing of sprinkler brands shall be permitted. Sprinklers shall be of all brass frame construction with a quick response frangible bulb type fusible element.
- B. Automatic Sprinklers: With heat-responsive element complying with the following:
 - 1. UL 199, for applications except residential.
 - 2. UL 1767, for early suppression, fast-response applications.
- C. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- D. Provide quick response sprinklers.
- E. Institutional Semi-Recessed or "Vandal-Resistant" sprinkler heads as required by application.
- F. Sprinkler Escutcheons: Materials, types, and finishes of sprinklers. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
- G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.5 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
- B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
- C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
- E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
- F. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.6 VALVES

- A. Valves shall be UL listed and FMG approved

2.7 WATERFLOW ALARMS

- A. Flow of water equal to or greater than that from a single automatic sprinkler (smallest orifice in system) shall result in an audible alarm on the premises within 5 minutes after such flow begins and until such flow stops.
- B. The alarm apparatus shall consist of a listed alarm check valve or other listed waterflow-indicating device with the necessary attachments to give an alarm.
- C. The apparatus for a dry pipe system shall consist of alarm attachments to the dry pipe valve.

2.8 FIRE DEPARTMENT CONNECTION

- A. Relocate the existing fire department connection and test drain to accommodate the renovations.

PART 3 - EXECUTION

3.1 FIRE-SUPPRESSION DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PREPARATION

- A. The nature of the work requires coordination with other trades. Shop fabrication shall be done at the Contractor's risk. Relocation of piping and components to avoid obstructions may be necessary. Relocation, if required, shall be done at the Contractor's expense. The installation shall be performed in a workmanlike manner as determined by the Owner's Representative and in accordance with the Contract Documents, manufacturer's printed installation instructions, and submitted and Owner's Representative reviewed drawings.
- B. Existing Sprinkler System Shutdown:
 - 1. Follow NFPA 13 recommendations.
 - 2. Before shutting down the sprinkler system to perform the Work, notify the Owner's Representative in writing, and the local fire department that the system is to be shut down temporarily. Give schedule which states date and time of proposed shut down and the approximate length of time that the system will be out of service. Request instructions for precautions that should be taken during the shut down period.
 - 3. Do not shut down the system until schedule is approved by the Owner's Representative.
 - 4. Return the existing system to pre-shutdown operation immediately after the Work has been completed. Give written notice to the Director's Representative that the system has been returned to pre-shutdown operation.

3.3 SPRINKLER APPLICATIONS

- A. General: Use sprinklers according to the following applications:
 - 1. Rooms/spaces without Ceilings: Upright sprinklers.
 - 2. All occupied rooms with Finished Ceilings: Recessed Pendent.
 - 3. Provide sprinkler guards for heads in mechanical and storage spaces, less than 8 ft. above finished floor subject to mechanical damage.
 - 4. Low ceilings (under 8 feet): **Concealed**
 - 5. Wall Mounting: Sidewall sprinklers.
 - 6. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
 - 7. Special Applications: Use extended-coverage, flow-control, and quick-response sprinklers where indicated.
- B. Finishes
 - a. Unfinished spaces not exposed to view: rough bronze.
 - b. Recessed Sprinklers: Chrome
 - c. Provide escutcheons with matching color for finished spaces.
 - d. Exposed sprinklers subject to corrosive atmospheres shall have a factory applied corrosion resistant coating.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 SYSTEM INSTALLATIONS

- A. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- B. A sprinkler head wrench of each style and model installed shall be provided to the owner at the completion of the project. A representative sampling of each sprinkler head style and model shall be provided to the owner and housed in a sprinkler head cabinet at or near the sprinkler riser. The number of sprinkler heads provided to the owner shall be in accordance with NFPA 13.
- C. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13

3.5 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceiling in center of all ceiling tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space or glycol per NFPA 13.
- C. Install sprinkler piping with drains for complete system drainage.
- D. Hangers and Supports: Comply with NFPA 13 for hanger materials.

3.6 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.7 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- C. Verify that specified tests of piping are complete.
- D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- F. Verify that potable-water supplies have correct types of backflow preventers.
- G. Verify that glycol system is correct percentage mixture per NFPA 13.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- H. Verify that fire department connections have same type compatible with local fire department equipment.
- I. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- J. Fill wet-pipe sprinkler piping with water.
- K. Energize circuits to electrical equipment and devices.
- L. Coordinate with fire alarm tests. Operate as required.

3.8 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers having paint other than factory finish.

3.9 PAINTING

- A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.10 PROTECTION

- A. Protect sprinklers from damage until Substantial Completion.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

END OF SECTION 210000

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

SECTION 220500 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 230500, common work results for plumbing are included in this section.

END OF SECTION 220500

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

SECTION 220516 – BRAIDED EXPANSION LOOPS AND FITTINGS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 230516, braided expansion loops and fittings for plumbing piping are specified in this Section.

END OF SECTION 220516

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 230529 for hangers and supports for plumbing piping and equipment.

END OF SECTION 220529

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 230553 for identification for plumbing piping and equipment.

END OF SECTION 220553

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 230700 for plumbing insulation.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING – SUPPLEMENTAL INFORMATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section “Common Work Results for Plumbing”
 - 2. Division 22 Section “Hangers and Supports”
 - 3. Division 23 Section – “Vibration and Seismic Controls For HVAC Piping and Equipment”
 - 4. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.

1.2 SUMMARY

- A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.
- B. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.
- C. General layout shown, provide piping to fixtures as required by the Maine Plumbing Code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

1.3 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Water meters.
 - 6. Escutcheons.
 - 7. Sleeves and sleeve seals.
 - 8. Water penetration systems.
- B. Field quality-control reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.
- C. Comply with local building and plumbing codes.
- D. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.
- E. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," and NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for combined fire-protection and domestic water service piping to building.
- F. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.
- G. Water line components shall be lead-free.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 COPPER TUBING

- A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
5. Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

C. Mechanically formed copper or steel tee connections are not acceptable.

2.3 VALVES

A. Ball Valves

1. The valve body and adapter shall be constructed using Lead Free brass. Lead Free ball valves shall comply with state codes and standards, where applicable, requiring reduced lead content.
2. ½" to 2" ball valves: 2-piece full port Lead Free brass ball valves: The valve must have a blowout proof pressure retaining 316 stainless steel stem, 316 stainless steel ball, virgin PTFE seats, seals, stem packing seal and thrust washer. Valve must have adjustable packing. Valves with O-ring stem seal only are not acceptable. Pressure rating no less than 600psi WOG non-shock, 150psi WSP. Valve shall be manufactured to the MSS-SP-110 standard and shall be a Watts Series LFB6080 (threaded) or LFB6081 (solder).
3. Valve sizes 2-1/2" to 4" threaded, shall be rated to 400psi WOG non-shock and 125psi WSP. Valve sizes 2-1/2" to 3" solder shall be rated to 400psi WOG non-shock and 125psi WSP. Valve shall be a Watts Series LFFBV-3C (threaded) or LFFBVS-3C (solder).
4. Provide locking handle where indicated.
5. Aquatherm Greenpipe: Valves shall be manufactured in accordance with the manufacturer's specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
6. Comply with MSS SP-110.

B. Swing check valves: Valves shall be manufactured out of Lead Free brass and be pressure rated to 125psi WSP, 200psi WOG non-shock. Valve shall have metal-to-metal seating, tee pattern design and solder end connections. The Lead Free brass check valves shall comply with state codes and standards, where applicable, requiring reduced lead content. Valve shall be a Watts Series LFCVS.

C. Wafer Check valves:

1. Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between 2 standard Class 125 flanges. Construct iron body valves with pressure containing parts of valves with materials conforming to ANSI/ASTM A 126, Grade B. Support hanger pin by removable side plug.
2. 2" and Larger: Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal: Nibco W920-W, Stockham WG970, Metraflex C-125, Hammond 9253, Milwaukee 1400, Watts ICV/ICV-F series, or approved equal.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

D. Swing check valves:

1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B
2. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71
3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
4. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413B, Stockham B319, Milwaukee 509 or approved equal.
5. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-B, Stockham B309, Milwaukee 1509 or approved equal.
6. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Hammond IR1124, Nibco F918-B, Stockham G931, Milwaukee F2974, Watts 411 or approved equal.

E. Refer to Division 22 Section "Plumbing Specialties" for balancing and drain valves.

2.4 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Hyspan Precision Products, Inc.
4. Mercer Rubber Co.
5. Metraflex, Inc.
6. Universal Metal Hose; a Hyspan company

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing. Working-Pressure Rating: Minimum 200 psig. End connections compatible with piping.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing. Working-Pressure Rating: Minimum 200 psig. End connections compatible with piping.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated. Piping 5" and larger: Grooved joints may be used on aboveground grooved-end piping.

C. Mechanically formed tee-branch outlets and brazed joints shall not be used.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Aboveground Domestic Water or Non-Potable Water Piping: Use the following piping materials for each size range:
1. NPS 3 and Smaller: Type L copper.
 2. NPS 4 to NPS 6: Type L copper.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use bronze ball valves for piping NPS 3 and smaller. Use cast-iron butterfly valves with flanged or grooved ends for piping NPS 4 and larger. Aquatherm: ball valves.
 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 3 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 4 and larger.
 3. Hot-Water-Piping, Balancing Duty: Calibrated, memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.

3.3 VALVE INSTALLATION

- A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment.
- B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops.
- C. Install hose end drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
- D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Refer to Division 22 Section "Plumbing Specialties" for calibrated balancing valves.

3.4 PIPING INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation.
- B. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each domestic water service.
- D. Provide dielectric fittings as specified in Section 230500.
- E. Install aboveground domestic water piping level and plumb.
- F. Provide firestopping as per Section 230500 "Common Work Results for HVAC".

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- H. Perform the following steps before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 - 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- I. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- J. Check plumbing specialties and verify proper settings, adjustments, and operation.
- K. Energize pumps and verify proper operation.

3.5 JOINT CONSTRUCTION

- A. Refer to Division 22 Section “Common Work Results for Plumbing” for basic piping joint construction.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.6 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump. Domestic water temperature maintenance pumps do not require flexible connectors.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Hanger, support, and anchor devices are specified in Division 22 Section "Hangers and Supports."
- B. Provide seismic restraints in accordance with Section 230548.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water service piping. Use transition fitting to join dissimilar piping materials.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the equipment and fixtures as shown on the plans.
- E. Connect water piping in sizes indicated, but not smaller than sizes of unit connections.
- F. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 FIELD QUALITY CONTROL

- A. Follow local code requirements.
- B. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Test domestic water piping as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- D. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch. Adjust calibrated balancing valves to flows indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.10 CLEANING

- A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses. Clean and disinfect domestic water piping per code requirements or administrative authority requirements. Sample procedure as indicated:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following: Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 221116

SECTION 221119 - PLUMBING SPECIALTIES-SUPPLEMENTAL INFORMATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"

1.2 SUMMARY

- A. This Section includes plumbing specialties.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Piping: 125 psig.
 - 2. Sanitary Waste and Vent Piping: 10-foot head of water.
 - 3. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data
- B. Field test reports.

1.6 QUALITY ASSURANCE

- A. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.
- D. [Comply with local building and plumbing codes.]
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- F. Water line components shall be lead-free.
- G. NSF Compliance: Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

- A. Provide access panels to concealed valves, cleanouts, and components that require service access. All components shall have proper access in accordance with manufactures' recommendations. Refer to Section 220500.

2.2 BACKFLOW PREVENTERS

- A. Manufacturers:
 - 1. Ames Co., Inc.
 - 2. Cla-Val Co.
 - 3. Apollo
 - 4. CMB Industries, Inc.; Febco Backflow Preventers.
 - 5. Conbraco Industries, Inc.
 - 6. Watts Industries, Inc.; Water Products Div.
 - 7. Zurn Industries, Inc.; Wilkins Div.
- B. General: ASSE standard, backflow preventers.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
 - 3. Interior Components: Corrosion-resistant materials. AWWA C550 or FDA-approved
 - 4. Exterior Finish: manufacturer's standard.
 - 5. Strainer: On inlet, lead-free.
 - 6. Lead free.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Backflow preventers for hot water over 110F shall be a listed type for that application.
- C. Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.
- D. Hose-Connection Vacuum Breakers: Watts Series 8FR; ASSE 1011, nickel plated, with non-removable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.
- E. Double-Check Backflow Prevention Assemblies:
 1. Watts Series LF007 (2-1/2" and smaller)
 2. Watts Series LF709 (3" and larger)
 3. ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 4. Lead-free
- F. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include ball or gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
 1. Provide lead-free construction.
 2. Provide air gap fitting.
 3. Provide lead-free bronze strainer/
 4. Watts Series LF909 or LF994

2.3 STRAINERS FOR DOMESTIC WATER PIPING

- A. 3" and smaller: Y-type strainer shall be domestically manufactured, and conform to MIL-S-16293, and be ANSI 3rd party certified to comply with states' lead plumbing law 0.25% maximum weighted average lead content requirement. The main body shall be low lead bronze (ASTM B 584), the access cover shall be yellow brass (ASTM B 16) or cast bronze (ASTM B 584), the strainer screen shall be 300 series stainless steel, 20 mesh. Screens shall be accessible for cleaning without removing the device from the line. The "Y" type strainer shall be a WILKINS Model YBXL. Drain: Pipe plug.
- B. 4" and larger: The lead-free cast iron "Y" type strainer shall be in compliance with MIL-S-16293F Type 2. The main body and access cover shall be cast iron (ASTM A 126 Class B) and coated with a FDA approved epoxy coating inside and out. The integral strainer screen shall be accessible for cleaning without removing the device from the line. The Cast Iron "Y" type strainer shall be a WILKINS Model FSC-DOM. Pressure/temperature: 200 psi @ 150°F WOG; End connections: Flanged Class 125 lb. Drain: Factory-installed, hose-end drain valve.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 HYDRANTS AND HOSE BIBBS

- A. Manufacturers:
1. Josam Co.
 2. Murdock, Inc.
 3. Simmons Manufacturing Co.
 4. Smith, Jay R. Mfg. Co.
 5. Tyler Pipe; Wade Div.
 6. Watts Industries, Inc.; Drainage Products Div.
 7. Woodford Manufacturing Co.
 8. Zurn
 9. MAPA Products
- B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.
1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
 2. Outlet: ASME B1.20.7, garden-hose threads.
 3. Operating Keys: One with each key-operation hydrant.
- C. Non-freeze Concealed-Outlet Wall Hydrants: Zurn Z1322-EZ encased Ecolotrol anti-siphon; ASSE 1019, 3/4" pipe connection; automatic draining with flush-mounting box with cover, integral non-removable hose-connection backflow preventer, casing and operating rod to match wall thickness, concealed outlet, and wall clamp. Provide nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover.
- D. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral non-removable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.
1. Finish for Equipment Rooms: Rough bronze.
 2. Finish for Finished Rooms: Chrome or nickel plated.
 3. Operation for Equipment Rooms: Wheel handle.
 4. Operation for Finished Rooms: Operating key.
 5. Include operating key with each operating-key hose bibb.
 6. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.5 WATER HAMMER ARRESTORS

- A. Lead-free 0.25% maximum weighted average lead content requirement, consist of a copper body with a low lead brass hexagonal male pipe threaded inlet, an acetal, polycarbonate or low lead brass piston with Buna Nitrile or EPDM o-rings and lead free solder; ASSE® Listed 1010, ANSI A112.26.1. The device shall be pre-charged and sealed at the factory. The Water Hammer Arrester shall be a WILKINS Model 1250XL.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Stack Flashing Fittings:

1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.8 CLEANOUTS

A. Manufacturers

1. Zurn
2. Smith, Jay R. Mfg. Co.
3. Josam Co.
4. Tyler Pipe, Wade Div.
5. Watts Industries, Inc., Drainage Products Div.
6. Mifab

- B. Cleanouts shall be easily accessible and shall be gastight and watertight. Provide a minimum clearance of 24 inches for the rodding. Size of cleanout shall be same as pipe size through 4". Pipes 4" and larger shall have 4" cleanouts.

- C. Floor Cleanouts: Mifab C1000 Series floor cleanout with heavy-duty nickel-bronze or stainless steel adjustable top.

1. Compliance: ANSI/ASME A112.36.2M.
2. Load Rating: Up to 7,499 pounds.
3. Body: A1, 8-inch diameter body. Lacquered, ASTM A 48, Class 25 cast iron body with anchor flange. O-ring secondary gasket seal. 4-inch; 4"NPS machined integral body threads.
4. Combined Access Cover and Plug Top Assembly: Heavy-duty, round, 5-inch diameter; square, 5-inch by 5-inch (for tile insertion), adjustable, Type 304 stainless steel top assembly with No. 4 satin finish. Neoprene primary gasket seal. Vandal-resistant stainless steel screws.
5. When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts.
6. In carpeted areas, provide carpet cleanout markers.

- D. Cleanouts shall consist of "Y" fittings and (1/8 inch) bends with brass or bronze screw plugs.

- E. Provide cleanouts at or near the base of the vertical stacks with the cleanout plug located approximately 24 inches above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack Cleanout shall consist of sanitary tees. . Extend the cleanouts to the wall access cover; Mifab 1400 Series.

- F. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

2.9 ROOF DRAINS

- A. Roof Drains: Comply with ASME A112.21.2M.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

B. Manufacturers

1. MIFAB
2. Josam Co.
3. Froet Industries
4. Smith, Jay R. Mfg. Co.
5. Tyler Pipe, Wade Div.
6. Watts
7. Zurn

C. Roof Drains: Mifab R1200-EU large sump roof drain Coordinate Drain Type with roofer:

1. Large Sump Roof Drain for 1-3/4 inches to 7 inches insulation. Compliance: ANSI/ASME A112.21.2M. Body: A2 deep sump body. Lacquered, ASTM-A 48, Class 25 cast iron body with anchor flange. Dome Strainer: Self-locking poly dome strainer. Free area of 136 square inches. Membrane Clamp Ring: 2-5/16-inch wide, ASTM A 48, Class 25 cast iron, waterproofing membrane clamp ring with integral gravel stop. Extension Flange: Adjustable, ASTM A 48, Class 25 cast iron, extension deck flange and under deck clamp.
2. Large Sump Roof Drain with Adjustable Ballast Guard for I.R.M.A. Roofs: MIFAB R1200-HC-M lacquered cast iron deep sump roof drain with anchor flange, adjustable extension with auxiliary drainage slots, secondary clamp, large cast iron waterproofing membrane clamp ring with integral gravel stop and metal dome strainer with a free area of 136 sq. inches.

D. Roof Drain Controlled Flow: Zurn Z105-DP cast iron body with flashing clamp, top-set deck plate and polyethylene dome. Trapezoidal weirs limit flow to leaders.

E. Roof Drain-Parapet Roofs: Zurn Z187 cast iron body, flashing clamp and loose set angle grate. Zurn Z191, Z191-RD or Z192 series cast iron downspout boots on exposed sheet metal leaders.

F. Overflow Roof Drains: “Froet Drain” bi-functional roof drains, or equal.

1. Dual Outlets:

- a. Primary Drain Outlet: Attached to storm piping
- b. Overflow Drain Outlet: Attached to relieve area outside of building, separate from primary drain system.
- c. Secondary drain downspout nozzle: J.R. Smith 1770; nozzle design diverts water away from building, eliminating wall stains. Wall flange covers rough opening and serves as anchor. Cast Bronze Nozzle and Flange. Provide bird screen.

2. Compliance:

- a. ANSI/ASME A112.6.4.
- b. IAPMO IGC 187.
- c. ICC-ES LC 1021.

3. Body:

- a. Bi-functional.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

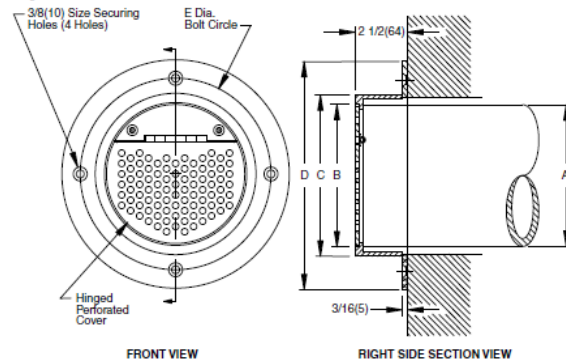
- b. Cast Iron: ASTM A 48, Class 25.
- c. Anchor flange.

- 4. Powder coated.
- 5. Dome Strainer:
 - a. Cast Iron: ASTM A 48, Class 25.

- 6. Minimum Free Area: 136 square inches.
- 7. Waterproofing Membrane Clamp Ring:
 - a. Width: 2.375 inches
 - b. ; Cast Iron: ASTM A 48, Class 25.

- 8. Integral Gravel Stop: 1-1/4-inch height minimum.
- 9. Pipe Size: as shown on plans.
- 10. Downspout Cover: Equal to Jay R. Smith, figure 1775, type 304 stainless steel cover with hinged perforated cover.

FUNCTION: Used as a downspout cover on a wall where an overflow roof drain concealed leader discharges rainwater to the ground.



- G. Scupper Drain:
 - 1. Equal to Zurn, model Z187, 8" x 12" Oblique Scupper Drain
 - a. Dura-Coated cast iron body with reversible back or bottom outlet, oblique aluminum grate with 90 degree combination frame and membrane clamp.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to hydronic systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
 4. Access shall be provided for testing, maintenance and repair. Locate backflow preventer between 2 feet and 5 feet above floor.
 5. Test of Backflow Prevention Assemblies: Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:
 - a. Data on Device Data on Testing Firm
 - b. Type of Assembly Name
 - c. Manufacturer Address
 - d. Model Number Certified Tester
 - e. Serial Number Certified Tester No.
 - f. Size Date of Test
 - g. Location
 - h. Test Pressure Readings Serial Number and Test Data of Gauges
 - i. If the unit fails to meet specified requirements, the unit shall be repaired and retested.
- C. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- D. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.
- E. Trap primers:
1. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - a. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - b. Size: Same as floor drain inlet.
 2. Install trap seal primers in accordance with manufacturer's instructions.
 3. Cycle trap seal primers a minimum of 6 times to ensure optimum performance.
 4. Ensure flux and other debris is removed.
 5. Use only Teflon tape around threads. Do not use pipe dope or paste.
 6. Do not solder fittings directly onto inlet or outlet of primer.
 7. Do not install trap seal primers closer than 40 feet apart when using same potable water supply line.
 8. Mount trap seal primers in a vertical position 1 foot above finished floor for every 20 feet of floor drain trap make-up water line.
 9. Install union connection above trap seal primers.
 10. Install line shut-off valve upstream of trap seal primers to shut off water supply when performing maintenance on trap seal primers.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

11. Avoid direct installation to prevent foreign material from entering directly into trap seal primers.
- F. Install expansion joints on vertical risers, stacks, and conductors if indicated.
- G. Cleanouts:
1. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated: Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated. Locate at each change in direction of piping greater than 45 degrees. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping. Locate at base of each vertical soil and waste stack.
 2. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
 3. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
 4. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- H. Install floor drains in accordance with manufacturer's instructions at locations indicated on the drawings.
1. Protect installed floor drains from damage during construction.
 2. Install floor drains at low points of surface areas to be drained.
 3. Install floor drains plumb, level, and to correct elevation.
 4. Ensure top of floor drains are flush with top of finished floor.
 5. Install floor drains using manufacturer's supplied hardware.
 6. Coordinate depressed/pitched slab with concrete contractor.
 7. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 8. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- I. Roof Drains:
1. Coordination:
 - a. Roof drains installed and flashed by roofing contractor.
 - b. Roof drains furnished, insulated, and connected to piping by Division 22.
 2. Examine areas to receive roof drains. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.
 3. Install roof drains in accordance with manufacturer's instructions at locations indicated on the drawings.
 4. Install roof drains plumb, level, and to correct elevation.
 5. Install roof drains using manufacturer's supplied hardware.
 6. Protect installed roof drains from damage during construction.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- J. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- K. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- L. Install wood-blocking reinforcement for wall mounting and recessed-type plumbing specialties.
- M. Install individual shutoff valve in each water supply to plumbing specialties. Install shutoff valves in accessible locations.
- N. Install air vents at piping high points. Include ball valve in inlet.
- O. Install traps on plumbing specialty drain outlets.
- P. Water hammer arrestors shall be installed at solenoid valves, as shown on the plans and as recommended by Plumbing & Drainage Institute Standard PDI-WH-201. Locate units at the end of branch lines, between the last two fixtures served. Size units based on fixture unit total of branch. All branch pipes serving flush valve water closets shall have water hammer arrestors.
- Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect plumbing specialties to piping specified in other Division 22 Sections.
- D. Connect plumbing specialties and devices that require power according to Electrical Specification Sections.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and their installation, including piping and electrical connections. Report results in writing. Representative shall train Owner's maintenance personnel to adjust, operate, and maintain.
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221119

SECTION 223500 – INDIRECT-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"

1.2 SUMMARY

- A. This Section includes indirect-fired water heaters.

1.3 SUBMITTALS

- A. Product Data: For each type and size of indirect-fired water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For indirect-fired water heaters to include in emergency, operation, and maintenance manuals.
- C. Warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of indirect-fired water heaters through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of indirect-fired water heaters that fail in materials or workmanship within specified warranty period.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Failures include, but are not limited to, the following:
 - a. Structural failures including indirect-fired water heater, storage tank, and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period(s): From date of Substantial Completion: 5 years.

PART 2 - PRODUCTS

2.1 INDIRECT-FIRED STORAGE WATER HEATERS

A. Manufacturers

1. Manufacturers: Subject to compliance with requirements, provide products by Viessmann, to match existing.

B. Description: Indirect fired, Equal to Viessmann Vitocell 300-V, less circulator and controls.

C. Storage-Tank-Shell Construction: SA 240-316 Ti stainless steel with 150-psig working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, pressure gage, thermometer, blowdown, vent, and controls as required. Attach tappings to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
2. Interior Finish: 316L Stainless steel
3. Insulation: CFC-free 2 1/4" foamed-in-place wrap around PET, HCFC-free insulation. Comply with ASHRAE 90.1. (less than 0.4 F/hr heat loss)
4. Outer Jacket: Polyethylene.
5. Provide factory T&P relief-valve.

D. Heat Exchanger System:

1. 1 1/4" stainless steel heat exchanger, extending to bottom of tank.

PART 3 - EXECUTION

3.1 STORAGE WATER HEATER INSTALLATION

- A. Install indirect-fired water heaters on concrete bases. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing"
- B. Install indirect-fired water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install seismic restraints for indirect-fired water heaters. Anchor to substrate.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Install temperature and pressure relief valves in top portion of storage tank shells of indirect-fired water heaters with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Fill indirect-fired water heaters with water, purge, and startup in accordance with manufactures' recommendations.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to indirect-fired water heaters to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Remove and replace indirect-fired water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain indirect-fired water heaters. Refer to Division 1.

END OF SECTION 223500

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"
 - 2. Section 221116 - Domestic Water Piping: Material and installation of piping systems, valves, and piping specialties.
 - 3. Division 22 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.2 SUMMARY

- A. Plumbing Fixtures
- B. Electric Water Coolers
- C. Emergency Plumbing Fixtures.

1.3 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.
- D. [Comply with local building and plumbing codes.]
- E. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.
- F. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- G. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- H. Water line components shall be lead-free.

1.5 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Common Plumbing Fixture Requirements
 - 1. Fixtures shall be water conservation type in accordance with local, state, and federal requirements.
 - 2. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws.
 - 3. Fixture color shall be white except as specified herein.
 - 4. Provide combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
 - 5. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings.
 - 6. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap.
 - 7. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view.
 - 8. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

9. Fixture supports for off-the-floor fixtures shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.
10. Provide access panels to concealed valves and components. All components shall have proper access in accordance with manufactures' recommendations. Refer to Section 220500.
11. Mounting heights: Refer to Architectural Plans.

2.2 TANK TYPE WATER CLOSETS

A. Manufacturers

1. American Standard, Inc.
2. Kohler Co.
3. Toto
4. Zurn

B. ADA pressure assisted toilet: American Standard model #2467.016, Vitreous China, Cadet Right Height Elongated Pressure -Assisted Toilet, 1.6 gpf. EverClean surface inhibits growth of bacteria, mold and mildew. Bowl rim height 16 1/2", 2-1/8" trapway.

C. Color: Factory White.

D. Provide closet supply kit includes one chrome plated solid brass angle stop with round wheel-handle, all brass stem and replaceable high tech purple washer. The high tech washer shall be resistant to chlorine, chloramine and high water temperatures. The kit shall also include a 12" flexible chrome plated copper closet riser and one chrome plated steel flange.

E. Seats: color-matched and design-matched solid plastic toilet seat and cover with slow-close hinges and EverClean surface.

F. Provide closet bolt/wax ring and hardware installation kit.

2.3 LAVATORIES

A. Lavatory Manufacturers:

1. Kohler (Basis of Design)
2. American Standard, Inc
3. Toto
4. Zurn

B. Typical for All Lavatories:

1. Coordinate hole punchings with faucet.
2. Provide overflow.
3. Drain fitting: type 304 stainless steel fixed grid.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. C/O plug with 1-1/4" diameter 17-gauge tailpiece and cast brass locknut for sink depths up to 2-1/4". Offset tailpiece for ADA applications.
 5. P-trap: chrome plated, cast body p-trap, tubular wall bend 10-1/2" CL, die cast nuts, shallow escutcheon with 1-1/4" compression inlet x 1-1/2" compression outlet.
 6. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft; loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two chrome-plated steel flanges; connections: 1/2" sweat x 3/8" OD.
 7. Color: White.
- C. ADA Wall-Hung Lavatory: Kohler Pinoir K-2035 wall-mount lavatory shall be 20" in length, 18" in depth. Lavatory shall be made of vitreous china. Lavatory shall have 4" centers.
- D. Lavatory Shield: Provide the Pinoir pipe shroud to conceal all lavatory piping and mixing valves.

2.4 LAVATORY FAUCETS

- A. Faucet Manufacturers:
1. Chicago
 2. Zurn
 3. Kohler
 4. American Standard
 5. Symmons
- B. ADA Two Handle Faucet: Chicago Faucets 802-317ABCP heavy duty cast brass centerset faucet, 4" centers, two handle, Polished chrome plated finish with polished under spout , Metal hold-down package, Color indexed metal handles with vandal resistant screws, 1/4 turn ceramic structures.
1. With stainless steel open grid strainer
 2. Vandal Resistant 0.5 USGPM Flow Control Non-Aerating Spray Outlet
 3. 3" ADA lever blade handles.

2.5 STAINLESS STEEL SINKS

- A. Sink Manufacturers:
1. Elkay Manufacturing Co.
 2. Just Manufacturing Co.
 3. Kindred
 4. Advance Tabco
- B. Faucet Manufacturers
1. Symmons
 2. Delta Commercial
 3. Chicago
 4. Zurn
 5. Kohler
 6. American Standard

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

C. Common requirements

1. Protective Shielding Guards: Provide for ADA installation with exposed piping.
2. Hole punchings to match faucet type.
3. Supplies: Provide stops below sink

D. Exam Room Sink: Elkay LRAD 1517 counter-mounting, single compartment, Type 304stainless-steel fixture.

1. Overall Size: 15" X 17-1/2".
2. Sink Faucet: Chicago Faucets 895-317E29ABCP two handle faucet with 3 1/2" rigid gooseneck faucet; 1/2 inch IPS connections; 3 hole installation (include\ optional escutcheon), 4" centers; metal construction with chrome finish; ASME A112.18.1-2005. Provide non aerating, laminar flow outlet.
3. Drain Fitting: type 304 stainless steel fixed grid strainer; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2" elbow for ADA offset.

E. Clean Room Sink (Left) and Autoclave sink: Elkay LR 1517 counter-mounting, single compartment, Type 304 stainless-steel fixture.

1. Overall Size: 15" X 17-1/2".
2. Sink Faucet: Chicago Faucets 895-317E29ABCP two handle faucet with 3 1/2" rigid gooseneck faucet; 1/2 inch IPS connections; 3 hole installation (include\ optional escutcheon) with 4" centers; metal construction with chrome finish; ASME A112.18.1-2005. Provide non aerating, laminar flow outlet.
3. Drain Fitting: type 304 stainless steel fixed grid strainer; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2" elbow for ADA offset.

F. Clean Room Sink (Right): Elkay LR 1720 counter-mounting, single compartment, Type 304 stainless-steel fixture.

1. Overall Size: 17" X 20".
2. Sink Faucet: Chicago Faucets 895-317E29ABCP two handle faucet with 3 1/2" rigid gooseneck faucet; 1/2 inch IPS connections; 3 hole installation (include\ optional escutcheon) with 8" centers; metal construction with chrome finish; ASME A112.18.1-2005. Provide non aerating, laminar flow outlet
3. Provide Guardian G1200 faucet mounted eyewash. The unit shall be equipped with a diverter valve for the eyewash and a separate control valve for the faucet. Outlet heads shall be mounted 3" apart and deliver a soft, aerated flow of water. Heads shall angle forward toward user. Angle of heads shall be adjustable to permit full coverage and avoid splashing. Furnish with float-off dust covers to protect outlet heads. Forged brass diverter valve, quarter turn ball valve with chrome plated brass ball, molded TFE seals and plastic handle, 55/54"-27 female thread body. Furnished with three adaptors (15/16"-27, 13/16"-27 and 3/8" IPS) for installing on most commonly used faucets, including laboratory-type faucets.
4. Provide non aerating laminar flow outlet.
5. Drain Fitting: type 304 stainless steel fixed grid strainer; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2" elbow for ADA offset.

G. Nurse's Station Nourishment Sink: Elkay LRAD 2918 counter-mounting, single compartment, Type 304stainless-steel fixture.

1. Overall Size: 29" X 18" X 6".

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Sink Faucet: Chicago Faucets 895-317E29ABCP two handle faucet with 3 ½” rigid gooseneck faucet; 1/2 inch IPS connections; 3 hole installation (include\ optional escutcheon), 4” centers; metal construction with chrome finish; ASME A112.18.1-2005. Provide non aerating, laminar flow outlet.
3. Drain Fitting: type 304 stainless steel fixed grid strainer; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2" elbow for ADA offset.

H. Post-op sink: Elkay LR 1517 counter-mounting, single compartment, Type 304 stainless-steel fixture.

1. Overall Size: 15” X 17-1/2” X 6”.
2. Sink Faucet: Chicago Faucets 895-317E29ABCP two handle faucet with 3 ½” rigid gooseneck faucet; 1/2 inch IPS connections; 3 hole installation (include\ optional escutcheon) with 4” centers; metal construction with chrome finish; ASME A112.18.1-2005. Provide non aerating, laminar flow outlet.
3. Drain Fitting: type 304 stainless steel fixed grid strainer; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2" elbow for ADA offset.

I. Staff Sink: Elkay LRADQ2521, counter-mounting, single compartment, Type 304stainless-steel fixture.

1. Overall Size: 25” X 21-1/4”.
2. Sink Faucet: Chicago Faucets Model 2300-8E34ABCP single handle kitchen faucet; integral vacuum breaker and ceramic control components; 1/2 inch IPS connections; single hole or 3 hole installation (include\ optional escutcheon); metal construction with chrome finish; ASME A112.18.1-2005.
3. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2" elbow for ADA offset.

2.6 SCRUB SINK

A. Scrub Sinks: two-station, wall-mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Steris, Amsco Flexmatic (Basis of Design)
 - b. Skytron – (SS2122-MK)
 - c. Universal Metal; (BLICKMAN 8000 SERIES)
 - d. Continental Metal Products

B. Unit construction shall be #16 gauge, type 304, stainless steel double station slant front scrub-up sink with manually operated faucets, coved corners, wall hanger, full length backsplash, and full enclosure. Exposed surfaces shall be polished to a satin finish. Underside shall be sound deadened; ASME A112.19.3/CSA B45.4. Fixture shall include 18 gauge stainless skirt to conceal piping, chromium plated brass strainer with gasket, tailpiece, and nut. Exposed surfaces shall be phosphatized, scaled, and powder painted with corrosion resistant textured finish. Washing compartment shall be glass beaded to a matte finish.

C. Include knee operated push controls for both the water and soap dispenser, separate controls for each sink station.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Fixture shall include thermostatically controlled mixing valves with anti-scald feature to regulate water temperature.
 - 1. Nominal Size: 64” wide by 27” projection from wall by 51 1/2” high (AFF).
 - 2. Drain: two LK18B SS perforated strainer grid, drain fitting with 1-1/2” OD x 4” SS tailpiece.
 - 3. Support: ASME A112.6.1M, Type II sink carrier.

2.7 EMERGENCY PLUMBING FIXTURES

A. Manufacturers

- 1. Bradley Corporation
- 2. Encon Safety Products
- 3. Guardian Equipment Co.
- 4. Haws Corporation.
- 5. Speakman Co.
- 6. Chicago Faucets

- B. ANSI Standard: Comply with ANSI Z358.1-1998, "Emergency Eyewash and Shower Equipment." Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

C. Wall-Mounted Eye Wash:

- 1. Third party certified to ANSI Z358.1, the eyewash shall deliver 2.4 GPM @ 30/70 psi of flowing pressure. Unit shall provide a non-injurious stream of water.
- 2. Unit shall be supplied with 1/2” chrome plated (CP) single motion activation stay open ball valve with CP ball. Eyewash shall include stainless steel (SS) actuator with actuation graphic, 7” X 11” sign and SS wall mounting bracket.
- 3. Unit shall be supplied with self-adjusting 2.4 gpm regulator to assure a constant and even dual stream flow pattern under 30/70 psi hydraulic conditions.
- 4. Eyewash heads with integral hinged covers to be manufactured of solvent resistant acetal mounted on chrome plated brass wye in a type 304 SS bowl.
- 5. Eyewash covers shall be provided to inhibit dust and/or contamination when not in use. Eyewash units with deteriorating screens/filters are not acceptable.
- 6. Eyewash shall be Encon Safety Products Model 01045001.
- 7. Tempering Unit: Lawler 911 E or equal by the Leonard Valve Co. Model TA-300.

D. Wall-Mounted Eye/Face Wash:

- 1. Eye/Face Wash shall deliver 6.4 gpm @ 30/70 psi of flowing pressure; provide self-adjusting regulator. Eyewash shall provide a non-injurious stream of water for 15 minutes or longer. Eye/Facewash shall be Encon Safety Products Model 01035501 or equal by the Guardian Equipment Co Model G-1750P.

- E. Unit shall be supplied with 1/2” chrome plated (CP) single motion activation stay open ball valve Co. Provide ball valves and check valves on inlets.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION - GENERAL

- A. Assemble and support fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- D. Install traps on fixture outlets as required.
- E. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section "Common Work Results for Plumbing" for escutcheons.
- F. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.3 SINKS AND LAVATORIES

- A. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- B. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- C. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.
- C. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- D. Provide plumbing hookups to Fixtures and Equipment Specified in Section 113100 “Residential Appliances”. Connect fixtures and equipment with water supplies Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

3.5 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING

- A. Operate and adjust fixtures. Replace damaged and malfunctioning fixtures.
- B. Adjust water pressure to produce proper flow and stream.
- C. Adjust tempering devices to a maximum outlet temperature of 110 degrees F.
- D. Emergency plumbing fixtures: adjust to approximately 85°F temperature.
- E. Replace washers and seals of leaking and dripping faucets and stops.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures and other fittings with manufacturers' recommended cleaning methods and materials. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts. Remove sediment and debris from drains.
- C. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.8 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless allowed in Division 1.

END OF SECTION 224000

SECTION 226213 - VACUUM PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 15 inches mercury.
- B. Related Sections include the following:

1.3 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. WAGD: Waste anesthetic gas disposal.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Vacuum pipes and fittings.
 - 2. Vacuum valves and valve boxes.
 - 3. Medical vacuum service connections and vacuum-bottle brackets.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
2. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
3. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

- C. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- F. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.

- G. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Medical Vacuum Service(s): Do not interrupt medical vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of medical vacuum service.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Do not proceed with interruption of medical vacuum service(s) without Construction Manager's written permission.

1.7 COORDINATION

- A. Coordinate medical vacuum service connections with other service connections.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.2 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.3 VALVES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Allied Healthcare Products, Inc.; Chemetron Div.
 2. Amico Corporation.
 3. BeaconMedaes.
 4. Conbraco Industries, Inc.
 5. NIBCO INC.
 - a. Squire-Cogswell/Aeros Instruments, Inc.
- B. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
 1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever type with locking device.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

- D. Bronze Check Valves: In-line pattern.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Operation: Spring loaded.
 - 3. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

- E. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever type with locking device.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 7. Vacuum Gage: Manufacturer installed on one copper-tube extension.

- F. Zone Valve Boxes: Formed steel or aluminum or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
 - 1. Interior Finish: Factory-applied white enamel.
 - 2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
 - 3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

- G. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where for wall mounting.

2.4 MEDICAL VACUUM SERVICE CONNECTIONS

- A. Basis-of-Design Product: BeaconMedaes.

- B. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates shall not be required as service connection is part of a multiple unit or assembly with cover plate. Refer to Section 226313 for additional outlets to be included with the assembly station. Furnish recessed-type units made for concealed piping unless otherwise indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Coordinate strictly with Eyecare Medical Group to match existing outlet, accessory, and connection types and configurations.
1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body inlet block.
 - c. Seals that will prevent vacuum leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Seals that will prevent vacuum leakage.
 - c. Cover plate with gas-service label.
 3. Quick-Coupler Service Connections: Suction inlets for medical vacuum medical vacuum and WAGD evacuation service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
 4. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.
 - b. WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.
 5. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
 6. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.5 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Hyspan Precision Products, Inc.
 4. Mercer Rubber Co.
 5. Metraflex, Inc.
 6. Proco Products, Inc.
 7. Unaflex.
 8. Universal Metal Hose; a Hyspan Co.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: 250 psig minimum.
 - 2. End Connections: Threaded copper pipe or plain-end copper tube.

2.6 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Connect new copper tubing to existing tubing with memory-metal couplings.
- B. Medical Vacuum and WAGD Piping: Use the following piping materials for each size range:
 - 1. Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- C. Drain Piping: Use the following piping materials:
 - 1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Comply with ASSE Standard #6010 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install vacuum and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
- I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- O. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.
- P. Install seismic restraints on vacuum piping.
- Q. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
- T. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- V. Install sleeve seals for piping penetrations of concrete walls and slabs.

3.4 VALVE APPLICATIONS

- A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
- F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
- G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.6 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Apply appropriate tape to external pipe threads.
- E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
- G. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

- A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
- B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
- C. Install medical vacuum piping system area and master alarm panels where indicated.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
- I. Install supports for vertical copper tubing every 10 feet.

3.9 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Medical Vacuum: Black letters on white background.
 - 2. WAGD: White letters on violet background.

3.10 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
- B. Tests and Inspections:
 - 1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
 - 2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for vacuum systems.
 - f. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Final tie-in test.
 - g. Operational vacuum test.
 - h. Verify correct labeling of equipment and components.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.11 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 226213

SECTION 226313 - GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig.
 - 2. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.
- B. Owner-Furnished Material:
 - 1. Bulk gas storage tanks.
 - 2. Owner will furnish gases for medical gas concentration testing specified in this Section.
- C. Related Sections include the following:
 - 1. Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities" for vacuum piping systems for laboratory and healthcare facilities.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. D.I.S.S.: Diameter-index safety system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical gas piping systems include medical nitrogen and nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.
- E. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Gas manifolds and bulk gas storage tanks and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 SUBMITTALS

A. Product Data: For the following:

1. Tubes and fittings.
2. Valves and valve boxes.
3. Medical gas service connections.
4. Electrical service connections.
5. Patient service consoles.
6. Medical nitrogen pressure control panels.
7. Ceiling columns. Include integral service connections.
8. Ceiling hose assemblies. Include integral service connections.
9. Gas manifolds.
10. Bulk gas storage tanks. Include rated capacities and operating weights.
11. Medical gas alarm system components.
12. Gas cylinder storage racks.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer and testing agency.

E. Brazing certificates.

F. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds and bulk gas storage tanks, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas and Compressed Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- F. NFPA Compliance:
 - 1. Comply with NFPA 50, "Bulk Oxygen Systems at Consumer Sites," for bulk oxygen storage tanks.
 - 2. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
- G. CGA Compliance: Comply with CGA G-8.1, "Nitrous Oxide Systems at Consumer Sites," for bulk nitrous oxide storage tanks.
- H. UL Compliance:
 - 1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
 - 2. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Gas and Compressed Air Services: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of services.
 - 2. Do not proceed with interruption of services without Construction Manager's written permission.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate medical gas service connections with other service connections.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
 - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
 - 4. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

2.3 VALVES

- A. Basis-of-Design Product:
 - 1. BeaconMedaes.
- B. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- C. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever type with locking device.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Check Valves: In-line pattern, bronze.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Operation: Spring loaded.
 - 3. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

- E. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever type with locking device.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 7. Pressure Gage: Manufacturer-installed on one copper-tube extension.

- F. Zone Valve Boxes: Formed steel or aluminum or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1. Interior Finish: Factory-applied white enamel.
 - 2. Cover Plate: Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
 - 3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

- G. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
 - 1. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
 - 2. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4, ASTM B 819, copper tubing with NPS 1 minimum ball valve and plugged inlet.
 - 3. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig.
 - 4. Instrumentation: Pressure gage.

- H. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

- I. Pressure Regulators: Spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.4 SERVICE CONNECTIONS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. BeaconMedaes.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. General Requirements for Service Connections: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates shall not be required as service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
- C. All rough in and finishing assemblies shall match the configuration and connection styles of the existing fixtures, except that blank sections shall not be required. For Post Op stations, configuration from left to right shall be Oxygen, Nurse Call, Emergency receptacle, Slide, Vacuum, Light Switch, Slide, Vacuum. For the OR stations, left to right, provide Oxygen, Nitrogen, Slide, Vacuum, Vacuum. Confirm layout configuration with Eyecare Medical Group.
1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
 - c. Double seals that will prevent gas leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Double seals that will prevent gas leakage.
 - c. Cover plate with gas-service label.
 3. Quick-Coupler Service Connections: Pressure outlets for nitrous oxide and oxygen service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
 4. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
 - b. Medical Oxygen Service Connections: D.I.S.S. No. 1240.
 5. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL NITROGEN PRESSURE CONTROL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. BeaconMedaes.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
1. Minimum Working Pressure: 200 psig.
 2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
 3. Pressure Gages: 0- to 300-psig range.
 4. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
 5. Before final assembly, provide temporary dust shield and U-tube for testing.
 6. Label cover plate "Nitrogen Pressure Control."

2.6 GAS MANIFOLDS

A. Duplex Specialty Gas Manifolds:

1. Basis-of-Design Product: BeaconMedaes.
2. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
3. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
4. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
5. Nitrogen Gas Manifold: For **4 cylinders** at 115-psig line pressure, with electric heater or orifice design that will prevent freezing during high demand.
6. Specialty Gas Cylinders: Will be furnished by Owner.
7. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
8. Mounting: Wall with mounting brackets for manifold control cabinet and headers.

B. Medical Gas Manifolds: Comply with NFPA 99, Ch. 5, for high-pressure medical gas cylinders.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2.7 MEDICAL PIPING ALARM SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. BeaconMedaes.
- B. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 1. Low-Pressure Operating Range: 0- to 100-psig.
 2. High-Pressure Operating Range: Up to 250-psig.
- E. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 1. Mounting: Recessed installation. Coordinate wall thickness required.
 2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.
- F. Master Alarm Panels: With separate trouble alarm signals, pressure gages, and indicators for medical gas piping systems.
 1. Include alarm signals when the following conditions exist:
 - a. Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig and changeover is made to alternate bank.
 - b. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.

2.8 GAS CYLINDER STORAGE RACKS

- A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
- B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

2.9 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:
1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. Drain Piping: Use one of the following piping materials:
1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.
 2. PVC pipe, PVC fittings, and solvent-cemented joints.
- C. Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of medical gas piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
- M. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- N. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- P. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.4 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on gas piping where reduced pressure is required.
- F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.5 JOINT CONSTRUCTION

- A. Ream ends of PVC pipes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Threaded Joints: Apply appropriate tape to external pipe threads.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
- E. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
- F. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
- G. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

3.6 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
- B. Install nitrogen pressure-control panels in walls. Attach to substrate.
- C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- E. Install gas manifolds anchored to substrate.
- F. Install gas cylinders and connect to manifold piping.
- G. Install gas manifolds with seismic restraints as indicated.

3.7 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

- A. Install medical gas alarm system components in locations required by and according to NFPA 99.
- B. Install medical gas area and master alarm panels where indicated.
- C. Install computer interface cabinet with connection to medical gas piping alarm system and facility computer.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches of each fitting and coupling.
- H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

- J. Install supports for vertical copper tubing every 10 feet.

3.9 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
1. Nitrogen: White letters on black background.
 2. Oxygen: White letters on green background or green letters on white background.

3.10 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

- A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.
- B. Perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.
- C. Tests and Inspections:
1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 2. Repair leaks and retest until no leaks exist.
 3. Inspect specialty gas regulators for proper operation.

3.11 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:
 - 1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical vacuum piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive pressure medical gas piping.
 - f. Standing pressure test for vacuum systems.
 - g. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical gas concentration test.
 - k. Medical air purity test.
 - l. Verify correct labeling of equipment and components.
 - m. Verify the following source equipment:
 - 1) Medical gas supply sources.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 226313

SECTION 230500 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to Division 21, 22, & 23 sections.

1.2 GENERAL

- A. This Section includes mechanical items common to all of this division specification sections.
- B. Provide services, skilled and common labor, and all apparatus and materials required for the complete installation as shown and within the intent of the contract documents, field conditions, and code requirements.
- C. The intention of these Contract Documents is to call for finished work, fully tested and ready for operation. Any components or labor not mentioned in the Contract Documents but required for functioning systems shall be provided. Should there appear to be any discrepancies or questions of intent, the Contractor shall refer the matter to the Architect/Engineer for decision before start of any related work.
- D. The drawings show the general arrangement of systems and equipment but do not show all required fittings and offsets that may be necessary to connect pipes and ductwork to equipment, and to coordinate with other trades. Provide all necessary fittings, offsets and runs based on field measurements and at no additional cost. Coordinate with other trades for space available and relative location of equipment and accessories. Pipe and duct location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- E. This contractor will be responsible to carry out the commissioning requirements specified. Refer to Division 1 for additional requirements.

1.3 EFFICIENCY MAINE

- A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.
- B. The contractor shall also:
 - 1. Become familiar with the Efficiency Maine Business Program including available incentives and the application and review process.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Review plans and specifications for compliance with Efficiency Maine standards for applicable systems and technologies.
 3. Review plans and specifications for any and all incentive opportunities, prescriptive and custom.
- C. The project schedule shall reflect and accommodate the time required to achieve application preapproval from EM. No equipment shall be purchased until preapproval is received from EM.
- D. All invoices shall be forwarded to EM within 60 days of the completion of work. This deliverable shall be shown on the project schedule as a milestone date and coordinated with all contractors to assure compliance with this requirement.

1.4 DEFINITIONS

- A. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- B. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- C. "Provide": Furnish and install, complete and ready for the intended use.
- D. "Shall": The word shall is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and procedures and from which no deviation is permitted.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and attics.
- F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- G. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- H. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- I. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 SUBMITTALS

- A. Provide in accordance with Division 1 of the specifications.

1.6 SUBSTITUTIONS

- A. Provide in accordance with Division 1 of the specifications.

1.7 QUALITY ASSURANCE

- A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.
- B. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- D. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Comply with provisions in ASME B31 Series, "Code for Pressure Piping." Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- E. Electrical Characteristics for Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- F. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- G. Plumbing work shall be performed by, or under, the direct supervision of a licensed master plumber.
- H. Electrical work shall be performed by, or under, the direct supervision of a licensed electrician.
- I. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
 - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Provide in accordance with Division 1 - Product Requirements.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

B. Piping:

1. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
2. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor.
3. Protect fittings, flanges, and piping specialties from moisture and dirt.
4. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

- A. Coordinate use of project space and sequence of installation of mechanical and electrical work, which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- B. Coordinate use of project space and sequence of installation of work.
- C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels and doors are specified in Division 8. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8.

1.10 TEST ADJUST AND BALANCE READINESS

- A. The Contractor shall provide and coordinate the services of qualified, responsible sub-contractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting, and balancing period.
- B. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate the systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB.
- C. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The Contractor shall allow adequate time for the testing and balancing activities of the Owner provided services, during the construction period,

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

- D. The Drawings and Specifications indicate valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB Firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.
- E. Complete operational readiness of the HVAC systems also requires that the following be accomplished:
1. Distribution Systems:
 - a. Verify installation for conformity to design. All supply, return, and exhaust ducts shall be terminated and tested as required by the Specification.
 - b. Dampers shall be properly located and functional. Dampers shall have tight closure and open fully with smooth and free operation.
 - c. Supply, return, exhaust, and transfer grilles, registers, diffusers, and terminal devices shall be installed and secured in a full open position.
 - d. Air handling systems, units, and associated apparatus shall be sealed to eliminate uncontrolled bypass or leakage of air. Final clean filters shall be in place, coils shall be clean with fins straightened, bearings properly greased, and the system shall be completely operational. The Contractor shall verify that all systems are operating within the design pressure limits of the piping and ductwork.
 - e. Under normal operating conditions, check condensate drains for proper connections and functioning. Cooling coil drain pans have a positive slope to drain. Cooling coil condensate drain trap maintains an air seal.
 - f. Check for proper sealing of air-handling unit components.
 - g. Fans shall be operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating, as per the starter manufacturer; record motor amperage and voltage on each phase at start-up, and verify they do not exceed nameplate ratings.
 - h. Thermal overload protection is in place for fans and other equipment. Bearings shall be greased. Belts shall be aligned and tight
 - i. Terminal units shall be installed and functional (i.e. controls functioning).
 2. Water Circulating Systems:
 - a. Verify installation for conformity to design. Hydronic systems are pressure tested, flushed, filled, and properly vented. Service and balance valves are fully open. Examine HVAC system and equipment installations to verify that indicated balancing devices are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation
 - b. All valves shall be set to their full open position. After the system is flushed and checked for proper operation, all strainers shall be removed and cleaned. The Contractor shall repeat the operation until circulating water is clean and then the start-up strainers shall be discarded. Bearings shall be greased.
 - c. Record pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating. Verify that the electrical heater elements are of the proper size and rating as per the starter manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- d. In preparation of TAB, water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Chemicals shall be added to closed systems to treat piping and inhibit corrosion. The system static pressure shall be adequate to completely fill the system without operating the pumps.
- e. Check and set operating parameters of the heat transfer and control devices to the design requirements.
- f. Proper balancing devices shall be in place and located correctly. These devices include but are not limited to flow meters, pressure taps, thermometer wells, balancing valves, etc. Heat transfer coils shall be checked for correct piping connections.

3. Automatic Controls

- a. The BAS shall verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.
- b. The BAS Contractor shall verify that all controlling instruments are calibrated and set for design operating conditions with the exception of components that require input from the TAB Agency, but a default shall be set. The Control Contractor shall cooperate with the TAB Agency and provide all software and interfaces to communicate with the system.
- c. The BAS Contractor shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB Agency that the BAS is operational. The BAS Contractor shall provide technical support (technicians and necessary computers) to the TAB Agency for a complete check of these systems.
- d. Prior to occupancy, each ventilation system shall be tested to ensure that OA dampers operate properly in accordance with system design.
- e. Fire Alarm: Division 26 shall thoroughly check all detection devices, sequences, inter-locks, etc. before notifying the TAB Agency that the system is operational. Division 26 shall certify that the systems are totally operational to the Contractor prior to the TAB beginning.

1.11 RENOVATION PROJECTS

- A. Project Conditions: Full Owner Occupancy: The Owner intends to occupy the project site during construction. The Contractor shall cooperate with the Owner to minimize conflicts with the Owner's operations.
- B. Project Conditions: Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner to minimize conflicts with the Owner's operations.
- C. Project Conditions: No Owner Occupancy until final acceptance: The Owner intends to occupy the building only after construction is 100% complete and the building has been accepted.
- D. The Contractor shall study all drawings and specifications, visit the site, and get acquainted with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to be familiarized with the conditions and extent of the proposed work. The Contractor shall execute all alterations, additions, removals, relocations or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the drawing and specifications.
- E. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize use of driveways and entrances. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- G. Follow the recommended procedures of the SMACNA IAQ Guidelines for Occupied Buildings under Construction.
1. Dust partitions and depressurization of the work are performed under Division 1.
 2. The return side of an HVAC system is, by definition, under negative pressure and thus capable of drawing in nearby construction dust and odor. When possible, the entire system shall be shut down during heavy construction or demolition. The system shall be isolated from the surrounding environment as much as possible (e.g., all tiles in place for a ceiling plenum, duct and air handler leaks repaired) to prevent induction of pollutants.
 3. Return system openings in (and immediately adjacent to) the construction area shall be sealed with plastic.
 4. When the system must remain operational during construction, temporary filters shall be added to return grilles. All filters must receive frequent periodic maintenance and be replaced at end of project.
 5. When the general system must remain operational, the heaviest work areas shall be dampered off or otherwise blocked if temporary imbalance of the return air system does not create a greater problem.
 6. The mechanical room shall not be used to store construction or waste materials.
 7. Diffusers, VAV boxes, and ducts may be adequately protected in most cases where the above measures are implemented. When the system is off for the duration of construction, diffusers shall also be sealed in plastic for further protection. Ducts, diffusers, and window units shall be inspected upon completion of the work for the amount of deposited particulate present and cleaned where needed. If significant dust deposits are observed in the system during construction, some particulate discharge can be expected during start-up. When such a discharge is only minor, delaying re-occupancy long enough to clean up the dust may be sufficient. In more severe cases, installing temporary coarse filters on diffusers or cleaning the ducts may be necessary. The condition of the main filters shall be checked whenever visible particulates are discharged from the system.
- H. Continuity of Services: The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to “General Conditions of the Contract for Construction” for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner’s Representative. Provide, as part of contract, temporary plumbing and mechanical and electrical connections and relocations as required to accomplish the above.
- I. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services. Notify Owner at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions. Indicate method of providing temporary utilities. Do not proceed with utility interruptions without Owner's written permission.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

PART 2 - PRODUCT

2.1 PRODUCT CRITERIA

- A. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
- B. Equipment Service: Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.
- C. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- D. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- E. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
- F. Asbestos products or equipment or materials containing asbestos shall not be used.

2.2 PIPE JOINING MATERIALS

- A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods. Refer to individual piping Sections for special joining materials not listed below.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- E. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- G. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- H. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAgl, silver alloy for refrigerant piping, unless otherwise indicated.
- I. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- J. Solvent Cements for Joining Plastic Piping: CPVC Piping: ASTM F 493. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve; ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.4 DIELECTRIC FITTINGS

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. Fittings shall match piping specifications. Threaded dielectric union, ANSI B16.39. Watts Series LF3000 (lead free) or approved equal. Flange union with dielectric gasket and bolt sleeves, ANSI B16.42. Dielectric flange fittings: Watts Series LF3100.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve; Thunderline Link-Seal, or approved equal.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Glass-reinforced nylon.
 - 3. Connecting Bolts and Nuts: Stainless steel, of length required to secure pressure plates to sealing elements.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 ESCUTCHEONS

- A. Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated. Metals and finish shall conform to ASME A112.19.2. Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. ID shall closely fit around pipe, tube, and insulation of insulated piping and an OD that completely cover the opening.
- B. All escutcheons shall have setscrews for maintaining a fixed position against a surface.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout. Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications. Design Mix: 5000-psi, 28-day compressive strength. Packaging: Premixed and factory packaged.

2.8 ROOFING

- A. Coordinate roofing with Division 7.
- B. Roof Edge Protection System, required for any mechanical items located within 10 feet of roof edge.
 - 1. Roof edge protection system shall be KeeGuard Roof Edge Protection System, or approved equal. System shall be a counterweighted guardrail system with 42" min. height to provide code-compliant protection for mechanical equipment located less than 10 feet from the edge of the roof. System shall withstand a minimum load of 200 lbs. in any direction to all components per OSHA Regulation 29 CFR 1910.23.
 - 2. Components: Pipe: ASTM A53 1-1/2 inch schedule 40, Galvanized. Rails, Posts, and fittings: 1-1/2 inch diameter steel pipe, galvanized. Mounting Bases: Galvanized steel bases to have a rubber pad placed under the plate at the job site. Counterweights: Galvanized steel counterweights to have a rubber pad placed under the plate at the job site. Finish: galvanized mill finish to the requirements of ASTM A53. Provide per manufacturers recommendations.

2.9 MOTORS

- A. Motor Characteristics
 - 1. Motors 1/2 HP and Larger: Three phase.
 - 2. Motors smaller than 1/2 HP: Single phase.
 - 3. Frequency Rating: 60 Hz.
 - 4. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
 - 5. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.
 - 6. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
 - 7. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

8. Enclosure: as specified.

B. Polyphase Motors

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium efficiency ratings shall meet or exceed the NEMA Premium qualifying efficiencies. Efficiencies shall be eligible for utility rebates. For example, 1800-RPM ODP minimum required efficiency for a 7.5 HP motor is 91.0%
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors shall have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.
5. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.
8. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Single-Phase Motors

1. Type: One of the following, to suit starting torque and requirements of specific motor application: Permanent-split capacitor, Split-phase start, capacitor run, Capacitor start, capacitor run.
2. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
3. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
4. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

D. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Bearing Protection Ring

1. All motors to be operated with a Variable Frequency Drive shall be equipped with a bearing protection ring (shaft grounding ring).
2. The bearing protection ring shall be manufactured by Aegis, model SGR.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Ring shall be factory installed where available, installed per manufacturer's recommendations. Where not available as a factory installed option, the ring shall be field installed in strict accordance with the motor and ring manufacturer's recommendations.
4. For motors up to 100 hp, ring shall be mounted on either the drive end or the non-drive end of the motor. For motors larger than 100 hp, insulate one bearing journal or install a ceramic bearing on the non-drive end of the motor and install the bearing protection ring on the opposite end.
5. All Aegis Rings will be installed as per manufacturer's specifications.
6. All motor shafts will be cleaned and free of foreign material and coated with Colloidal Silver, where Aegis Rings contact the motor shaft.
7. Colloidal Silver is available from Aegis, and shall be installed per manufacturer's specifications.
8. Solid Rings shall be the preferred method of installation, and installed with a two part epoxy, supplied by Aegis.
9. Refer to Section 260526 for Additional Motor Grounding and bonding requirements.

2.10 VIBRATION ISOLATION

- A. All equipment shall be isolated to prevent vibration transmission to the building structure.

PART 3 - EXECUTION

3.1 DEMOLITION AND REMOVALS

- A. Refer to Division 1 for general demolition requirements and procedures.

3.2 COMMON REQUIREMENTS

- A. Install piping, ductwork, and equipment to allow maximum possible headroom unless specific mounting heights are indicated. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- C. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- D. Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced so as to be left in safe structural condition in accordance with the local building code requirements.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Install piping and ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- G. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.
- H. Install piping to permit valve servicing.
- I. Install equipment and other components to allow right of way for piping installed at required slope.
- J. Install free of sags and bends.
- K. Provide unions or flanges at connections to equipment.
- L. Install fittings for changes in direction and branch connections.
- M. Make allowances for application of insulation.
- N. Select system components with pressure rating equal to or greater than system operating pressure.
- O. Verify final equipment locations for roughing-in.
- P. Protection and Cleaning: Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items shall be replaced. Protect all finished parts of equipment. Close duct and pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and the relevant specification section specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8. Only brazing alloys having a liquid temperature above 1000°F shall be used.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows: Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPE PENETRATIONS

- A. Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed.
- B. Refer to Section 230700 "Mechanical Insulation".
- C. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation.
- D. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install steel pipe sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Sleeves are not required in drywall construction.
 5. Sleeves are not required for core-drilled holes. Piping through concrete or masonry shall not be subject to any load from the building construction.
- E. To prevent accidental liquid spills from passing to a lower level, provide the following:
1. For sleeves: Extend sleeve 1-1/2 inch above finished floor and provide sealant for watertight joint.
 2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
 3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- F. Radon: There is a potential radon issue at this project location; floor penetrations shall be made with care. The floor assembly will be as shown on the architectural and structural plans. All ground floor penetrations including floor drains shall be sealed with polyurethane sealant. Installation must also conform to any requirements for radon intrusion.
1. When applying sealant, make sure surfaces are clean and dry, and free of grit and that the surface temperature is above freezing (or as recommended by sealant manufacturer). Apply sealants in accordance with the manufacturer's recommended practice. Typical dimensions for caulk beads are 1/2 in. deep by 1/4 in. to 1/2 in. wide. It may be necessary to use backer rod when applying sealant in wide gaps.
- G. Exterior-Wall Pipe Penetrations:
1. Provide PVC Annular space between sleeves where pipes and/or conduit pass through exterior concrete or slabs. Sleeves or penetrations shall not be placed through footings, piers, pedestals, drop caps, columns, pile caps or pilasters unless specifically noted.
 2. Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals. Provide trim. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- H. Escutcheons: Provide for penetrations in finished spaces where pipes are exposed.
- I. Plastic and copper piping penetrating framing members, and within one-inch of the framing, shall be protected with 10-gauge steel nailing plates. The steel plate shall extend along the framing member a minimum of 1.5" beyond the OD of the pipe or tubing.
- ### 3.5 PIPING CONNECTIONS
- A. Make connections according to the following, unless otherwise indicated: Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment. Install flanges or Victaulic couplings, in piping NPS 2-1/2 and larger, adjacent to flanged or grooved-ended valves and at final connection to each piece of equipment. Provide dielectric fittings at connection between copper and ferrous metal.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Swing Connections for Expansion: Connect risers and branch connections to mains with at least five pipe fittings, including tee in main. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Provide in accordance with Division 5.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor materials and equipment. Field Welding: Comply with AWS D1.1.

3.8 FIRESTOPPING

- A. Firestop protection for DWV and storm water piping is specified in Section 221316.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Division 7 for materials. Seal all penetrations through fire-or smoke-rated wall, partition, ceiling, or roof assemblies with firestopping system. Refer to Architectural plans for location of rated assemblies. Refer to Division 7 for firestopping systems.

3.9 PAINTING

- A. Painting of plumbing and mechanical systems, equipment, and components is specified in Division 9.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.10 CONCRETE HOUSEKEEPING PADS

- A. Concrete pads shall be provided by Division 22 & 23.
- B. Provide in accordance with Section 033000 – “Cast -In-Place Concrete”.
- C. Provide in accordance with Division 3.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Construct concrete bases not less than 4 inches larger in both directions than supported unit.
- E. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. [Refer to seismic restraint manufacturer's written instructions.]
- F. Provide 4" high (+/-) housekeeping pads for the following:
 - 1. Base Mounted Pumps
 - 2. Expansion Tanks
 - 3. As noted on plans
 - 4. As recommended by Equipment manufacturer.

3.11 ROOFING

- A. Refer to Division 7.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

3.12 PROJECT CLOSEOUT

- A. Provide Demonstration and Training in accordance with Section 017900.
- B. Provide Demonstration and Training in accordance Division 1.
- C. Provide Project Record Documents in accordance with Section 017839.
- D. Provide Project Record Documents in accordance with Division 1.
- E. Follow Closeout procedures as per Section 017700.
- F. Follow Closeout procedures as per Division 1.
- G. Provide Operation and Maintenance information in accordance with Sections 017823 and 019100.2.
- H. Provide Operation and Maintenance information in accordance with Division 1.

END OF SECTION 230500

SECTION 230516 – BRAIDED EXPANSION LOOPS AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 23 Section “Common Work Results for Mechanical”

1.2 SUMMARY

- A. This Section includes braided pipe expansion loops.
- B. Provide swing fittings at branches to terminal equipment for mechanical piping systems as specified in Section 230500.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products suitable for piping system fluids, materials, working pressures, and temperatures.

1.4 SUBMITTALS

- A. Product Data: For each type of expansion fitting indicated.
- B. Schedule: Indicate manufacturer's number, size, location, and features for each expansion fitting and loop.
- C. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Metraflex Co.
 2. Flex Hose Co., Inc.
 3. Flexicraft

2.2 BRAIDED EXPANSION LOOPS

- A. Provide flexible expansion loops of size and type noted on drawings; Metraflex Metraloop expansion joints, or approved equal. Flexible loops shall consist of two flexible sections of hose and braid, two 90° elbows, and a 180° return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180° return, and a drain/air release plug.
- B. Flexible loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application.
- C. Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings.
- D. Size for 4" end-to-end movement.

2.3 ANCHORS

- A. Metraflex Model PA anchor clamp, or approved equal. Provide light weight anchor for low load; compatible with braided expansion loop manufactures recommendations for "no thrust" expansion joints. Clamps to pipe.

2.4 GUIDES

- A. Metraflex Model PGIV shall be of the radial type employing a heavy wall guide cylinder with weld down or bolt down anchor base. A two section guide spider, having 1/8" maximum diametrical clearance with guide cylinder inside diameter, bolted or welded tight to the carrier pipe which slides through the guide cylinder I.D. Cylinder shall be of sufficient size to clear pipe insulation and long enough to prevent over travel of the spider.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head; ASTM F 844, steel, plain, flat washers.
- C. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application. Stud: Threaded, zinc-coated carbon steel. Expansion Plug: Zinc-coated steel. Washer and Nut: Zinc-coated steel.
- D. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application. Bonding Material: ASTM C 881, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated; Washer and Nut: Zinc-coated steel.
- E. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

PART 3 - EXECUTION

3.1 BRAIDED EXPANSION LOOP INSTALLATION

- A. Install expansion fittings according to manufacturer's written instructions.
- B. Install expansion fittings in sizes matching pipe size in which they are installed.
- C. Align expansion fittings to avoid end-loading and torsional stress.
- D. Loops can be installed in a neutral, pre-compressed or pre-extended condition as required for the application.
- E. A pipe guide shall be installed anywhere within 15 pipe diameters on each side of the braided expansion loop. Loops anchored on one side need only one guide on the traveling side. Attach guides to pipe and secure to building structure.
- F. Install pipe anchors according to expansion fitting manufacturer's written instructions.
 - 1. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
 - 2. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 3. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install guides on each side of pipe expansion fittings and loops as recommended by manufacturer.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 230519 – THERMOMETERS AND PRESSURE GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section “Common Work Results for Mechanical”
 - 2. Mechanical equipment Sections that specify meters and gauges as part of factory-fabricated equipment.

1.2 SUMMARY

- A. This Section includes thermometers and pressure gauges.

1.3 ACTION SUBMITTALS

- A. Product Data: Include scale range, ratings, and calibrated performance curves for each gauge, fitting, specialty, and accessory specified.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ashcroft
 - 2. Weksler
 - 3. Ernst Gauge Co.
 - 4. Trerice: H. O. Trerice Co.
 - 5. Weiss Instruments, Inc.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.2 THERMOMETERS

- A. Liquid-In-Glass Industrial Thermometers: shall be a blue reading (Fill Type Spirit: Blue colored, organic) liquid-in-glass adjustable angle type, 9" scale, cast aluminum case with cured polyester powder coating, clear acrylic window and brass separable thermowell. Thermometers will be Terice BX9 Series or approved equal.
- B. Scale Range: Temperature ranges for services listed are as follows: The proper range will be selected so that the operating temperature of the material being measured will fall approximately in the middle of the scale.
1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
 2. Domestic Cold Water: 0 to 100°F, with 1°F scale divisions.
 3. Condenser Water: 30 to 130°F, with 11°F scale divisions.
 4. Chilled Water: 0 to 100°F, with 1°F scale divisions.
 5. Heating Hot Water: 30 to 180°F, with 2°F scale divisions.
- C. Thermowells: Provide fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
1. Material: Brass, for use in copper piping.
 2. Material: Stainless steel, for use in steel piping.
 3. Where insulation thickness exceeds 2", a longer stem thermometer will be used with an extension neck brass separable thermowell. The extension neck will be at least 2" long.
 4. Thermometers for measuring fluid temperatures will have stems with insertion lengths of roughly half of the pipe diameter; minimum insertion length will be 2".
 5. Cap: Threaded, with chain permanently fastened to socket. Heat-Transfer Fluid: Mixture of graphite and glycerin.

2.3 PRESSURE GAUGES

- A. Pressure gauges shall be 3½" dial size with a flangeless cast aluminum case, stainless steel friction ring and glass window. Movement will be brass with a bronze bourdon tube and brass socket. Dial face will be white with black figures; pointer will be friction adjustable type. Accuracy shall be ±1% of scale range, ASME B40.1 Grade 1A. Pressure gauges will be Terice No. 600CB approved equal.
1. Connector: Brass, NPT 1/4.
 2. Units of Measure: PSI
 3. Provide silicone-damped movement.
 4. Range: The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.
 5. Install pressure-gauge needle valve and snubber (Terice No. 872 pressure snubbers) in piping to pressure gauges; ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.
 6. Needle Valves: Terice 735 Series; NPS 1/4 brass or 316 stainless steel needle type.
- B. Scale Range: Pressure ranges for services listed are as follows: The proper range will be selected so that the operating pressure of the material being measured will fall approximately in the middle of the scale.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Domestic Hot Water: 0 to 100 psi
2. Domestic Cold Water: 0 to 100 psi.
3. Condenser Water: 0 to 60 psi.
4. Chilled Water: 0 to 60 psi
5. Heating Hot Water: 0 to 60 psi.
6. LPS: 0 to 30 psi
7. LPS Condensate: 0 to 100 psi
8. HPS: 0 to 100 psi

2.4 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flow Design, Inc.
 2. Peterson Equipment Co., Inc.
 3. Terrice, H. O. Co.
 4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 5. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 GAUGE INSTALLATION, GENERAL

- A. Install according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install thermowells with extension on insulated piping.
- C. Install separable sockets in vertical position in piping tees.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 PRESSURE-GAUGE INSTALLATION

- A. Install pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position.
- B. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- C. Install valve and syphon fitting in piping for each pressure gage for steam.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties. Install adjacent to machines and equipment to allow service and maintenance. Connect per manufacturers recommendations.

3.5 ADJUSTING AND CLEANING

- A. Calibrate according to manufacturer's written instructions, after installation.
- B. Adjust faces to proper angle for best visibility.
- C. Clean windows and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 230519

SECTION 220529 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for Mechanical"
 - 2. Division 23 Section "Mechanical Insulation"
 - 3. Division 23 Section "Ductwork"

1.2 SUMMARY

- A. This Section includes hangers and supports for piping and equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.
 - 3. Welded steel support designs

1.5 QUALITY ASSURANCE

- A. Install in accordance with MSS SP69 - Manufacturers Standardization Society: Pipe Hangers and Supports- Selection and Application
- B. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
- C. Pipe Hangers, Supports, and Components: The materials of all pipe hanging and supporting elements shall be in accordance with MSS SP-58.
- D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pipe Hangers and Supports:
 - a. B-Line Systems, Inc.
 - b. Carpenter & Patterson, Inc.
 - c. Grinnell Corp.
 - d. Hubbard Enterprises/Holdrite®
 - e. National Pipe Hanger Corp.
 - f. Piping Technology & Products, Inc.
 - g. Unistrut
 - h. Anvil International, Inc.
 - i. Empire

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS (“UNISTRUT”)

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.
 - b. Flex-Strut Inc.
 - c. Thomas & Betts Corporation.
 - d. Unistrut Corporation; Tyco International, Ltd.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Unistrut Perma-green or similar.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. ERICO International Corporation.
3. National Pipe Hanger Corporation.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Piping Technology & Products, Inc.
6. Value Engineered Products, Inc.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Buckaroos, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. Shields: G90 galvanized steel.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland Cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic .
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: One or more; plastic.
 3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 ACCESSORY PRODUCTS

- A. Vertical Mid-Span Piping Supports: For use with vertically-installed pipe, NPS 4 (DN 100) and smaller, for a distance exceeding 48 inches (1.2 m). Subject to compliance with requirements, provide Holdrite; HOLDRITE Stout Bracket System, or equal.
- B. Equipment Supports: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
- C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Provide per manufactures recommendations and calculations.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
1. Provide per manufactures recommendations and calculations.
 2. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 3. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by plumbing code and ASME B31.9 for building services piping.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

N. Insulated Piping:

1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- G. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
- H. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- I. Use padded hangers for piping that is subject to scratching.
- J. Use thermal-hanger shield inserts for insulated piping and tubing.
- K. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 and larger.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 and larger if no insulation is required.
 - 3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 1.
 - 4. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 and larger.
 - 6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 7. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 and larger if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 and larger, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 and larger, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 10. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 and larger if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- L. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 and larger.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 and larger if longer ends are required for riser clamps.
- M. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel weld-less Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams. Provide hex lag screws for wood beams; size as per manufacturers recommendations.
 13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- O. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.7 HANGER SPACING

- A. Support piping and tubing not listed below according to MSS SP-69 and manufacturer's written instructions.
- B. Water and Steam Boiler Piping Supports (State of Maine Fuel Board Rules)
1. NPS 1/2": Maximum span, 6 feet; minimum rod size, 3/8 inch.
 2. NPS 3/4 to 1: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/4: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 6. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 8. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.
 9. NPS 5: Maximum span, 10 feet; minimum rod size, 5/8 inch.
 10. NPS 6: Maximum span, 10 feet; minimum rod size, 3/4 inch.
 11. NPS 8: Maximum span, 10 feet; minimum rod size, 3/4 inch.
- C. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod sizes:
1. NPS 3/4 to 1-1/4": Maximum span, 7 feet; minimum rod size, 3/8 inch.
 2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
 5. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 6. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.
 7. NPS 5: Maximum span, 10 feet; minimum rod size, 5/8 inch.
 8. NPS 6: Maximum span, 10 feet; minimum rod size, 3/4 inch.
 9. NPS 8: Maximum span, 10 feet; minimum rod size, 3/4 inch.
 10. NPS 10: Maximum span, 10 feet; minimum rod size, 7/8 inch.
 11. NPS 12: Maximum span, 10 feet; minimum rod size, 7/8 inch.
- D. Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:
1. NPS 1/2 and 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2 to 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.
 6. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 7. NPS 4: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 8. Maximum vertical steel and copper pipe attachment spacing: 10 feet.
- E. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non adhesive isolation tape- B-Line Iso-pipe. Galvanized felt isolators sized for copper tubing may also be used, B-Line B3195CT.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

F. Piping Hangers for Plastic Piping:

1. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
2. In systems where large fluctuations in temperature occur, allowances must be made for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow for expansion and contraction, hangers must be placed so as not to restrict this movement.
3. Hangers shall not compress, distort, cut or abrade the piping. All piping shall be supported at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal. Pipe should also be supported at all branch ends and at all changes of direction.
4. Install hangers for piping with the following maximum horizontal spacing and minimum rod diameters (pipe temperature 100°F or lower).
 - a. NPS 1 and smaller: 4 feet with 3/8-inch rod.
 - b. NPS 1-1/4 and 1-1/2 and NPS 2: 5 feet with 3/8-inch rod.
 - c. NPS 3: 6 feet with 1/2-inch rod.
 - d. NPS 4: 6.5 feet with 5/8-inch rod.
 - e. NPS 6 and 8: 8 feet with 3/4-inch rod.
5. Install supports for vertical piping every 10 feet.

G. Support vertical piping independently of connected horizontal piping. Support vertical pipes at base and at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.

H. Place a hanger within 12 inches of each horizontal elbow.

I. Horizontal pipe isolation:

1. The first four pipe hangers in the main lines near mechanical equipment shall be Mason Type PC30N, or approved equal. Brace hanger rods with SRC clamps.
2. Floor supported piping shall rest on Type SLR isolators.
3. Hanger locations that also have seismic restraints attached must have type RW Rebound Washers to limit uplift.
4. Where piping connects to mechanical equipment install expansion joints stainless hoses if expansion joints are not suitable for the service.
5. Adjust active height of spring isolators. Adjust isolators after piping systems have been filled and equipment is at operating weight. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 230529

SECTION 230548 - MECHANICAL SEISMIC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Common Work Results for HVAC".
 - 3. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.

1.2 SUMMARY

- A. It is the intent of the seismic portion of this specification to keep building system components in place during a seismic event.
- B. All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.
- C. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements.
- D. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.3 SCOPE

- A. The work in this section includes, but is not limited to the following:
 - 1. Seismic restraints for fuel gas piping.

1.4 PERFORMANCE REQUIREMENTS

- A. Manufacturer of seismic control equipment shall have the following responsibilities:
 - 1. Determine seismic restraint sizes and locations.
 - 2. Provide seismic restraints as scheduled or specified.
 - 3. Provide calculations and materials if required for restraint of un-isolated equipment.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
- B. Seismic restraints shall be designed in accordance with seismic force levels as detailed herein.
- C. Applicable Code: IBC
- D. Seismic Design Category C
- E. Design Spectral Response at Short Periods (SDS): See structural plans.
- F. Short Period Spectral Response Acceleration (SS): See structural plans.
- G. Building Use Group or Occupancy Category II
- H. Equipment Schedule: The following list indicates individual equipment importance factors, $I_p=1.5$:
 1. Natural gas piping

1.5 SUBMITTALS

- A. The manufacturer of seismic restraints shall provide submittals for products as follows:
 1. Catalog cuts or data sheets on specific restraints detailing compliance with the specification.
 2. Detailed schedules of flexible and rigidly mounted equipment, showing seismic restraints by referencing numbered descriptive drawings.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:
 1. Design Calculations: Calculate requirements for selecting seismic restraints.
 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 3. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
 4. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.
- C. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

- A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Section 230500. The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly attached to the building structural flooring, so to withstand anticipated seismic forces. In addition, the size of the housekeeping pad is to be coordinated with the seismic restraint manufacturer so to ensure that adequate edge distances exist in order to obtain desired design anchor capabilities.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

- A. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, Type SCBH between the hanger rod nut and the clevis or Type SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.
- B. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

certified load ratings. Solid seismic brace assemblies shall be Type SSB as manufactured by Mason Industries, Inc.

- C. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
- D. Note: seismic cable restraints, seismic solid braces, and steel angles above apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze.
- E. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California. Clevis cross brace shall be Type CCB as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- B. All mechanical equipment shall be vibration isolated and seismically restrained as specified.
- C. Installation of seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.
- D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

- G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- H. Correct, at no additional cost, all installations that are deemed defective in workmanship and materials at the contractor's expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
 - 1. Flanges of structural beams.
 - 2. Upper truss cords in bar joist construction.
 - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- J. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, piping or conduit. Cable assemblies shall be installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.
 - 1. The support rods must be braced when necessary to accept compressive loads with steel angles and rod clamp assemblies.
 - 2. At all locations where restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with pipe clevis cross bolt braces.

3.3 SEISMIC RESTRAINT OF PIPING

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."
- B. Piping shall be provided with seismic restraints in accordance with Seismic Restraint Manual – Guidelines for Mechanical Systems dated 1998, as published by SMACNA.
 - 1. Seismically restrain the following piping.
 - a. Natural gas piping that is 1" I.D. or larger.
 - 2. Piping exclusions:
 - a. Gas piping less than 1" inside diameter.
 - b. All piping suspended by individual hangers 12" or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" limit is exceeded by any hanger in the run, seismic bracing is required for the run.
 - c. The 12" exemption applies for trapeze-supported systems if the top of each item supported by the trapeze qualifies.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Transverse piping restraints shall be at 20' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or tee or combined stresses are within allowable limits at longer distances.
6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.

3.4 ADJUSTING

- A. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230548

SECTION 230553 – IDENTIFICATION FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Valve numbering scheme. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Markers: Engraved, color-coded laminated plastic; attach with screws or contact-type, permanent adhesive. Size: 2-1/2" x 1" or as applicable.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Terminology: Match schedules as closely as possible.
 2. Data: Name and plan number, equipment service, design capacity, and other design parameters such as pressure drop, entering and leaving conditions, and speed.
- B. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Seton, Brady, or approved equal; preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 - a. Potable water: green background and white lettering.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length. Size of letters and length of color field per ASME A13.1.
 3. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location.
 4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
 5. Minimum length of color field and size of letters shall be in accordance with Uniform Plumbing Code requirements.
- B. Types:
1. Self-adhesive type: Seton Opti-Code.
 2. Snap-around type: Seton Setmark.
 3. Wrap-around type: Seton Ultra-mark; PVF over-laminated polyester construction seals in and protects graphics; suitable for outdoor or harsh environments.

2.3 DUCT IDENTIFICATION DEVICES

- A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved 1-1/2" round with 1/4-inch letters for piping system legend and 1/2-inch black-filled numbers, with numbering scheme; 3/16" hole for fastener; Material: 19-gauge brass; Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 22 or 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. All scheduled equipment.
 - b. Space GAS monitor/transmitter device

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.
 - 1. Ceilings 10 feet and lower: Letters shall be ¼” high, black.
 - 2. Ceilings higher than 10 feet: Letters shall be 3/8” high, black.
 - 3. Label all equipment above ceiling that requires servicing or access.
 - 4. Red: Smoke detectors (SD), Fire dampers (FD), and similar fire dampers
 - 5. Green: HVAC terminal units; example: (VAV- #)
 - 6. Orange: HVAC shutoff valves; example: heating main shutoff valves, main duct volume dampers, radiant manifolds, control valves, etc. (HWS, HWR)
 - 7. Locate labels on the ceiling grid, adjacent to the ceiling tile that provides the best access to the valve or item that requires servicing.

3.3 PIPING IDENTIFICATION

- A. Piping Identification Types:
 - 1. Piping or Insulation 5-7/8 inch OD or smaller: Snap-around marker or self-adhesive marker.
 - 2. Piping or Insulation 6 inch OD and Larger: Strap-around with nylon ties or self-adhesive marker.
 - 3. Provide wrap-around pipe markers for outdoor pipes. Install wrap-around pipe markers completely around pipe.
- B. Install manufactured pipe markers indicating service on each piping system.
 - 1. Install pipe markers to manufacturer's instructions.
 - 2. Identify piping, concealed or exposed. Include service and flow direction.
 - 3. Install in clear view and align with axis of piping.
 - 4. Locate identification at maximum 20 feet centers on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
 - 5. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 6. At least one per room.
- C. Unions covered by insulation: Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

3.4 DUCT IDENTIFICATION

- A. Locate duct markers as follows.
 - 1. Ducts leaving mechanical rooms.
 - 2. Ducts at riser shaft branches.
- B. Install duct markers with permanent adhesive on air ducts in the following color codes:
 - 1. Green: For cold-air supply ducts.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Yellow: For hot-air supply ducts.
 3. Blue: For return ducts.
 4. Red: For exhaust-, outside, or relief air ducts
 5. Identify by system tag and type.
 6. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.6 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room. Provide (2) copies of valve schedules burned to a DVD or memory stick; Word or Excel format.

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing (TAB) of mechanical systems.

1.3 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm. Warranties specified in this Section.
- C. Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing." TAB firm's forms approved by Architect. TABB "Contractors Certification Manual."

1.4 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."
- C. TAB Firm Qualifications: Perform all work in accordance with AABC, TABB, or NEBB procedures.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - GENERAL

2.1 EXAMINATION AND PREPARATION

- A. Prior to commencing testing adjusting and balancing of environmental systems, verify the following HVAC Operational Readiness conditions, if deficiencies are evident, submit Deficiency Report to Architect. Do not begin testing, adjusting, and balancing of environmental system until deficiencies have been remedied.
- B. Mechanical contractor shall prepare the systems as required by the Section 230500 Paragraph "Test Adjust and Balance Readiness".
- C. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

2.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, and similar controls and devices, to show final settings. Permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.
- D. Report on noise problems to the Contractor, A/E, and Owner which are discovered during balancing.
- E. Existing Systems T-A-B
 - 1. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - a. EF-____system
 - b. AHU-_____ system
 - 2. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
 - 3. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
 - 4. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 5. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
 - 6. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 - 7. T-A-B procedures for various HVAC systems shall be in accordance with the specification hereinafter.

2.3 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Fans: -5% to +10%
 - 2. Supply Air Outlets: 0% to +10%.
 - 3. Exhaust/Return Air Inlets: -10% to 0%
 - 4. Heating-Water Flow Rate: -10% to 0%
 - 5. Cooling-Water Flow Rate: -5% to +5%

2.4 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.5 FINAL REPORT

- A. The TAB activities described shall culminate in a report neatly typed and arranged. Include with the data the date tested, personnel present, and a list of all measurements taken. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.
- B. Include a list of instruments used for procedures, along with proof of calibration. Include instrument calibration report data: instrument type and make, serial number, application, dates of use, and dates of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB firm who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following: Indicated versus final performance, Notable characteristics of systems; Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Notes to explain why certain final data in the body of reports varies from indicated values.
- E. Provide report data for procedures described herein.

2.6 COMMISSIONING - TAB FINAL ACCEPTENCE INSPECTION

- A. Prior to performance of the TAB final acceptance inspection, provide copies of reports, sample forms, checklists, and certificates to the commissioning agent (CxA). Notify the CxA at least 10 days in advance, and provide access for the CxA to witness testing and balancing Work. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA. The CxA will notify testing and balancing Subcontractor

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

10 days in advance of the date of field verification. Notice will not include data points to be verified.

- B. At the time of TAB final acceptance inspection, the TAB Agency shall recheck, in the presence of the CxA, specific and random selections of data recorded in the certified test and balance report. The TAB Agency shall use the same instruments (by model and serial number) that were used when original data were collected.
- C. Points and areas for recheck shall be selected by the CxA.
- D. Measurements and test procedures shall be the same as the submitted and approved test and balance agenda.
- E. Selections for verification, specific plus random, shall not exceed 10% of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.
- F. If 10% of the random verification tests demonstrate a measured flow deviation of 10% or more from that recorded in the certified test and balance report, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test and balance report submitted, and a new inspection test made, all at no additional cost to the Owner.
- G. Final Acceptance will occur after successful completion of the TAB verification process.

PART 3 - TAB PROCEDURES

3.1 PROCEDURES FOR MOTORS – THIS APPLIES TO ALL HVAC SYSTEM MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Full-load amperage and service factor.
 - 6. Nameplate and measured voltage, each phase.
 - 7. Nameplate and measured amperage, each phase.
 - 8. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data. Adjust VFDs to skip critical frequencies.

3.2 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. System Diagrams: Include schematic layouts of as-built air distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Terminal units.
 - 4. Volume dampers.
- B. Test and adjust fan RPM to design requirements. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
- C. Test and record motor full load nameplate rating and actual ampere draw.
- D. Test and record system static pressures, fan suction, and discharge; static pressure across each component that makes up an air system. Measure static pressures entering and leaving other devices under final balanced conditions.
- E. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur.
- F. Recommend corrective action to align design and actual conditions. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in all operating modes to determine the maximum required brake horsepower.
- G. [TAB contractor shall carry an allowance of (\$500, \$750, \$1000) for fan and/or motor sheave replacement required to achieve system air flow within specified tolerance from design. Remaining portion of allowance shall be credited back to owner by the completion of TAB.]
- H. Adjust all main supply and return air duct to within tolerances of proper design CFM. Make air velocity measurements in ducts by Pitot tube traverse entire cross sectional area of duct in accordance with SMACNA equal area method or Log Linear method. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved. Where sufficient space in sub-main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.
- I. Test and adjust each diffuser, grille, and register. Reading and tests of diffusers, grilles, and registers shall include design CFM and adjusted CFM.
- J. [Chilled Beams: The most accurate means of determining the primary air delivery, is to rely on the manufacturer's plenum pressure vs. volume relationship, which is typically measured with a precision orifice. Confirmation of zone flow rates shall be accomplished via a duct traverse at a node of common intersection.]

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- K. Adjust patterns of adjustable outlets for proper distribution without drafts.
- L. Where modulating dampers or economizers are provided, take measurement at full return air, minimum outside air, and 100 percent outside air mode of operation.
- M. In coordination with the BAS contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.
- N. Adjust outside air automatic and manual dampers for design conditions within specified tolerances.
- O. Procedures for Variable-Air-Volume Systems
 - 1. Develop a plan to simulate diversity. When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
 - 2. After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - a. Set outside-air dampers at minimum and return- and exhaust-air dampers at a position that simulates full-cooling load.
 - b. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - c. Measure total system airflow. Adjust to within indicated airflow.
 - d. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - e. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - f. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
 - g. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 - h. Record the final fan performance data.
- P. Air-Handling Unit Test Reports (AHU, FCU, _____): For air-handling units, include the following:
 - 1. Test conditions for fan performance forms including the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Fan drive settings including settings and percentage of maximum pitch diameter.
 - d. Settings for supply-air, static-pressure controller.
 - e. Other system operating conditions that affect performance.
2. Unit Data: Include the following:
- a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
3. Motor Data: as specified hereinbefore.
4. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Coil static-pressure differential for each coil in inches wg.
 - g. Outside airflow in cfm.
 - h. Return airflow in cfm.
 - i. Outside-air damper position.
 - j. Return-air damper position.
 - k. Supply and Return Fan VFD Hz.

Q. Fan Test Reports:

1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - i. Number of belts, make, and size.
2. Motor Data: as specified hereinbefore.
3. Test Data (Indicated and Actual Values):

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- R. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- S. Air-Terminal-Device Reports, VAV, Chilled Beam, _____
1. Unit Data:
 - a. Manufacturer, type size, and fittings.
 - b. System and air-handling unit identification.
 - c. Location and zone.
 - d. Test apparatus used.
 - e. Area served.
 - f. Air-terminal-device manufacturer and model.
 - g. Air-terminal-device number from system diagram.
 - h. Air-terminal-device type and model number.
 - i. Air-terminal-device size.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
- T. Procedures for Heat-Transfer Coils
1. Coil Test Reports:
 - a. System identification.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Location.
 - c. Make and model number.
 - d. Face area in sq. ft.
2. Test Data (Indicated and Actual Values):
- a. Airflow rate in cfm.
 - b. Face area in sq. ft.
 - c. Average face velocity in fpm.
 - d. Air pressure drop in inches wg.
 - e. Water flow rate in gpm.
 - f. Water pressure differential in feet of head.

3.3 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. System Diagrams: Include schematic layouts of as-built hydronic distribution systems. Present each system with single-line diagram and include the following:
 1. Water flow rates.
 2. Pipe and valve sizes and locations.
 3. Terminal units.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set system controls so automatic valves are wide open.
 6. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- D. Hydronic balancing shall include the following minimum data:
 1. Prepare itemized equipment schedules, listing all hydronic elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all hydronic elements, all zone balancing valves, and circuit pumps, ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions, and measured conditions. Prepare individual pump report sheets for each zone or circuit.
 2. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
 3. Effect system balance with automatic control valves fully open to heat or cooling transfer elements.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Adjust balancing valves at each coil and balancing valve for design flow. Adjust hydronic distribution systems by means of balancing valve; do not use service or shut-off valves for balancing unless indexed for balance point.
 5. Water pressure shall be recorded at all gauge connections
- E. For primary-secondary-flow hydronic systems, balance the primary system crossover flow first, and then balance the secondary system.
- F. For coils equipped with three-way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.
- G. Pumps:
1. Adjust balancing valves or VFD at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve. (Note: If discharge valves on the pumps are used for balancing, record the head being restricted by the valves).
 2. Where available pump capacity is less than total flow requirements or individual system parts, proportional balancing must be performed.
 3. Do not deadhead the pumps. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
 4. Calculate impeller size by plotting the shutoff head on pump curves and include the following pump test report data:
 5. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Pump rpm.
 - i. Impeller diameter in inches.
 - j. Motor Data: as specified herein before.
 6. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Pump VFD Hz.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

H. Procedures for Chillers

1. Balance water flow through each evaporator [**and condenser**] to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
2. Chiller Test Reports:
 - a. Unit Data:
 - 1) Unit identification.
 - 2) Make and model number.
 - 3) Manufacturer's serial number.
 - b. Evaporator Test Reports (Indicated and Actual Values):
 - 1) Entering-water temperature in deg F.
 - 2) Leaving-water temperature in deg F.
 - 3) Entering-water pressure in feet of head or psig.
 - 4) Water pressure differential in feet of head or psig.
 - 5) [Minimum-flow bypass GPM.]
 - 6) GPM flow

I. Procedures for Boilers

1. Measure entering- and leaving-water temperatures and water flow.
2. Boiler Test Reports:
 - a. Unit Data:
 - 1) Unit identification.
 - 2) Location.
 - 3) Service.
 - 4) Make and type.
 - 5) Model and serial numbers.
 - 6) Voltage at each connection.
 - 7) Amperage for each phase.
 - b. Test Data (Indicated and Actual Values):
 - 1) Operating pressure in psig.
 - 2) Operating temperature in deg F.
 - 3) Water pressure differential in feet of head.
 - 4) GPM flow
 - 5) Voltage at each connection.
 - 6) Amperage for each phase.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 PROCEDURES FOR DOMESTIC HOT WATER RECIRCULATION SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system.
- B. System Diagrams: Include schematic layouts of as-built domestic hot water systems. Present each system with single-line diagram and include the following:
 - 1. Water flow rates.
 - 2. Pipe and valve sizes and locations.
 - 3. Recirculation valve settings/flows
- C. Balancing shall include the following minimum data:
 - 1. Pump flow
 - 2. Balancing valve flows: proportionally balance flow to each recirculation loop.
- D. Pumps:
 - 1. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve. (Note: If discharge valves on the pumps are used for balancing, record the head being restricted by the valves).
 - 2. Do not deadhead the pumps. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
 - 3. Calculate impeller size by plotting the shutoff head on pump curves and include the following pump test report data:
 - 4. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Pump rpm.
 - i. Impeller diameter in inches.
 - j. Seal type.
 - k. Motor Data: as specified herein before.
 - 5. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.5 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

- A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions. Measure space pressure differential where pressure is used as the design criteria and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - 1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 - 2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - 3. Test room pressurization first, then zones, and finish with building pressurization.
- C. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- D. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 - 1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 - 2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test over-pressurization and under-pressurization, and observe and report on the system's ability to revert to the set point.
 - 3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- E. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- F. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.6 TESTING OF BUILDING AUTOMATION SYSTEMS

- A. Assist the BAS Contractor as follows:
 - 1. Work with the Temperature Control Contractor to ensure the most effective total system operation is within the design limitations, and to obtain mutual understanding of intended control performance.
 - 2. Verify that all control devices are properly connected and operated by the intended controller.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
4. Observe the calibration of all controllers.
5. Verify the proper application of all normally opened and normally closed valves.
6. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. The Control Contractor shall relocate as deemed necessary by the TAB Agency.
7. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications.
8. Verify the operation of all interlock systems.
9. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

END OF SECTION 230593

SECTION – 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 7 for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Common Work Results for Mechanical"
 - 3. Division 23 Section "Hangers and Supports for Piping and Equipment" for pipe insulation shields and protection saddles.
 - 4. Division 23 Section "Metal Ducts" for duct liner.

1.2 SUMMARY

- A. This Section includes insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 ACTION SUBMITTALS

- A. Product Data: Identify thermal conductivity, Greenguard Certification, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- C. Store tapes, adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer.
- D. Follow manufacturer's recommended handling practices.
- E. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- F. Fiber Glass and Mold: Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with other trades for insulation application.
- B. Schedule insulation application after testing systems. Insulation application may begin on segments of systems that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Certainteed
 - 2. Knauf
 - 3. Owens-Corning
 - 4. John Mansville
 - 5. Armstrong
 - 6. Aeroflex USA
 - 7. Nomaco K-Flex
 - 8. Pabco.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.2 PIPING INSULATION MATERIALS

A. General

1. Supply fiber glass products that have achieved GREENGUARD Children & Schools Certification.
2. Surface Burning Characteristics: Insulation and related materials shall have surface burning characteristics determined by test performed on identical products per ASTM E 84 mounted and installed as per ASTM E 2231. All testing shall be performed by a testing and inspecting agency acceptable to authorities having jurisdiction. Insulation, jacket materials, adhesives, mastics, tapes and cement material containers shall be labeled with appropriate markings of applicable testing and inspecting agency. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. Supply fiber glass products that are manufactured using a certified 25 % minimum recycled content.

B. Provide thermal hanger shields as specified in Section 230529.

C. Glass Fiber:

1. Knauf 1000° Pipe Insulation with ECOSE Technology meeting ASTM C547 Type IV Grade A, ASTM C585, and ASTM C795; rigid, molded, noncombustible per ASTM E136; k value: ASTM C335, 0.23 at 75°F mean temperature. Maximum Service Temperature: 1000°F, or Johns Manville's Micro-Lok® HP meeting ASTM C547, Type I, maximum service temperature of 850°F meeting the other requirements. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C1136 Type I, secured with self-sealing longitudinal laps and butt strips.
2. PVC Fitting Covers: The Proto Fitting Cover System or Johns Manville Zeston® polyvinyl chloride (PVC) parts shall consist of one piece and two piece pre-molded high impact UV-resistant PVC fitting covers with fiberglass inserts and accessories, which include elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings. Fittings shall be made of Zeston® or LoSMOKE® grade PVC, 25/50 rated per ASTM E-84. Thermal Value of fiberglass insert: K value of 0.26 at 75°F; resistance to fungi and bacteria. (ASTM G 21, ASTM G 22): does not promote growth of fungi or bacteria.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Materials shall have a maximum thermal conductivity of 0.27 Btu-in/h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
4. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure-A, latest revision.
5. Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. Provide Armaflex WB finish for outdoor exposed piping.
- E. Calcium Silicate Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I. IIG's Thermo-12 Gold
 - F. Closed Cell Pipe Insulation: Pittsburgh Corning Foamglas, or approved equal; a lightweight, rigid insulating material composed of millions of completely sealed glass cells, each an insulating space. ASTM C 552-00 "Specification for Cellular Glass Thermal Insulation" operating temperatures from -450°F to +900°F; water permeability 0.00 perm-inch.
 - G. Pipe & Tank Insulation: Glass Fiber, Knauf with ECOSE Technology or equivalent; semi-rigid, limited combustible meeting requirements of NRC 1.36; ASTM C 795 and MIL-I-24244 C; k value: ASTM C 177, 0.25 at 75°F mean temperature. Maximum Service Temperature: 850°F. Compressive Strength: not less than 150 PSF @ 10% deformation for 2 inch thickness per ASTM C 165. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type II. Johns Manville Micro-Flex[®] Large Diameter Pipe and Tank Wrap meeting ASTM C1393, Type III. Limited combustible meeting k value: ASTM C 177, 0.25 at 75°F mean temperature. Maximum Service Temperature: 850°F. Compressive Strength: not less than 150 PSF @ 10% deformation for 2 inch thickness per ASTM C 165. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type II
 - H. Solar Thermal: UT Solaflex Tube and Roll Insulation - High Temperature & UV Resistant; provide outside array piping insulation with a capability of withstanding 300 degrees F. Protect outside piping insulation from water damage and ultraviolet degradation with a suitable outer coating. Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision
 - I. Removable/reusable Insulation Blankets: Auburn Manufacturing EverGreen Cut 'n Wrap, or approved equal; engineered insulating composite with a fiberglass inner core and high-performance polymer coated woven glass fiber fabric outer layer on both sides. Kits contain a 4'x 8' modularized blanket rated to 500°F and a roll of double sided hook and loop fastener making onsite fabrication of removable/reusable insulation blankets quick and easy. Up to 500°F; Weight, oz/ft² 7.65; Effective Thickness, in. 1.25 ± 0.25; Surface Burning Characteristics: Does not exceed 25 Flame Spread, 50 Smoke Developed when tested in accordance with ASTM E-84. Materials shall have a maximum thermal conductivity of 0.372 Btu-in/h-ft²- °F at a 100°F mean temperature when tested in accordance with ASTM C335.

2.3 DUCTWORK INSULATION MATERIALS

- A. Flexible Fiber Glass Blanket: Johns Manville's Microlite[®] XG Duct Wrap or Knauf Friendly Feel[®] Duct Wrap with ECOSE Technology meeting ASTM C553 Types I, II and III, and ASTM C1290; GREENGUARD certified; flexible, limited combustible; k value: ASTM C177, 0.29 at 75°F mean temperature. Maximum Service Temperature: faced: 250°F; unfaced: 350°F. Vapor Retarder Jacket: FSK conforming to ASTM C1136 Type II. Installation: Maximum allowable compression is 25%. Securement: Secured in place using outward cinching staples in combination with appropriate pressure-sensitive aluminum foil or PSK tape, or in combination

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

with glass fabric and vapor retarder mastic. Density: concealed areas: Minimum 0.75 PCF; exposed areas: Minimum 1.0 PCF.

- B. Rigid Fiber Glass Board: Johns Manville's 817 Series Spin-Glas® or Knauf Insulation Board with ECOSE Technology meeting ASTM C 612 Type IA and IB; rigid. Maximum Service Temperature: 450°. Density: Minimum 6 PCF; k value: ASTM C177, 0.22 at 75°F mean temperature. Vapor Retarder Jacket: ASJ conforming to ASTM C1136 Type I, or FSK or PSK conforming to ASTM C1136 Type II in combination with protective jacket where necessary.

2.4 FIELD-APPLIED JACKETS FOR PIPING

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. PVC: Johns Manville's Zeston® PVC fittings, jacketing, and accessories or Proto Corporation 25/50 or Indoor/Outdoor, UV-resistant fittings, jacketing and accessories, white. Fitting cover system consists of pre-molded, high-impact PVC materials with fiber glass inserts. Fiber glass insert has a thermal conductivity (k value) of 0.26 at 75° F mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.
- C. Aluminum Jacket: Factory cut and rolled to required size. Comply with ASTM B 209, 3003 alloy, and H-14 temper. Finish and Thickness: Corrugated finish, 0.010 inch thick. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and Kraft paper. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.
- D. Stainless-Steel Jacket: ASTM A666, Type 304 or 316; 0.10 inch thick; and factory cut and rolled to required size. Moisture Barrier: 3-mil- thick, heat-bonded polyethylene and Kraft paper. Elbows: Gore type, for 45- and 90-degree elbows in same material, finish, and thickness as jacket. Jacket Bands: Stainless steel, Type 304, 3/4 inch wide.

2.5 EXTERIOR DUCTWORK

- A. Rigid roof insulation board, 2" thickness; with high-performance jacketing: VentureClad-1577, or approved equal; high performance jacketing product shall perform well over a wide temperature range; -30°F to +300°F service temperature.
 - 1. Zero permeability, absolute vapor barrier
 - 2. High puncture and tear resistance
 - 3. Contain tested and approved mold inhibiting agents
 - 4. A 5-ply self adhesive material shall install easily with no off-site fabrication required
 - 5. The cold weather acrylic adhesive shall apply easily at temperatures as cold as -10°F.
 - 6. Flame spread/smoke developed: 10/20 (UL 723)
 - 7. 6-mil thickness (PSTC-133)
 - 8. Exceeds standard building design requirements (UL 723 10/20 Flame Spread/Smoke Rating). Meets requirements of FSIS Directive 5000.1, 9 CFR, Part 416 for USDA and FDA facilities and Department of Health and Human Services Construction Guide for Food Facilities
 - 9. Provide in natural aluminum stucco embossed finish.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 ACCESSORY MATERIALS

- A. Accessory materials installed as part of insulation work under this section shall include (but not be limited to):
 - 1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
 - 2. Adhesive: As recommended by insulation material manufacturer. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated
 - 3. Support Materials - Hanger straps, hanger rods, saddles, support rings
- B. All accessory materials shall be installed in accordance with manufacturer's instructions.
- C. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION & PREPARATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application. Verify that systems to be insulated have been tested and are free of defects. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- D. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.2 GENERAL APPLICATION REQUIREMENTS

- A. Provide insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout, including the length of ducts and fittings, valves, and specialties.
- B. Provide insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each system as specified in insulation system schedules.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Provide accessories compatible with insulation materials and suitable for the service. Provide accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Provide insulation with longitudinal seams at top and bottom of horizontal pipe runs and equipment.
- E. Provide multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Provide insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Provide insulation over fittings, valves, and specialties, with continuous thermal and least number of joints practical.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and specialties around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Provide insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

- A. Insulation Installation at Roof or Aboveground Exterior Wall Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof/wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof/wall flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof/wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Penetrations:
 1. Fire Dampers: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 2. Pipe or duct penetrations (no fire damper): Install insulation continuously through penetrations of fire-rated walls and partitions. Comply with requirements in Division 7 for firestopping and fire-resistive joint sealers.

3.4 INSTALLATION OF PIPING INSULATION

- A. Metal shields shall be installed between hangers or supports and the piping insulation. Provide in accordance with Section 230529.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- C. Insulate instrument connections for specialties (examples: thermometers, sensors, etc.) on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at fittings and equipment that require servicing and locations with service requirements.
- E. Glass Fiber Piping Insulation
1. Locate seams in the least visible location.
 2. Insulation installed on piping operating below ambient temperatures must have a continuous vapor retarder. All joints, seams and fittings must be sealed. On systems operating above ambient, the butt joints should not be sealed.

F. Flexible Elastomeric Insulation

1. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges: Install pipe insulation to outer diameter of pipe flange. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
4. Insulation Installation on Valves and Pipe Specialties: Install preformed valve covers manufactured of same material as pipe insulation when available. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. Install insulation to flanges as specified for flange insulation application. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
5. After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Prior to applying the finish, the insulation shall be wiped clean with denatured alcohol. The finish shall not be tinted. To insure good adhesion, the temperature should be above 50 °F during application and drying. Outdoor exposed piping shall have the seams located on the lower half of the pipe.
6. Outdoor exposed piping shall be painted with two coats of Armaflex WB Finish. Prior to applying the Finish, the insulation shall be wiped clean with denatured alcohol. The Finish shall not be tinted. Outdoor exposed piping shall have the seams located on the lower half of the pipe.

3.5 INSTALLATION OF DUCTWORK INSULATION

A. Flexible Fiberglass Blanket Insulation Installation:

1. Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
3. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
4. Firmly butt all joints.
5. Where vapor retarder performance is required, all penetrations and damage to the facing shall be repaired using pressure-sensitive tape matching the facing, or mastic prior to system startup. Pressure-sensitive tapes shall be a minimum 3 inches wide and shall be applied with moving pressure using a squeegee or other appropriate sealing tool. Closure shall have a 25/50 Flame Spread/Smoke Developed Rating per UL 723. The longitudinal seam of the vapor retarder must be overlapped a minimum of 2 inches.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Insulation shall be additionally secured to the bottom of rectangular ductwork over 24 inches wide using mechanical fasteners on 18-inch centers. Care should be exercised to avoid over-compression of the insulation during installation.
 - d. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - e. Do not over-compress insulation during installation. Install Duct Wrap using manufacturer's stretch-out tables to obtain specified R-value using a maximum compression of 25%.
 - f. Impale insulation over pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 8. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- C. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
1. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 2. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
- D. Fire-rated insulation system installation: Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating. Insulate duct access panels and doors to achieve same fire rating as duct.

3.6 INSTALLATION OF EQUIPMENT/ TANK INSULATION

A. Fiber Glass

1. Apply insulation to the equipment surface with joints firmly butted and as close as possible to the equipment surface. Insulation shall be secured as required with mechanical fasteners or banding material. Fasteners shall be located a maximum of 3" from each edge and spaced no greater than 12" on center.
2. For below ambient systems, vapor retarder jacketing shall overlap a minimum of 2" at all seams and be sealed with appropriate pressure-sensitive tape or mastic. All penetrations and facing damage shall be covered with a minimum 2" overlap of tape or mastic.

B. Flexible Elastomeric:

1. Install insulation over entire surface of tanks and vessels.
2. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
3. Seal longitudinal seams and end joints.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Insulation Installation on Pumps: Insulate chilled water pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing that does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.
- D. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.9 PIPING INSULATION APPLICATION SCHEDULE

- A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. For piping systems not indicated, insulate to with a similar thickness and type as those specified.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. All cold surfaces that may “sweat” must be insulated. Vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. For above-ambient services, do not install insulation to the following: testing agency labels and stamps, nameplates, and cleanouts.
- D. Insulation thicknesses and installations shall meet or exceed the requirements of ASHRAE Standard 90.1-2007, or thicknesses indicated, whichever is of superior insulating performance.
- E. If piping type is omitted from list below, provide insulation as per similar duty.
- F. Provide PVC jackets in the following locations:
 - 1. For piping exposed in mechanical rooms within 6 feet above finished floor or high traffic areas.
 - 2. Exposed vertical piping in finished spaces.
- G. Domestic hot and recirculated hot water:
 - 1. Pipe size 1-1/4” and less: Glass Fiber, ½” thickness.
 - 2. Pipe size 1-1/2 and larger: Glass Fiber, 1” thickness.
 - 3. Aquatherm: refer to Specification 221116, 2.4.F.
- H. Domestic cold water
 - 1. Pipe size 1-1/4” and less: Glass Fiber, 1” thickness.
 - 2. Pipe size 1-1/2 and larger: Glass Fiber, 1.5” thickness.
 - 3. Aquatherm: refer to Specification 221116, 2.4.F.
- I. Horizontal Rainwater conductors: Glass Fiber, 1” thickness. [Provide for all horizontal piping and any vertical piping within 10 feet of the roof drain.]
- J. Roof Drain Bodies: Flexible Elastomeric, ½” thickness.
- K. AC pan drain or other cold drain piping; (35° to 60°F): Flexible Elastomeric, ½” thickness; Note: Insulation not required for PVC pan drains at rooftop units or in mechanical rooms.
- L. Chilled Water (40°F to 60°F):
 - 1. Pipe size 1-1/4” and less: Glass Fiber, ½” thickness.
 - 2. Pipe size 1-1/2 and larger: Glass Fiber, 1” thickness.
 - 3. Aquatherm: refer to Specification 232113, 2.5.F.
- M. Chilled Water, outdoors: Closed Cell Pipe Insulation; 1” thickness. Provide aluminum jacket

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- N. Heating supply and return (indoor), 105F to 140F:
1. Pipe size 1-1/4" and less: Glass Fiber; 1" thickness.
 2. Pipe size 1-1/2" and larger: Glass Fiber; 1.5" thickness.
 3. Insulation is not required for unions, flexible connectors, control valves, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 1-inch of un-insulated items.
 4. Insulation is not required between the heating control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is 1 in or less.
 5. Heating hot-water manual shutoff valves and balance valves 4"Ø and larger: same as water piping; no insulation required 3"Ø and smaller.
- O. Heating supply and return (indoor), 141F to 200F:
1. Pipe size 1-1/4" and less: Glass Fiber; 1.5" thickness
 2. Pipe size 1-1/2" and larger: Glass Fiber; 2" thickness.
 3. Insulation is not required for unions, flexible connectors, control valves, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 1-inch of un-insulated items.
 4. Insulation is not required between the heating control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is 1 in or less.
 5. Heating hot-water manual shutoff valves and balance valves 4"Ø and larger: same as water piping; no insulation required 3"Ø and smaller.
- P. Heating supply and return (outdoor):
1. Pipe size 1-1/4" and less: Glass Fiber; 2" thickness.
 2. Pipe size 1-1/2" and larger: Glass Fiber; 2.5" thickness.
 3. Insulation is not required for unions, flexible connectors, control valves, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 1-inch of un-insulated items.

3.10 EQUIPMENT INSULATION

- A. For equipment not indicated, insulate to with a similar thickness and type as those specified.
- B. Install insulation over entire surface of tanks and vessels. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive. Seal longitudinal seams and end joints.
- C. For Equipment insulation exposed in mechanical rooms or subject to mechanical abuse, finish with minimum 0.020 inch thick PVC jacketing or metal or laminated self-adhesive water and weather seals. All other insulation shall be finished as appropriate for the location and service or as specified on the drawings.
- D. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
- E. Omit insulation from the following, except for cold surfaces, which shall be provided with removable covers:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Hot water expansion tanks
 2. Hot water pumps
 3. Vibration-control devices.
 4. Testing agency labels and stamps.
 5. Nameplates and data plates.
 6. Manholes, hand holes, or cleanouts.
- F. Removable Covers for Maintenance Access: Construct insulation on parts of equipment such as chilled water pumps; or other equipment which must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Use ¾” flexible elastomeric insulation.
- G. Cooling & heating system expansion tanks, chemical feed tanks, buffer tanks and similar equipment: same as water piping.
- H. Air separators: same as water piping.
- I. Heating hot-water heat exchangers; steam-to-water converters; deaerators (not factory insulated); Insulation Material: Pipe & Tank Insulation, 2” thickness.
- J. Hot equipment not factory insulated, Examples: steam flash-tank, flash-separator, moisture-separator, and blow-off-tank insulation shall be one of the following:
1. Calcium Silicate: 2” thick.
 2. Pipe & Tank Insulation: 2” thick.

3.11 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section. For duct systems not indicated, insulate to with a similar thickness and type as those specified.
- B. Insulation thicknesses and installations shall meet or exceed the requirements of ASHRAE Standard 90.1-2007, or thicknesses indicated, whichever is of superior insulating performance.
- C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Metal ducts with duct liner.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums, casings, and access doors.
 4. Flexible connectors.

3.12 DUCT AND PLENUM APPLICATION SCHEDULE

- A. AHU Supply Ducts: Flexible Fiber Glass Blanket;
1. Concealed or Unconditioned Space: R-6, 1.5” thickness.
 2. Exposed to Conditioned Space: None

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Exterior Supply Ducts: Insulation Board with high performance jacket.
- C. Return ducts within conditioned space: None required.
- D. Concealed outside air intake, relief, or exhaust ducts and plenums [within 20 feet of exterior]: Flexible Fiber Glass Blanket; R-8, 2” thickness.
- E. Exposed outside air intake, relief, or exhaust ducts and plenums [within 20 feet of exterior]: Rigid Fiber Glass Board; R-8, 2” thickness.

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. The intent of this specification is to provide an open source Building Automation Control System (BACS) based on the Tridium Niagara AX Platform and a network of freely programmable interoperable open protocol BACnet digital controllers. The Interoperable BACnet controllers shall be fully programmable via the embedded Niagara WorkBench tool requiring only a web browser to complete the programming process.
- B. Products requiring a licensed, non-embedded, off site programming tool are not acceptable. Open source as referred to herein shall mean that the Tridium Niagara Network Area Controller and the Interoperable Digital BACnet Controllers (IDC) products are available from multiple contractor and vendor sources, affording the owner freedom of choice and competitive bidding for the initial installation of the (BACS) and future system expansions and modifications not limited by contractor, vendor or networking protocol. No territorially restricted OEM brands, single vendor or “branch only” products are acceptable. All products must be available for purchase by any qualified contractor that the owner chooses to do the initial installation and any future expansion or modifications.
- C. The successful bidder shall demonstrate to the owner via a product website dealer/contractor locator, that there are multiple contractors and vendors in the project geographic area to choose from. No exceptions to this requirement will be allowed.
- D. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation Control System (BACS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.
- E. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.
- F. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).
- G. The scope for the Phase II project shall include the following:
 - 1. Provide new head end based upon the Tridium Niagra AX Platform.
 - 2. Individual controllers for the new VAV boxes, to control the damper, reheat coil control valve, and existing fan coil unit control valves, integrated with the Tridium Platform.
 - 3. New sensors at the areas served by new VAV boxes.
 - 4. Integration of existing 20 ton chiller controller, existing 80 ton chiller controller, and one new 40 ton chiller controller.
 - 5. Integration for the new RTU-1 controller.
 - 6. Integration with software upgrades as required for nine existing AHU controllers (Trane UPCM).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Field installed controls for RTU-2, including a master controller, integrated with the new platform.
8. Integration for the boiler controllers.
9. Integration for the humidifier controllers.
10. Complete temperature and pressurization control for spaces throughout the addition and renovation areas.

1.2 SYSTEM DESCRIPTION

- A. The entire Building Automation Control System shall be comprised of a network of interoperable, stand-alone digital controllers communicating via BACnet™ communication protocols to a Network Area Controller (NAC). Temperature Control System products shall be by approved manufacturers. Equivalent BACnet™ products must be approved in writing by the consulting Engineer and be submitted for approval ten (10) days prior to the date of the bid submittal.
- B. The Building Automation Control Systems (BACS) consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and perform functions specified.
- C. The Building Automation Control System shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to BACnet™ (IBC) controllers and other open protocol systems/devices provided under Division 23 or Division 26.
- D. The BACS as provided in this Division shall be based on a hierarchical architecture incorporating the Niagara AX Framework™. Equivalent products must be approved in writing by the consulting Engineer and be submitted for approval ten (10) days prior to the date of the bid submittal. Systems not developed on the Niagara AX Framework™ platform are unacceptable.
- E. The BACS shall monitor and control equipment as called for by the "Sequence of Operation" and points list.
- F. The BACS shall provide full graphic software capable of complete system operation for up to 34 simultaneous Thin-Client workstations.
- G. The BACS shall provide full graphic operator interface to include the following graphics as a minimum:
 1. Home page to include a minimum of six critical points, i.e. Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW etc.
 2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
 3. Detail graphics for each mechanical system to include; AHUs (Air Handling Units), ERUs (Energy Recovery Units), TUs (Terminal Units), EFs (Exhaust Fans), Chillers and associated controls, Boilers, and Converters as a minimum.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- H. The BACS shall provide the following data links to electronically formatted information for operator access and use.
1. Project control as-built documentation; to include all BACS drawings and diagrams converted to Adobe Acrobat .pdf filers.
 2. TCS Bill of Material for each system, i.e. AHU, RTU, FCU, Boiler etc.
 3. Technical literature specification data sheets for all components listed in the BACS Bill of Material.
- I. The BACS shall provide automated alarming software capable of sending messages to email compatible cellular telephones and pagers via the owner's e-mail service. The email alarm paging system shall be able to segregate users, time schedules, and equipment, and be capable of being programmed by the owner.
- J. It is preferable that any dedicated configuration tool required for controller configuration have the capability to be launched from within the applicable Network Management Software. If the configuration tool(s) can not be launched from the Network Management Software, any software required for controller configuration shall be included as a leave-behind tool with enough license capability to support the installation.
- K. The contractor shall provide the appropriate quantity of legal copies of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be generally available in the market. No closed and/or unavailable tools will be permitted. Contractor shall convey all software tools and their legal licenses at project close out.

1.3 SUBMITTAL

- A. Four copies of shop drawings of the components and devices for the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves, dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package. Division 26 contractors supplying products and systems, as part of their packages shall provide catalog data sheets, wiring diagrams and point lists to the Division 23 contractor for proper coordination of work.
- B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media, and protocol. Though the Division 23 and 26 contractors shall provide these diagrams for their portions of work, the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN) and/or Local Area Network (LAN) utilized by the BACS.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.
- C. Submittal shall also include a complete point list of all points to be connected to the BACS. Division 23 and 26 contractors shall provide necessary point lists, protocol documentation, and factory support information for systems provided in their respective divisions but integrated into the BACS.
- D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or Owner.
- E. Upon completion of the work, provide a complete set of ‘as-built’ drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the ‘as-built’ drawings shall be provided in addition to the documents on compact disk. Division 23 and 26 contractors shall provide as-builts for their portions of work. The Division 23 contractor shall be responsible for as-builts pertaining to overall BACS architecture and network diagrams. All as-built drawings shall also be installed into the BACS server in a dedicated directory.

1.4 SPECIFICATION NOMENCLATURE

- A. Acronyms used in this specification are as follows:

DDCS	Direct Digital Control System Building Automation Control System
GUI	Graphical User Interface
IBC	Interoperable BACnet Controller
IDC	Interoperable Digital Controller
LAN	Local Area Network
NAC	Network Area Controller
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement
PMI	Power Measurement Interface
POT	Portable Operator’s Terminal
TCS	Temperature Control System
WAN	Wide Area Network
WBI	Web Browser Interface

1.5 DIVISION OF WORK

- A. The Division 23 and 26 (if applicable) contractors shall be responsible for all controllers (IDC and IBC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.
- B. The Division 23 contractor shall be responsible for the Network Area Controller(s) (NAC), software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, LonWorks network management and connection of the NAC to the local or wide area network.

1.6 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 26, Electrical:
 - 1. Providing motor starters and disconnect switches (unless otherwise noted).
 - 2. Power wiring and conduit (unless otherwise noted).
 - 3. Provision, installation and wiring of smoke detectors (unless otherwise noted).
 - 4. Other equipment and wiring as specified in Division 26.

1.7 AGENCY AND CODE APPROVALS

- A. All products of the BACS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
 - 1. UL-916; Energy Management Systems
 - 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 “signal Equipment”
 - 3. CE
 - 4. FCC, Part 15, Subpart J, Class A Computing Devices

1.8 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall agree to the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.
- B. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

with the NAC, BACS, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

- C. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within Niagara AX Framework (Niagara) based controllers and/or servers and any related LAN / WAN / Intranet and all connected routers and devices.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.10 QUALITY ASSURANCE

- A. Proven Experience: Provide a list of no less than ten similar projects which have building control systems specified. These projects must be on-line and functional such that the Owner's Representative would observe a direct digital control system in full operation. The Contractor must be a direct, wholly owned branch of a national control's manufacturer, or a representative not a wholesale distributor.
- B. Quality of Compliance: Control systems shall be installed by trained control mechanics regularly employed in installation and calibration of BACS equipment by the manufacturer of temperature control equipment.
- C. Contractor Requirements
 1. Longevity: The BACS contractor shall have a minimum of ten years experience installing, and servicing computerized building systems. All subcontractors utilized by the BACS contractor shall have a minimum of five-year experience within their appropriate trades.
 2. Past Projects: The BAS contractor shall have completed a minimum of ten projects within the last five years that are at least equal in dollar value and scope to this project. A list of similar projects, dollar volume, scope, contact name and contact number shall be provided by the BAS contractor if asked for by the owner.
 3. Personnel, Coverage and Response Capabilities: The BACS contractor shall have a minimum of ten full time electronic service personnel and two factory trained DDC control technicians within a 140 mile radius of the project location
 4. The BACS contractor shall have an established 24-hour emergency service organization. A dedicated telephone number shall be provided to the owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BACS contractor.
 5. The Potential Low Bidder will submit with Bid Documents a qualification statement demonstrating how the above Contractor requirements shall be achieved. Any Potential

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

Low Bidder that does not meet all of the criteria shall not be considered and shall be rejected for not complying with the specifications.

1.11 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 - MATERIALS

2.1 GENERAL

- A. The Building Automation Control System (BACS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.
- B. The installed system shall provide secure password access to all features, functions and data contained in the overall BACS.

2.2 ACCEPTABLE MANUFACTURERS

- A. Basis-of-Design: Tridium Niagara-AX™. Subject to compliance with requirements, provide either the product named or an alternate product by one of the other manufacturers specified. System must operate on an open licensed JACE with the AX Workbench. No Appliance may be used. All JACE controllers shall operate with the Brand ID set to “none”, and compatibility modes set for “all”.
- B. Acceptable installers/programmers:
 - 1. XL Mechanical
 - 2. Honeywell Corporate
 - 3. Johnson Controls - 477 Congress Street, Portland, Maine

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet™ technology, MODBUS™, OPC, and other open and proprietary communication protocols into one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

industry standards including ANSI / ASHRAE™ Standard 135-2001 and BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified.

- C. All components and controllers supplied under this Division shall be true “peer-to-peer” communicating devices. Components or controllers requiring “polling” by a host to pass data shall not be acceptable.
- D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. Systems requiring proprietary database and user interface programs shall not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a “flat” single tiered architecture shall not be acceptable.
 - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for local network connected user interfaces.
 - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4 NETWORKS

- A. The Local Area Network (LAN) shall be a 100 Megabit/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.
- B. Local area network minimum physical and media access requirements:
 - 1. Ethernet; IEEE standard 802.3
 - 2. Cable; 100 Base-T, UTP-8 wire, category 5
 - 3. Minimum throughput; 100 Mbps.

2.5 NETWORK ACCESS

- A. Remote Access.
 - 1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

2.6 NETWORK AREA CONTROLLER (NAC)

- A. The contractor shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided under Divisions 23 and 26. It is the responsibility of the contractor to coordinate with the Division 23 and 26 contractors to determine the quantity and type of devices.
- B. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization
 - 6. Integration of BACnet controller data
 - 7. Network Management functions for BACnet based devices
- C. The Network Area Controller shall provide the following hardware features as a minimum:
 - 1. One Ethernet Port – 10/100 Mbps
 - 2. One RS-232 port
 - 3. One RS-485 port if BACnet controllers are used.
 - 4. Battery Backup
 - 5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 - 6. The NAC must be capable of operation over a temperature range of 32 to 122°F
 - 7. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F
 - 8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing
- D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- E. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- F. Event Alarm Notification and actions
 - 1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - 2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network, or remote via dial-up telephone connection or wide-area network.
 - 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. In alarm
 - b. Return to normal
 - c. Fault condition
 4. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and/or classes of alarms, i.e.: security, HVAC, Fire, etc.
 5. Provide timed (schedule) routing of alarms by class, object, group, or node.
 6. Provide alarm generation from binary object “runtime” and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- G. Controller and network failures shall be treated as alarms and annunciated.
- H. Alarms shall be annunciated in any of the following manners as defined by the user:
1. Screen message text
 2. Email of the complete alarm message to multiple recipients via the owner’s e-mail service. Provide the ability to route and email alarms based on:
 - a. Day of week
 - b. Time of day
 - c. Recipient
 3. Pagers via paging services that initiate a page on receipt of email message via the owner’s e-mail service
 4. Graphic with flashing alarm object(s)
 5. Printed message, routed directly to a dedicated alarm printer
- I. The following shall be recorded by the NAC for each alarm (at a minimum):
1. Time and date
 2. Location (building, floor, zone, office number, etc.)
 3. Equipment (air handler #, access way, etc.)
 4. Acknowledge time, date, and user who issued acknowledgement.
 5. Number of occurrences since last acknowledgement.
- J. Alarm actions may be initiated by user defined programmable objects created for that purpose.
- K. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- L. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- M. Provide a “query” feature to allow review of specific alarms by user defined parameters.
- N. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- O. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.7 DATA COLLECTION AND STORAGE

- A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
- B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
 - 1. Designating the log as interval or deviation.
 - 2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - 3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.
- D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- E. All log data shall be available to the user in the following data formats:
 - 1. HTML
 - 2. XML
 - 3. Plain Text
 - 4. Comma or tab separated values
 - 5. PDF
- F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
- G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - 1. Archive on time of day
 - 2. Archive on user-defined number of data stores in the log (buffer size)
 - 3. Archive when log has reached it's user-defined capacity of data stores
 - 4. Provide ability to clear logs once archived

2.8 AUDIT LOG

- A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
1. Time and date
 2. User ID
 3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.9 DATABASE BACKUP AND STORAGE

- A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
- B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
- C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.10 ADVANCED UNITARY CONTROLLER

- A. The controller platform shall be designed specifically to control HVAC – ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units, and radiant panels. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions.
- B. Minimum Requirements:
1. The controller shall be capable of either integrating with other devices or stand-alone operation.
 2. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
 3. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
 - a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
 - b. Accuracy: ± 1 minute per month at 77° F (25° C).
 - c. Power Failure Backup: 24 hours at 32° to 122° F (0° to 50° C).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
5. The controller shall have an internal DC power supply to power external sensors.
 - a. Power Output: 20 VDC \pm 10% at 75 mA.
6. The controller shall have a visual indication (LED) of the status of the device:
 - a. Controller operating normally.
 - b. Controller in process of download.
 - c. Controller in manual mode under control of software tool.
 - d. Controller lost its configuration.
 - e. No power to controller, low voltage, or controller damage.
 - f. Processor and/or controller are not operating.
7. The minimum controller Environmental ratings
 - a. Operating Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
 - b. Storage Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
 - c. Relative Humidity: 5% to 95% non-condensing.
8. The controller shall have the additional approval requirements, listings, and approvals:
 - a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - b. CSA (LR95329-3) Listed
 - c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
 - d. Meets Canadian standard C108.8 (radiated emissions).
 - e. Conforms to the following requirements per European Consortium standards:
 - EN 61000-6-1; 2001 (EU Immunity)
 - EN 61000-6-3; 2001 (EU Emissions)
9. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
10. The controller shall have sufficient on-board inputs and outputs to support the application.
 - a. Analog outputs (AO) shall be capable of being configured to support 0-10 V, 2-10 V or 4-20 mA devices.
 - b. Triac outputs shall be capable of switching 30 Volts at 500 mA.
 - c. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring. Input and Output wiring terminals shall be designated with color coded labels.
 - d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).
11. The controller shall provide for “user defined” Network Variables (NV) for customized configurations and naming using Niagara AX Framework™.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. The controller shall support 62 Network Variables with a byte count of 31 per variable.
 - b. The controller shall support 1,922 separate data values.
12. The controller shall provide “continuous” automated loop tuning with an Adaptive Integral Algorithm Control Loop.
 13. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized “sequence of operations” as outlined in Section 4.
 - a. Discharge air control and low limit
 - b. Pressure-dependent dual duct without flow mixing.
 - c. Variable air volume with return flow tracking.
 - d. Economizer with differential enthalpy.
 - e. Minimum air flow coordinated with CO2.
 - f. Unit ventilator cycle (1,2,3) 2-pipe.
 - g. Unit ventilator cycle (1,2,3) 2-pipe with face/bypass.
 - h. with EOC valve.

2.11 GRAPHICAL USER INTERFACE SOFTWARE

A. Operating System:

1. The Workstation with GUI shall run on Microsoft Windows XP Professional.

B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimal knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of, a graphic background the GUI shall support the use of scanned pictures.
2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

unacknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.12 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BACS, shall not be acceptable.
- C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface (if used). Systems that require different graphic views, different means of graphic generation, or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - 4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - 5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - 6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 1. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No text entry shall be required.
 - c. View logs and charts
 - d. View and acknowledge alarms
 - e. Setup and execute SQL queries on log and archive information
7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to set a specific home page for each user. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
 8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.13 SYSTEM CONFIGURATION TOOL

- A. The Workstation Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- C. Programming Methods
 1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
 2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
 3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.14 LIBRARY

- A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
- D. All control objects shall conform to the control objects specified in the BACnet specification.
- E. The library shall include applications or objects for the following functions, at a minimum:
 1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
 2. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
 4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
 5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
 6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

- F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
 3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an “on” condition. The user must be able to specify either input condition as the “on” condition.
 4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
 6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
 7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
 8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

complete testing of the new object. Allow new objects to be stored in the library for re-use.

9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
 10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an “On” state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
 11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the “contained” application that are represented on the graphical shell of this container.
- G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:
1. For BACnet devices, provide the following objects at a minimum:
 - a. Analog In
 - b. Analog Out
 - c. Analog Value
 - d. Binary
 - e. Binary In
 - f. Binary Out
 - g. Binary Value
 - h. Multi-State In
 - i. Multi-State Out
 - j. Multi-State Value
 - k. Schedule Export
 - l. Calendar Export
 - m. Trend Export
 - n. Device
 2. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. For BACnet devices, provide the following support at a minimum
 - a. Segmentation
 - b. Segmented Request
 - c. Segmented Response
 - d. Application Services
 - e. Read Property
 - f. Read Property Multiple
 - g. Write Property
 - h. Who-has
 - i. I-have
 - j. Who-is
 - k. I-am
 - l. Media Types
 - m. Ethernet
 - n. BACnet IP Annex J
 - o. MSTP
 - p. BACnet Broadcast Management Device (BBMD) function
 - q. Routing

2.15 DDE DEVICE INTEGRATION

- A. The Network Area Controller shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.
- B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BACS. Objects provided shall include at a minimum:
 1. DDE Generic AI Object
 2. DDE Generic AO Object
 3. DDE Generic BO Object
 4. DDE Generic BI Object

2.16 MODBUS SYSTEM INTEGRATION

- A. The Network Area Controller shall support the integration of device data from Modbus RTU, ASCII, or TCP control system devices. The connection to the Modbus system shall be via an RS-232, RS485, or Ethernet IP as required by the device.
- B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the FPMS. Objects provided shall include at a minimum:
 1. Read/Write Modbus AI Registers
 2. Read/Write Modbus AO Registers
 3. Read/Write Modbus BI Registers
 4. Read/Write Modbus BO Registers

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the Network Area Controller.
- D. The BACS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning

2.17 OPC SYSTEM INTEGRATION

- A. The Network Area Controller shall act as an OPC client and shall support the integration of device data from OPC servers. The connection to the OPC server shall be Ethernet IP as required by the device. The OPC client shall support third party OPC servers compatible with the Data Access 1.0 and 2.0 specifications.
- B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the OPC system data into the BAS. Objects provided shall include at a minimum:
 - 1. Read/Write OPC AI Object
 - 2. Read/Write OPC AO Object
 - 3. Read/Write OPC BI Object
 - 4. Read/Write OPC BO Object
 - 5. Read/Write OPC Date/Time Input Object
 - 6. Read/Write OPC Date/Time Output Object
 - 7. Read/Write OPC String Input Object
 - 8. Read/Write OPC String Output Object
- C. All scheduling, alarming, logging and global supervisory control functions, of the OPC system devices, shall be performed by the Network Area Controller.
- D. The BACS supplier shall provide an OPC client communications driver. The equipment system vendor that provided the equipment utilizing OPC shall provide documentation of the system's OPC server interface and shall provide factory support at no charge during system commissioning.

2.3 OTHER CONTROL SYSTEM HARDWARE

- A. Alternate device manufacturers will be considered with the approval of the engineer.
- B. Space Temperature Wall Module: Temperature sensing modules mounted on the wall in occupied spaces. Optional setpoint, indication, and override switches must be provided as specified.
 - 1. Manufacturers: Subject to compliance with requirements. Provide products by one of the manufacturers specified.
 - a. ACI
 - b. Honeywell

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- c. Johnson Controls
 - d. Novar
 - e. Siemens Building Technologies
 - f. Trend
2. Sensor shall contain digital display and user function keys along with temperature sensor. Sensor shall function as occupant control unit. It shall allow occupant to raise and lower setpoint and activate terminal unit for night override use all within limits as programmed by building operator.
 3. Provide means for occupant to view room setpoint, room temperature and outside air temperature at each controller. Override time may be set and viewed in 0.1 hour increments. Override time countdown shall be automatic, but may be reset to zero using function keys on unit. Display shall be blank in unoccupied mode unless a function button is pressed.
 4. Space temperature sensors shall be accurate to plus or minus 0.5 deg. F at 77 deg. F.
- C. Duct Mount, Pipe Mount, and Outside Air Temperature Sensors:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. CI
 - b. Honeywell
 - c. Johnson Controls
 - d. Novar
 - e. Siemens Building Technologies
 - f. Trend
 2. Outside air sensors shall include an integral sun shield.
 3. Temperature sensors shall have an accuracy of plus or minus 1.0 deg. F. over operating range.
 4. Duct sensors shall have sensor approximately in center of the duct, and shall have selectable lengths of 6, 12, and 18 inches.
 5. Multipoint averaging element sensors shall be provided where specified, and shall have a minimum of one foot of sensor length for each square foot of duct area (provide multiple sensors if necessary).
 6. Pipe mount sensors shall have copper, or stainless steel separable wells.
- D. Current Switches: Solid state, split core, current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point shall be provided where specified. Current switches shall include an integral LED for indication of trip condition.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. ACI
 - b. Honeywell
 - c. RIB, Inc.
 - d. Veris Industries

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Sensing range 0.5 – 250 Amps.
 3. Output 0.3 A @ 200 VAC/VDC / 0.15 A @ 300 VAC/VDC
 4. Operating frequency 40 Hz -1 kHz.
 5. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing
 6. Approvals CE, UL.
- E. Current Sensors: Solid state, split core linear current sensors shall be provided where specified.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. ACI
 - b. Honeywell
 - c. RIB, Inc.
 - d. Veris Industries
 2. Linear output of 0-5 VDC, 0-10 VDC, or 4-20 mA.
 3. Scale sensors so that average operating current is between 20-80% full scale.
 4. Accuracy plus or minus 1.0% (5-100% full scale)
 5. Operating frequency 50-600 Hz.
 6. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing
 7. Approvals CE, UL.
- F. Low Temperature Limit Switches. Safety low limit shall be manual reset twenty foot limited fill type responsive to the coolest section of its length.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
 2. Low Limit Setpoint shall be adjustable between 20 and 60 deg. F. (-5 and 15 deg. C.)
 3. Switch enclosure shall be dustproof and moisture-proof.
 4. Switch shall break control circuit on temperature fall. Contact ratings shall be 10.2 FLA at 120 VAC, and 6.5 FLA at 240 VAC.
 5. Ambient Temperature range -20 to 125 deg. F. (-11 to 52 deg. C.)
 6. Operating Temperature Range 20 to 60 deg. F. (-5 to 15 deg. C.)
- G. High Temperature Limit Switches. Safety high limit (fire stats) shall be manual reset type.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- c. Siemens Building Technologies
 - d. TAC
2. High Limit Setpoint shall be adjustable between 100 and 240 deg. F. (38 and 116 deg. C.)
 3. Switch enclosure shall be dustproof and moisture-proof.
 4. Switch shall break control circuit on temperature fall. Contact ratings shall be 10 FLA at 120 VAC, and 5 FLA at 240 VAC.
 5. Ambient Temperature range -20 to 190 deg. F. (-28 to 88 deg. C.) at case, and 350 deg. F (177 deg. C.) at the sensor.
 6. Operating Temperature Range 100 to 240 deg. F. (38 to 116 deg. C.)
- H. CO2 Sensors.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. TelAire
 - c. Vaisala
 2. Carbon Dioxide sensors shall be 0-10 Vdc, 2-10 Vdc, or 4-20 mA linear analog output type, with corrosion free gold-plated non-dispersive infrared sensing, designed for duct or wall mounting.
 3. Sensor shall incorporate internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 75 PPM accuracy at full scale.
 4. Where specified, sensor shall have an LCD display that displays the sensor reading and status.
- I. Differential Pressure Sensors
1. Manufacturers:
 - a. ACI
 - b. Honeywell
 - c. RIB, Inc.
 - d. Veris Industries
 2. Sensor shall have four field selectable ranges: 0.1, 0.24, 0.5, 1.0 in w.c. for low pressure models, and 1.0, 2.5, 5, 10 for high pressure models.
 3. Sensor shall provide zero calibration via pushbutton or digital input.
 4. Sensor shall have field selectable outputs of 0-5 VDC, 0-10 VDC, and 4-20 mA
 5. Where specified, sensor shall have and LCD display that displays measured value.
 6. Sensor overpressure rating shall be 3 PSID proof, and 5 PSID burst.
 7. Sensor accuracy shall be plus or minus 1% FS selected range.
- J. Enthalpy Sensors.
- (Option 1 – Changeover type – Select one)* Duct mounted enthalpy sensor shall include a temperature sensor and a humidity sensor constructed to close an electrical contact upon a drop in enthalpy (total heat) to enable economizer modes of operation where specified.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

(Option 2 – Proportional analog signal– Select one) Provide duct mounted sensor including solid state temperature and humidity sensors with electronics which shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Siemens Building Technologies

- K. Annular Pitot Tube Flow Meter. Annular pitot tube shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of austenitic stainless steel.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Air Monitor Corporation
 - b. Ultratech
 - c. Wetmaster Co., Ltd.
 - d. Johnson Controls
 2. Sensor shall have an accuracy of $\pm .25\%$ of full flow and a repeatability of $\pm .05\%$ of measured value.
 3. Transmitter shall be electronic and shall produce a linear output of 0-10 Vdc, 0-5 Vdc, or 4 to 20 mA dc corresponding to the required flow span.
 4. The transmitter shall include non-interacting zero and span adjustments.

- L. Standard Automatic Control Dampers. Provide all automatic control dampers not specified to be integral with other equipment.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Greenheck
 - b. Honeywell
 - c. Johnson Controls
 - d. Ruskin
 2. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream.
 3. Blades shall not be over 8 inches wide or less than 16-gauge galvanized steel triple V type for rigidity.
 4. Bearings shall be acetyl, oilite, nylon or ball-bearing with $\frac{1}{2}$ inch diameter plated steel shafts.
 5. Dampers shall be suitable for temperature ranges of -40 to 180F.
 6. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.
 7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

velocity and shall withstand a maximum system pressure of 5.0 in. w.c. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand a maximum system pressure of 4.0 in. w.c. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and shall withstand a maximum system pressure of 2.5 in. w.c. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized.

8. Maximum leakage for dampers in excess of sixteen inches square shall be 30 CFM per square foot at static pressure of 1 inch of WC. Testing and ratings to be in accordance with AMCA Standard 500.
- M. Low Leakage Automatic Control Dampers. Provide all automatic control dampers not specified to be integral with other equipment.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Greenheck
 - b. Honeywell
 - c. Johnson Controls
 - d. Ruskin
 2. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream.
 3. Blades shall not be over 8 inches wide or less than 16-gauge galvanized steel triple V type for rigidity.
 4. Bearings shall be acetyl, oilite, nylon or ball-bearing with ½ inch diameter plated steel shafts.
 5. Dampers shall be suitable for temperature ranges of -40 to 180F.
 6. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.
 7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm velocity and shall withstand a maximum system pressure of 5.0 in. w.c. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand a maximum system pressure of 4.0 in. w.c. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and shall withstand a maximum system pressure of 2.5 in. w.c.
 8. Side seals shall be stainless steel of the tight-seal spring type.
 9. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all low leakage control dampers with the temperature control submittal.
 10. Maximum leakage for low leakage dampers in excess of sixteen inches square shall be 8 CFM per square foot at static pressure of 1 inch of WC.
 11. Low leakage damper blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage.
 12. Testing and ratings shall be in accordance with AMCA Standard 500.
 13. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized. Testing and ratings to be in accordance with AMCA Standard 500.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- N. Round Motorized Dampers. Round dampers shall be provided where specified and shall be factory mounted in a section of round duct a minimum of 12 inches long, but no less than one inch longer than the duct diameter.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Greenheck
 - b. Honeywell
 - c. Johnson Controls
 - d. Ruskin
 2. Duct shall be sleeve type spiral duct crimped on the downstream end, 24 gage galvanized minimum except duct over 12 inches in diameter shall be 22 gage.
 3. Duct shall have an integral galvanized steel actuator mounting plate and a ½ inch zinc-coated steel blade shaft extending a minimum of 2 inches beyond the actuator mounting plate.
 4. Shaft bearings shall be flanged bronze oilite pressed into the frame.
 5. The blade shall be a minimum 16 gage galvanized steel, and damper frame shall be provided with closed-cell neoprene seals with silicone rubber bead. Damper shall be designed for a 2500 ft/min approach velocity and a 4 inch minimum static pressure.
 6. Damper shall be suitable for operation from 32 to 130F temperatures.
 7. Damper and actuator combination shall be designed for leakage rates less than 13 cfm per square foot at one inch w.c. differential and 25 cfm at four inches w.c. Actuator shall have an external declutch lever to allow manual blade positioning during equipment and power malfunctions.
- O. Control Valves: (*Globe Type*) Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
 2. Two-position valves shall be line size.
 3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
 4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through, and linear through the bypass. Rangeability shall be 50:1 or greater.
 5. Provide valve position indicator and a method to operate valves manually during system start-up, or actuator power loss or failure on all valves.
 6. Leakage rate shall be no more than ANSI Class III (for heating) or ANSI Class IV (for cooling).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Valves 1/2 inch through 3 inches shall be screwed pattern except where solder connections are specified for valves 1/2 or 3/4 inches.
 8. Three-way valve bypass ports shall be of Cv to provide constant flow through the control loop.
 9. Two-way valves shall close off against the net differential pressure resulting from the maximum head pressure of the system pumps less all loop pressure losses. Three-way valves shall close off against the difference in head pressure between the controlled load and the bypass line.
 10. Valves 2-1/2 inch and larger shall be flanged and ANSI/ASME-rated to withstand the pressures and temperatures specified.
 11. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable discs.
- P. Control Valves: (*Characterized Ball Valves*) Control valves 1/2 to 3 inches shall be 2-way or 3-way forged brass screwed pattern constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
 - e. Griswold Controls
 2. Two-position valves shall be line size.
 3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
 4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear flow through the bypass.
 5. Leakage rate shall be ANSI Class IV (no more than 0.01% of Cv).
 6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
 7. Valves shall be rated for no less than 360 psig at 250 degrees F.
 8. Provide a method to operate valves manually during system start-up, or actuator power loss or failure on all valves.
 9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.
 10. Valves shall have stainless-steel or chemically nickel-plated brass stem and throttling port.
 11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
 12. Valves shall be tagged with Cv rating and model number.
- Q. Control Valves: (*Characterized Ball Valves*) Control valves 4 to 6 inches shall be 2-way or 3-way cast iron ANSI Class 125 flanged connections as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. Griswold Controls
 2. Two-position valves shall be line size.
 3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's maximum differential pressure shall not be exceeded in order to prevent cavitation.
 4. Two-way water valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear with 20% reduced flow through the bypass. Rangeability shall be 100:1 or greater.
 5. A-port leakage rate shall be ANSI Class IV (no more than 0.01% of Cv) or better.
 6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
 7. Valves shall be rated for no less than 240 psig at 250 degrees F.
 8. Provide a method to operate valves manually during actuator power loss or failure.
 9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.
 10. Valve ball and stem shall be 316 stainless-steel.
 11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
 12. Valves shall be tagged with Cv rating and model number.
- R. Butterfly Control Valves: Where specified, butterfly control valves 2" to 20" in size shall be cast iron body type for 2-way applications and constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Three-way applications shall consist of 2-way valves assembled to a "Tee" fitting with common actuators and operating linkage.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Bray
 - b. Honeywell
 - c. Johnson Controls
 - d. Siemens Building Technologies
 - e. Tyco International
 2. Valves shall have tapped lugs for standard flange connection, and meet ANSI/ASME requirements to withstand the pressures and temperatures encountered.
 3. Valve shall have a corrosion, ultra-violet, and wear-resistant coating for outdoor applications.
 4. Resilient-seated valves shall use food-grade elastomeric seats. Seat shall also function as the flange gaskets.
 5. Valves shall be designed for isolation and the absence of downstream piping at rated differential pressure.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. All valves shall be line size.
 7. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psid at rated flow (except as may be noted on the drawings) up to a maximum stroke of 60° disk rotation. Manufacturer's maximum fluid velocity shall not be exceeded in order to prevent cavitation.
 8. Valves shall be rated for bubble tight shutoff at no less than 150 psi differential pressure for full cut valves, or 50 psi for under cut valves.
 9. Valve disc shall be of corrosion-resistant construction appropriate for the controlled media such as nylon-coated cast iron, aluminum bronze, or stainless steel.
 10. Valve stems shall be stainless steel, with inboard top and bottom bearings, and an external corrosion resistant top bearing to absorb actuator side thrust.
 11. Actuator mounting flange shall conform to ISO 5211 for actuator interchangeability.
 12. Actuator shall be available with NEMA 4X (IP65) rated enclosure suitable for outdoor installation.
 13. Valves shall be tagged with Cv rating and model number.
- S. Actuators, General. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off. Valves shall be provided with actuators suitable for floating or analog signal control as required to match the controller output. Actuators shall be power failure return type where valves or dampers are required to fail to a safe position and where specified.
- T. Non-Spring Return Low Torque Direct Coupled 35 & 70 lb-in Actuators. Actuators shall be 35 or 70 lb-in. with strokes adjustable for 45, 60, or 90 degree rotation applications and designed for operation between 20 and 125 F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
 2. Each actuator shall also have a minimum position adjustable rotation of 0 to 30 degrees.
 3. Actuators shall be for floating or two position (ML 6161 or ML6174) control, or for 4-20 mA or 2-10Vdc (ML7161 or ML7174) input signals.
 4. Analog control actuators shall have a cover mounted direct/reverse acting switch.
 5. Actuator motor shall be magnetically coupled or shall have limit switch stops to disengage power at the ends of the stroke.
 6. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.
 7. Actuators shall have NEMA 1 environmental protection rating and be 24 volt and UL listed with UL94-5V plenum requirement compliance.
 8. Minimum design life of actuators shall be for 1,500,000 repositions and 35 lb-in. models shall be designed for 50,000 open-close cycles and 70 lb-in. models shall be designed for 40,000 open-close cycles.
 9. Actuator options shall include 1) Auxiliary feedback potentiometers, 2) open-closed indicator switches, 3) actuator timings of 90 seconds, 3 minutes, or 7 minutes, one or two auxiliary switches, and 4) torque of 35 or 70 lb-in.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- U. Non-Spring Return High Torque 177 and 300 lb-in Actuators. Actuators shall be UL listed 24 Vac in NEMA 2 enclosures designed for operation between -5 and 140 F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
 2. Rotation direction shall be switch selectable.
 3. Minimum design life of actuators shall be for 1,500,000 repositions and for 60,000 open-close cycles.
 4. Actuators shall be suitable for the controller output signals encountered, floating or analog, and shall have full cycle timing of 95 seconds.
 5. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.

(Select one or more of the following descriptions required)

Actuators shall have 300 lb-in. torque.

Actuators shall have 177 lb-in. torque with adjustable stroke, 30 to 90 degrees.

Actuators shall have 177 lb-in. torque with adjustable stroke, 30 to 90 degrees, and shall auxiliary end switches to annunciate full open and full closed positions.
- V. Spring Return Direct Coupled Actuators. Actuators shall have torque ratings of 44lb-in., 88 lb-in., or 175 lb-in. Actuators shall be modulating 90 seconds nominal timing or two-position 45 seconds nominal timing types with strokes for 90 degree rotation applications and designed for operation between -40 and 140 F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
 2. Each torque rating group shall have optionally selected control types, floating control, 2-position 24 Vac, 2-position line voltage, or analog input which is switch selectable as 0-10Vdc, 10-0 Vdc, 2-10 Vdc, or 10-2 Vdc.
 3. Actuator spring return direction (open or closed) shall be easily reversed in the field, and actuators shall spring return in no greater than 20 seconds.
 4. Actuators shall be direct connected (no linkages), and shall have integral position indication.
 5. Actuators shall have NEMA 2 environmental protection rating, and UL approved and plenum rated per UL873.
 6. Minimum design life of modulating actuators shall be for 1,500,000 repositions and 60,000 spring returns, except 2-position actuators shall be for 50,000 spring returns.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Each actuator shall be provided with a manual power-off positioning lever for manual positioning during power loss or system malfunctions, including a gear-train lock to prevent spring action.
 8. Upon power restoration after gear lock, normal operation shall automatically recur.
- W. Fast Acting Two Position Fire & Smoke Actuators. Fire/smoke damper actuators shall be direct connected (no linkages) two-position spring return types with stroke for 90 degree nominal rotation applications and designed for 60,000 full stroke cycles and normal operation between 0 and 130 F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Siemens Building Technologies
 2. Actuators control shall be compatible with SPST control switch and with torque ratings of 30 lb-in.
 3. Actuator timing shall be 25 seconds maximum in powered instances and shall spring-return in 15 seconds.
 4. Actuators shall be UL listed with UL873 plenum rating with die-cast aluminum housing with integral junction box and conduit knockouts, and designed to operate reliably in smoke control systems requiring UL555S ratings up to 350F.
 5. The actuator shall be designed to operate for 30 minutes during a one-time excursion to 350F.
 6. Actuator shall require no special cycling during long-term holding, and shall “hold” with no audible noise at a power consumption of approximately half of the driving power.
 7. Actuators shall be 24 volt or 120 volt with models for clockwise (add a B suffix) and counter-clockwise (add an A suffix) spring return.
- X. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of ‘as-built’ control drawings (relating to the controls within that panel) shall be furnished within each control panel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.
- B. Install system and materials in accordance with manufacturer’s instructions, and as detailed on the project drawing set.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Drawings of the BACS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.
- D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by this contractor in accordance with these specifications.
- E. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by this contractor.

3.2 WIRING

- A. All electrical control wiring and power wiring to the control panels, NAC, computers and network components shall be the responsibility of the this contractor.
- B. The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters and motors.
- C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All BACS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where BACS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WIRING CRITERIA

- A. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.
- B. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.
- C. Provide circuit and wiring protection required by NFPA 70.
- D. Run all wiring located inside mechanical rooms in conduit.
- E. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.
- F. Input/output identification: Permanently label each field-installed wire at each end with descriptive text using a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.
- G. For controller power, provide new 120 VAC circuits, with ground.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- H. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.
- I. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.
- J. Grounding: Ground controllers and cabinets to a good earth ground as specified in Division 26.
- K. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.
- L. The Contractor shall be responsible for correcting all associated ground loop problems.
- M. Run wiring in panel enclosures in covered wire track.

3.4 COMPONENT IDENTIFICATION LABELING

- A. Using an electronic hand-held label maker with white tape and bold black block lettering, provide an identification label on the exterior of each new control panel, control device, actuator, and sensor. Also provide labels on the exterior of each new control actuator indicating the (full) open and (full) closed positions. For labels located outdoors, use exterior grade label tape, and provide labels on both the inside and outside of the panel door or device cover. Acceptable alternatives are white plastic labels with engraved bold black block lettering permanently attached to the control panel, control device, actuator, and sensor. Have the labels and wording approved by the BAS Owner prior to installation

3.5 WARRANTY

- A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.
- B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the Owner.

3.6 WARRANTY ACCESS

- A. The Owner shall grant to this contractor, reasonable access to the TCS and FMCS during the warranty period.
- B. The owner shall allow the contractor to access the BACS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.7 ACCEPTANCE TESTING

- A. Upon completion of the installation, this contractor shall load all system software and start-up the system. This contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
- B. This contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.
- C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- D. System Acceptance: Satisfactory completion is when this contractor and the Division 26 contractor have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.8 OPERATOR INSTRUCTION, TRAINING

- A. During system commissioning and at such time acceptable performance of the BACS hardware and software has been established this contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.
- B. This contractor shall provide 24 hours of instruction to the owner's designated personnel on the operation of the BACS and describe its intended use with respect to the programmed functions specified. Operator orientation of the systems shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
- C. The training shall be in three sessions as follows:
 - 1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
 - 2. First Follow-Up Training: Two days (8 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
 - 3. Warranty Follow Up: Two days (8 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

END OF SECTION 230900

SECTION 230901 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.
- B. Related Sections include the following:
 - 1. Division 23 Section “Common Work Results for Mechanical”
 - 2. Division 26

1.3 SUBMITTALS

- A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.
- C. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for VFDs and all installed components.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Comply with NFPA 70. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 COORDINATION

A. Coordinate power wiring to VFD with Division 26.

B. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Honeywell SmartVFD
 2. Eaton H-Max Series
 3. ABB ACH550
 4. Cerus Industrial P Series
 5. Danfoss VLT HVAC Drive
 6. GE AF-600 FP
 7. Allen-Bradley PowerFlex 700
 8. Toshiba VF-FS1
 9. Yaskawa E7 Series
 10. Siemens Micromaster

2.2 VARIABLE FREQUENCY DRIVES

- A. The VFDs shall be rated for voltage as scheduled. The VFD shall provide microprocessor based control for three-phase induction motors. The controller's full load output current rating shall be based on Variable Torque application at 40° C ambient and 1-16 kHz switching frequency below 50 HP and 1-10 kHz 50 HP and above to reduce motor noise and avoid increased motor losses.
- B. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFD are not accepted. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not accepted. The VFD shall run at the above listed switching frequencies.
- C. The VFD shall have an efficiency at full load and speed that exceeds 95% for VFD below 15 HP and 97% for drives 15 HP and above. The efficiency shall exceed 90% at 50% speed and load.
- D. The VFD shall maintain a minimum line side displacement power factor of 0.96, regardless of speed and load. The VFD shall have a one (1) minute overload current rating of 110% for variable torque applications.
- E. The VFD shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
- F. The VFD shall have an integral EMI/RFI filter as standard.
- G. The VFD shall limit harmonic distortion reflected onto the utility system to voltage and current levels as defined by IEEE 519-1992 for general systems applications, by utilizing the standard 3% nominal impedance integral AC three-phase line reactor. DC link chokes are not accepted.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- H. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling (PCC) being the point where the utility feeds multiple customers.
- I. Total harmonic distortion shall be calculated under worst case conditions in accordance with the procedure outlined in IEEE 519-1992. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.
- J. The system containing the VFD shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992. If the system cannot meet the harmonic levels with the VFD provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply an eighteen pulse, multiple bridge rectifier, AC to DC conversion section with phase shifting transformer for all drives above 75 HP. This eighteen pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not accepted above 75 HP.
- K. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
- L. Standard operating conditions shall be:
 - 1. Incoming Power: Three-phase, VAC as scheduled (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
 - 2. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
 - 3. Speed regulation of +/- 0.5% of base speed.
 - 4. Load inertia dependant carryover (ride-through) during utility loss.
 - 5. Insensitive to input line rotation.
 - 6. Humidity: 0 to 95% (non-condensing and non-corrosive).
 - 7. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
 - 8. Ambient Temperature: -10 to 40 °C (VT).
 - 9. Storage Temperature: -40 to 70 °C.
- M. Control Functions
 - 1. Frequently accessed VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not accepted, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
 - 2. The keypad shall include a Hand-Off-Auto membrane selection and an Inverter/Bypass membrane selection. When in “Hand” the VFD will be started and the speed will be controlled from the up/down arrows. When in “Off”, the VFD will be stopped. In “Auto”,

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- the VFD will start via an external contact closure or a communication network and the VFD speed will be controlled via an external speed reference.
3. The keypad shall have copy / paste capability.
 4. Upon initial power up of the VFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.
 5. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the VFD' RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this section through Section 18.
 6. The operator shall be able to scroll through the keypad menu to choose between the following:
 - a. Parameter Menu
 - b. Keypad Control
 - c. System Menu
 - d. Expander Boards
 - e. Monitoring Menu
 - f. Operate Menu
 7. The following setups and adjustments, at a minimum, are to be available:
 - a. Start command from keypad, remote or communications port
 - b. Speed command from keypad, remote or communications port
 - c. Motor direction selection
 - d. Maximum and minimum speed limits
 - e. Acceleration and deceleration times, two settable ranges
 - f. Critical (skip) frequency avoidance
 - g. Torque limit
 - h. Multiple attempt restart function
 - i. Multiple preset speeds adjustment
 - j. Catch a spinning motor start or normal start selection
 - k. Programmable analog output
- N. The VFD shall have the following system interfaces:
1. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following available as a minimum:
 - a. Remote manual/auto
 - b. Remote start/stop
 - c. Remote forward/reverse
 - d. Remote preset speeds
 - e. Remote external trip
 - f. Remote fault reset
 - g. Process control speed reference interface, 4-20mA DC
 - h. Potentiometer or process control speed reference interface, 0 -10VDC
 - i. RS-232 programming and operation interface port

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
 - a. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
 - 1) Fault
 - 2) Run
 - 3) Ready
 - 4) Reversing
 - 5) Jogging
 - 6) At speed
 - 7) In torque limit
 - 8) Motor rotation direction opposite of commanded
 - 9) Over-temperature
 - b. Programmable open collector output with available 24 Vdc power supply and selectable with the following available at minimum:
 - 1) Fault
 - 2) Run
 - 3) Ready
 - 4) Reversing
 - 5) Jogging
 - 6) At speed
 - 7) In torque limit
 - 8) Motor rotation direction opposite of commanded
 - 9) Overtemperature
 - c. Programmable analog output signal, selectable with the following available at minimum:
 - 1) Output frequency
 - 2) Frequency reference
 - 3) Motor speed
 - 4) Output current
 - 5) Motor torque
 - 6) Motor power
 - 7) Motor voltage
 - 8) DC link voltage
 - 9) PID controller reference value
 - 10) PID controller actual value 1
 - 11) PID controller actual value 2
 - 12) PID controller error value
 - 13) PID controller output
3. Capability of two additional expandable I/O interface cards. Upon installation, software shall automatically identify the interface card and activate the appropriate parameters. This should be done without adding any new software.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

O. Monitoring and Displays

1. The VFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
 - a. Run
 - b. Forward
 - c. Reverse
 - d. Stop
 - e. Ready
 - f. Alarm
 - g. Fault
 - h. Input/Output (I/O) Terminal
 - i. Keypad
 - j. Bus/communication
 - k. Hand
 - l. Auto
 - m. Off

2. The VFD keypad shall be capable of displaying the following monitoring functions at a minimum:
 - a. Motor Speed (RPM and %)
 - b. Frequency reference
 - c. Output frequency
 - d. Motor current
 - e. Motor torque
 - f. Motor power
 - g. Motor voltage
 - h. DC-link voltage
 - i. Heat sink temperature
 - j. Motor run time (resettable)
 - k. Total operating days counter
 - l. Operating hours (resettable)
 - m. Total megawatt hours
 - n. Megawatt hours (resettable)
 - o. Voltage level of analog input
 - p. Current level of analog input
 - q. Digital inputs status
 - r. Digital and relay outputs status
 - s. Motor temperature rise
 - t. PID references

P. Protective Functions

1. The VFD shall include the following protective features at minimum:
 - a. Over-current
 - b. Over-voltage
 - c. System fault
 - d. Under-voltage

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- e. Input line supervision
 - f. Output phase supervision
 - g. Under-temperature
 - h. Over-temperature
 - i. Motor stalled
 - j. Motor over temperature
 - k. Motor under-load
 - l. Logic voltage failure
 - m. Microprocessor failure
 - n. Brake chopper supervision
 - o. DC Injection braking
2. The VFD shall provide ground fault protection during power-up, starting, and running. VFD with no ground fault protection during running are not accepted.

Q. Diagnostic Features

1. Active Faults
2. The last 10 faults shall be recorded and stored in sequential order
3. Fault code and description of fault shall be displayed on the keypad.
4. Fault or alarm LED shall blink
5. Display drive data at time of fault
6. In the event several faults occur simultaneously, the sequence of active faults shall be viewable.
7. During a fault, the drive must be able to identify the following:
 - a. Drive Speed
 - b. Running hours
 - c. Running Days
 - d. Amps during fault
 - e. Motor Power
 - f. Motor Torque
 - g. DC bus Voltage
 - h. Drive Temperature
8. Fault History
 - a. The last 30 faults shall be recorded and stored in sequential order.
 - b. Display drive data at time of fault

R. Additional features included in the VFD:

1. The following indicating lights shall be provided on the keypad.
 - a. Drive Ready
 - b. Drive Run
 - c. Drive Fault
2. The current withstand rating of the drive shall be 100,000 AIC. The rating of the complete drive assembly shall be UL tested and listed at 65kAIC.
3. Communication card for interface with BACnet control system.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. The VFD shall have a cooling fan that is field replaceable using non-screw accessibility.
- S. Enclosure
1. The VFD shall be designed in a NEMA Type [1- general purpose] [12-drip tight] [3R-rain proof] enclosure. Packaging of the drive shall be designed and manufactured by the manufacturer of the drive for quality assurance.
 2. The VFD shall have complete front accessibility with easily removable assemblies.
 3. Cable entry shall be bottom entry.
- T. Disconnect Switch: allows a convenient means of disconnecting the drive from the line; operating mechanism can be padlocked in the OFF position; factory-mounted in the enclosure.
- U. Three contactor bypass includes an additional contactor to isolate the drive from line power for servicing while the bypass is operating. This bypass shall include a drive input disconnect, an VFD input isolation contactor, bypass contactor and an VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor overcurrent relays. The complete bypass system [Inverter-Off-Bypass] [Hand-Off-Auto with Inverter-Bypass] selector switch(s), and Inverter/Bypass pilot lights shall be packaged with the VFD. The unit may be set up for [manual] [automatic] bypass operation upon an VFD trip.
- V. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. Anchor each VFD assembly to steel-channel sills or unitstrut arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Comply with mounting and anchoring requirements specified in Division 26.
- C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according with labeling that indicates the controlled device.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices according to Division 26.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.7 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Engineer or authorized service representative to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD's on the job site. Sales representatives will not be accepted to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
 - 1. Inspection and final adjustments.
 - 2. Operational and functional checks of VFDs and spare parts.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.
- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

- A. The Contractor shall provide a training session for one normal workday with a maximum of one trip. Training and instruction time shall be in addition to that required for start-up service. The training shall be conducted by the manufacturer's qualified representative. The training program shall consist of the following:
1. Instructions on the proper operation of the equipment.
 2. Instructions on the proper maintenance of the equipment.

END OF SECTION 230901

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section “Common Work Results for Mechanical”
 - 2. Section 230900 – INSTRUMENTATION AND CONTROL FOR HVAC for control equipment and devices and submittal requirements.
 - 3. Division 23 Section “Testing, Adjusting, and Balancing”
 - 4. Division 26

1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.
 - 1. Provide automatic control for system operation as described herein, although word “automatic” or “automatically”, is not used.
 - 2. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.
 - 3. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.
- B. The system is BAS controlled using electric actuation. Provide proportional-integral-derivative (PID) algorithms for all control programs.
- C. Functions called for in sequence of operations are minimum requirements and not to limit additional BAS system capabilities. Determine, through operation of the system, proportional bands, interval time, integral periods, adjustment rates, and any other input information required to provide stable operation of the control programs.
- D. For each item of equipment, provide following functions which are not specifically mentioned in each Sequence of Operation:
 - 1. Start-Stop, manual, and scheduled
 - 2. On-Off status of each piece of equipment
 - 3. Run-time
 - 4. Alarm

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Provide Sequenced starting of all motors, whether or not specifically mentioned in each Sequence of Operation:
 - 1. At initial start-up
 - 2. For automatic starting on emergency power after power blackout
- F. All setpoints shall be monitored and adjustable. Setpoints listed herein are approximate. It is the responsibility of the BAS contractor to calibrate the system and all setpoints to actual working conditions once the system is on line.
- G. Normal positions for controlled devices:
 - 1. Unless noted, the following valves and dampers shall fail closed:
 - a. Cooling coil valves for coils located indoors shall close to the coil.
 - 2. Unless noted, the following valves and dampers shall fail open:
 - a. Heating coils.
 - b. Cooling coil valves for coils located outdoors shall open to the coil.

1.3 HEATING-WATER SUPPLY TEMPERATURE-CONTROL SEQUENCES (PRIMARY LOOP)

- A. Refer to Building Distribution Pumps paragraph.
- B. The system is DDC controlled using electric actuation.
- C. Primary/Secondary Boiler Plant
 - 1. Boilers B-4 shall be integrated with the existing B-1 through B-3.
 - 2. Each boiler shall run subject to its own internal safeties and controls.
 - 3. Upon a call for heat, the boiler controller shall turn on the appropriate pumps (boiler pump for space heating call; DHW pump for DHW call).
 - 4. For space heating, the temperature control will be based on a system supply sensor. The boiler controller is programmed at the factory to control the temperature of the outlet sensor. The control will automatically switch to the system supply sensor once it is connected.
 - 4. Cascade Control (Note: much of this sequence is part of the boilers' cascade control system. Provide wiring, sensors, devices, piping, and other components for a complete and functioning system.)
 - 5. The boilers will be wired together in a cascade sequence. In this application one boiler will be designated as the Leader control and all others will be designated as Member controls. Once the Leader boiler receives a call for heat from BAS, the control will determine what the set point will be.
 - 6. Outdoor air reset shall be controlled by the boiler controller. Provide a signal from a sun-shielded outside air temperature sensing element and transmitter. Connect the outdoor air sensor to the terminals on the Low Voltage Connection Board on the Leader boiler. The set point will be calculated based on the programmed reset curve parameters.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. If the water temperature at the system supply sensor is less than the set point + the turn-off offset - the off-on differential, then the control will initiate a call for heat on the Cascade. The Leader will energize the lead boiler on the Cascade. For a new startup this will be the Leader boiler. The boiler will fire at its ignition speed and will then modulate its firing rate to maintain the set point. If the first boiler reaches 100% of its firing rate, the Leader will calculate at what point the second boiler could fire at 20% of its firing rate. At this point, the Leader will fire the second boiler on the Cascade. For a new startup, this would be the first Member boiler. The boiler will fire at its ignition speed and will then modulate its firing rate to maintain the set point. If the set point still cannot be met, the Leader will continue firing more Members until either the heat demand is met or all boilers on the Cascade are firing.
8. As the heat demand decreases, the last boiler on will modulate down to 20% of its firing rate. Once the demand for that boiler is zero, it will shut down. As the heat demand decreases further, the second to last boiler will modulate down and shut off. This will continue until the demand is satisfied and all boilers are shut off.
9. To equalize the run time of all boilers on the Cascade, the firing sequence will automatically be changed at set intervals (change every 24 hours).
10. The boiler controller DHW Mode is programmed to heat an indirect domestic hot water tank. For DHW operation all boilers in the Cascade can be selected to provide heat for a DHW call. Connect the DHW thermostat to the terminals on the Low Voltage Connection Board marked for the DHW Thermostat. When the system receives a DHW call, the boiler control will reset the primary loop temperature up to serve the indirect domestic water tanks.
11. The controller will adjust primary loop set point to the programmed DHW set point and will adjust its firing rate to maintain this. Once the DHW call has been satisfied, the control will return to building heating control.
12. Night Setback operation of the boilers within the Cascade shall be provided. Programming of the Night Setback shall be done through the Leader boiler.

D. Operator Workstation: Display the following data:

1. Outside temperature.
2. Heating-water supply & return temperatures.
3. Heating-water supply temperature set point.
4. Boiler status/alarm for each boiler.
5. Domestic hot water generation pump status/failure
6. Domestic hot water supply to building temperature
7. Pumps status/failure
8. System pumps VFD status
9. System pumps VFD fault
10. System pumps VFD Hz.

1.4 BUILDING HEATING DISTRIBUTION (SECONDARY LOOP)

A. System Pumps:

1. Pumps shall be enabled by the boiler controller.
2. Locate a differential pressure sensor at the most hydraulically remote location. Pump flow will modulate as terminal unit two-way valves open and close. The pump VFD shall modulate as required to maintain pressure setpoint.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Pump operates continuously thru VFD and differential pressure transmitter.
4. Provide automatic lead-lag pump control. If lead pump fails, backup pump shall start and a lead-pump failure alarm shall be initiated.
5. Lead pump shall rotate weekly to equalize run time.
6. The BAS system shall use status wired to each VFD to confirm the pumps are in the desired state (i.e. on or off) and generates an alarm if status deviates from BAS start/stop control.

B. Reset water temperature control-secondary loop:

1. With boilers in building heat mode, the secondary (building) loop temperature shall be reset through the boiler controller via resetting the primary loop temperature based upon outside air temperature, as currently scheduled.
2. When boilers are in domestic water prioritization mode and primary loop is reset to 180 degrees, the secondary three way valve shall modulate through the boiler controller to maintain building loop reset temperature based upon outside air temperature, as currently scheduled.
3. BAS shall prevent the reset valve from going beyond 90% recirculation.

C. Operator Workstation: Display the following data:

1. Outside temperature.
2. Primary loop supply & return temperatures.
3. Secondary loop supply and return temperatures.
4. Primary/secondary loop temperature setpoint.
5. Boiler status/alarm for each boiler.
6. Domestic hot water generation pump status/failure
7. Domestic hot water supply to building temperature
8. Primary and secondary pumps status/failure
9. System pumps VFD status
10. System pumps VFD fault
11. System pumps VFD Hz.
12. Reset valve command/position.

1.5 VARIABLE PRIMARY FLOW CHILLED WATER PLANT (New Chiller and existing 20 ton Chiller)

- A. In a variable primary chilled water distribution system, VFDs on the CHWS pumps vary the flow through the chillers and out to the chilled water coils based on demand. This system includes a bypass loop to ensure minimum flow through the chiller
- B. Chillers shall be enabled to operate through BAS, sequenced in lead/lag fashion.
- C. Chilled Water Pumps shall be enabled and operate via lead lag sequence:
 1. Pumps shall be enabled by the chiller operation.
 2. Locate a differential pressure sensor at the most hydraulically remote location. Pump flow will modulate as terminal unit two-way valves open and close. The pump VFD shall modulate as required to maintain pressure setpoint. Pump operates continuously thru VFD and differential pressure transmitter.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Provide automatic lead-lag pump control. If lead pump fails, backup pump shall start and a lead-pump failure alarm shall be initiated. Lead pump shall rotate weekly to equalize run time.
 4. The DDC system shall use status wired to each VFD to confirm the pumps are in the desired state (i.e. on or off) and generates an alarm if status deviates from DDC start/stop control.
 5. The DDC system shall monitor and log system chilled water flow via a flow meter located as shown on the plans.
- D. Chiller Staging.
1. Chiller staging: cycle chillers in lead/lag fashion to maintain chilled water loop temperature.
 2. On call for a chiller to operate, its associated normally closed isolation valve shall be commanded to the open position.
 3. Once the valve reaches 30% open (adj.), the chiller shall be enabled to start.
 4. On call for chiller to shut down, motorized isolation valve shall close. Incorporate a time out sequence for valve closure to allow the chiller to fully shut down prior to cutting off the water flow.
- E. CHWS Bypass control valve shall be programmed to maintain minimum flow through the chillers.
1. Minimum flow for the each chiller shall be set to maintain minimum flow per manufacturer's recommendations.
 2. Bypass valve shall be sized for the minimum flow requirement for one chiller (60 GPM for the large chiller, 30 gpm for the small chiller).
 3. Bypass valve shall be normally open, such that with both chillers de-energized, valve is at the open position, to insure minimum flow through the evaporator barrel on chiller start-up.
 4. A water differential pressure sensor for each chiller will be located to sense the evaporator supply and return water pressures. The differential pressure sensor will serve as the master sensor for the AO—Adaptive Control algorithm.
 5. The double-seated linear (relationship between valve position and flow rate) bypass control valve shall modulate to maintain a configurable differential pressure setpoint (set to satisfy the operating chiller(s)).
 6. The control system shall modulate open the bypass valve as required to maintain minimum chilled water flow.
 7. Size the valve to operate properly with a pressure drop less than the set point of the system differential pressure sensor under all operating conditions.
- F. Operator Station Display: Add the following on operator workstation display terminal:
1. CHWS isolation valve % open (both chillers).
 2. Bypass valve % open.
 3. Chilled water pump status/alarm
 4. Chilled water supply/return temperature
 5. Chiller barrel differential pressure and pressure setpoint
 6. System differential pressure and pressure setpoint

1.6 ALL AIR SYSTEMS – TYPICAL SEQUENCE

- A. Applies to all RTU air systems.
- B. The AHU's shall have all temperature controls factory installed and operated by the manufacturer of the unit. Unit manufacturer shall provide all hardware and software for direct Bacnet interface with the Facility BAS. In general, discharge air temperature and humidity, economizer operation, chilled water valve modulation, hot water valve modulation, and safety/life safety operation shall be controlled through the equipment manufacturer controls. Scheduling, setpoints, status, cabinet temperature control, and alarming shall be via BAS.**
- C. Coordination of Air-Handling Unit Sequences: Ensure that all coil controls have common inputs and do not overlap in function. Provide a deadband between heating and cooling stages.
- D. Occupied mode:
 - 1. Occupied mode shall be determined by:
 - a. User defined occupancy schedule (Normal operation is occupied 24/7).
 - b. Local space temperature sensor with override button that will index the unit to the occupied mode for up to 2 hours.
 - 2. With the H-O-A starter in the automatic position, system starts supply fan to run continuously.
 - 3. Morning warm up shall be based on “optimal start” control based on building temperature and lag time to reach each zone’s setpoint. During warm up the OA and EA dampers are 100% closed, RA damper is 100% open, and heating coil control valve is 100% open (Units with VAV terminals shall have reheat coil control valves at 100% open). After each zone has reached setpoint, air system OA, RA and EA dampers go to set minimum positions, heating coil control valve modulates to maintain DA or Space setpoint (units with VAV terminals shall have control valves modulate as required to maintain space setpoints).
 - 4. Heating mode: Air handler 2-way control valve modulates to maintain DA setpoint (reset ability based on OA) or space setpoint as required for each specific system.
 - 5. Cooling Mode:
 - a. System resets supply-air temperature set point from higher, subject to warmest space temperature sensor reading. The control algorithm shall utilize the governing space temperature sensor as the master sensor and the discharge temperature sensor as the sub master sensor. The algorithm shall include a configurable reset limit and reset rate.
 - b. During occupied periods, when fan is running, system shall use a PID algorithm to control cooling to maintain discharge-air temperature.
 - c. Chilled water: modulate 2-way control valve.
 - 6. Economizer cooling: OA, RA and EA dampers modulate from set minimum positions to 100% OA and EA to maintain DA setpoint when OA is 55 F (space setpoint where applicable). Above 55 F OA and when RA enthalpy is higher than OA enthalpy, OA damper modulates to 100% open, RA damper modulates to 100% closed, EA damper

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

modulates 100% open. When OA enthalpy is higher than RA enthalpy, RA damper modulates open in sequence as OA damper modulates to the set minimum position.

E. Unoccupied mode (Off Mode):

1. OA, and EA dampers 100% closed, RA damper 100% open.
2. Associated exhaust fans do not operate.
3. Cabinet mounted temperature sensor, mounted in supply plenum, modulates 2-way control valve to maintain supply plenum at 65 F when air system fans are “off” and OA is below 40°F.
4. Supply fan cycles and each zone terminal unit will modulate heating output to maintain night set back temperature at 62 F (adj).
5. Systems shall have 2 hour (adj) unoccupied override ability. Associated exhaust fans shall also operate in override mode.

F. Safeties:

1. The supply fan and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.
2. Shall stop the supply fan; cause the system valves and dampers to return to their normal positions.
3. DDC Hardware reset of all proofs and safeties shall be via a local binary push-button input to the DDC Hardware.
4. A capillary freezestat shall initiate a low temperature alarm if the temperature drops below the freezestat's setpoint. Return to the normal mode of operation shall require manual reset at the freezestat. The DDC system shall monitor the freezestat through auxiliary contacts and shall indicate an alarm condition when the freezestat trips.
5. DA high temperature limit is 105 F (adj) and low temperature limit is 50 F (adj).

G. A status signal is wired to the supply fan VFD. The DDC system uses the status to confirm the fans are in the desired state (i.e. on or off) and generates an alarm if status deviates from DDC start/stop control.

H. Display of input points thru BMS:

1. System graphic
2. System occupied/unoccupied mode.
3. Coldest and warmest zones (all zones sampled)
4. Fan status/failure (typical all fans) (Print out Alarm)
5. OA commanded damper position.
6. RA commanded damper position.
7. EA commanded damper position.
8. Commanded heating control valve position,
9. DA temperature.
10. RA temperature.
11. Coil low temperature thermostat (Print out Alarm).
12. High DA limit (Print out Alarm).
13. Low DA limit (Print out Alarm).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

14. Filter air-pressure-drop indication (Print out at setpoint).
15. Supply-fan-discharge static-pressure indication and setpoint.
16. Supply-fan rpm and Hz. thru VFD.
17. Mixed-air-temperature indication.
18. Mixed-air-temperature set point.
19. Mixed-air damper position.
20. Filter air-pressure-drop indication.
21. Filter low-air-pressure set point.
22. Filter high-air-pressure set point.
23. Heating-coil control-valve position.
24. Supply-fan-discharge air-temperature indication.
25. Supply-fan-discharge air-temperature set point.
26. Discharge plenum temperature.
27. Cooling-coil control-valve position.
28. Minimum outside airflow indication.
29. Minimum outside airflow setpoint.

1.7 RTU-1

A. Occupied mode:

1. The air handling unit shall be scheduled to run through central BAS programming. Normal operation is 24/7 for occupied mode.
2. With the H-O-A starter in the automatic position, system starts supply fan and return fan to run continuously.

B. A status signal is wired to the supply and return fan VFDs. The BAS shall use the status to confirm the fans are in the desired state (i.e. on or off) and generates an alarm if status deviates from BAS start/stop control.

1. Ensure that all coil controls have common inputs and do not overlap in function. Provide a deadband between heating and cooling stages.
2. Heating mode: Air handler 2-way control valve modulates to maintain SA setpoint (reset ability based on OA).
3. Cooling Mode:
 - a. System resets supply-air temperature set point from higher, subject to space temperature sensor farthest from setpoint. The control algorithm shall utilize the governing space temperature sensor as the master sensor and the supply temperature sensor as the sub master sensor. The algorithm shall include a configurable reset limit and reset rate.
 - b. During occupied periods, when fan is running, system shall use a PID algorithm to control cooling to maintain supply-air temperature.
 - c. Chilled water: modulate 2-way control valve.
4. Economizer cooling:
 - a. OA, RA and EA dampers modulate from set minimum positions to 100% OA and EA to maintain SA setpoint.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. To save energy, economizer dampers shall be sequenced with chilled water cooling. To ensure proper sequencing, mixed air (MA) temperature shall not control the economizer. Instead, the dampers must be controlled by the same SA temperature controller used to control the mechanical cooling.
- c. Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Integration can greatly extend economizer operation, reducing cooling costs. For instance, a non-integrated air economizer will only be able to reduce cooling energy when OA temps are below 55°F to 60°F, depending on required SA temp. Above those temps, mechanical cooling is required so the non-integrated economizer is shut off. If the economizer were integrated it could continue to operate, continuing to reduce mechanical cooling energy even though it cannot provide the entire cooling load. The integrated economizer can continue to operate until the high-limit setpoint is reached.
- d. High Limit: Differential Enthalpy
 - 1) 5. Setting: OA enthalpy exceeds RA enthalpy.
 - 2) 6. Two enthalpy sensors shall be provided to compare total heat content of the indoor air and outdoor air to determine the most efficient air source when economizing. Differential enthalpy-based economizer change-over cycles require at least one enthalpy switch or sensor in the OA stream for the building or system and another switch or sensor in each air handling system's return air. The control strategy shall be arranged to change over from economizer mode to non-economizer mode if the actual measured enthalpy of its RA is less than the current OA enthalpy.
- C. Dehumidification: If the system is in the chilled water cooling mode and the return air relative humidity exceeds 60%; override the temperature sequence and open the chilled water coil and provide a dehumidification sequence.
- D. CDQ Dehumidification:
 - 1. When the space relative humidity is greater than setpoint, the discharge air dewpoint temperature setpoint will be dynamically reset based on the deviation of actual space relative humidity from the active space relative humidity setpoint. Rotation of the CDQ wheel will be enabled, the chilled water valve will modulate to maintain space relative humidity setpoint and the reheat will modulate to maintain the discharge air temperature cooling setpoint (55°F adj.). Mode will terminate when the space relative humidity falls below the relative humidity setpoint minus 3% (adj.).
 - 2. If the space relative humidity sensor fails, the supply air dewpoint setpoint will be set to 48°F (adj.). If both the space relative humidity sensor and the discharge air temperature sensor fail the dehumidification sequence will be terminated and an alarm will be annunciated.
- E. Supply Fan Control
 - 1. Supply fan VFD shall be set to operate at constant speed by the TAB technician to provide scheduled constant airflows to the spaces served.
 - 2. High and low static pressure switches located in intake and discharge ducts stops fan and signals alarm when static pressure rises above or below excessive-static-pressure set point.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Upon initial startup of the air handling system, the supply and return fan speed slowly ramps to the desired set points. Upon shutdown of the air handling system, the supply and return fans variable frequency drives are stopped.
4. VFDs shall be at minimum speed before energizing the fan (inherent in VFD's).

F. Return Fan Control

1. The return fan shall start any time the supply fan proves operation.
2. The return fan VFD speed shall not drop below 20% (adj.); this is set into the VFD.
3. The return fan shall maintain return duct static. Return air static pressure control shall be provided by a proportional integral derivative (PID) algorithm that modulates the VFD to maintain a duct static pressure set point, to be field set by the TAB technician to maintain scheduled differential pressure for the operating rooms, through all conditions.
4. Air flow measuring: The controller shall measure the outside airflow and modulate the outside air dampers to maintain the proper minimum outside air ventilation, overriding normal damper control. On dropping outside airflow, the controller shall modulate the outside air dampers open to maintain the outside airflow setpoint (adj.).

G. Operating Room Air System Smoke Control; additional requirements

1. NFPA 99 requires that ventilation systems for anesthetizing locations automatically prevent recirculation of smoke originating within the surgical suite. These systems must also prevent the circulation of smoke entering the system intake without interfering with the exhaust function of the system. It also requires that supply and exhaust systems for windowless anesthetizing locations be arranged to automatically vent smoke and other products of combustion. To comply with NFPA 99 requirements, the control sequence to ventilate products of combustion are as follows:
 - a. Smoke Evacuation Mode: Upon detection of products of combustion by a smoke detector within the surgery suite, the relief damper opens, the maximum outside-air damper opens, the return damper closes and the supply fan and return fan continue to operate at normal speed. The system operates in this manner until the fire-alarm system is reset. The OA & RA dampers shall be a Class II (minimum) leakage-rated smoke damper (this is specified in Section 237314 – Custom Air Handling Units) to allow as little leakage as possible.
 - b. If products of combustion are detected in the supply air and the system is in a smoke-evacuation mode, the supply fan shuts down, the outside dampers close and the return fan continues to operate in the relief mode.
 - c. If products of combustion are detected by the return-air smoke detector, the system is placed in smoke-evacuation mode (paragraph a. above).
 - d. The key to effective smoke control is a system that functions regardless of which detector is the first to detect smoke. A control-system priority shall be created depending upon which detector initiates first, meaning that the system cannot reset once it is in a smoke-evacuation mode without risking the introduction of smoke into an area or failing to relieve it from the space of origin. BAS may be overridden, but supply-air smoke detectors must always remain functional to ensure smoke is not introduced into a space.
 - e. Coils shall operate as required to maintain supply air temperature.

- H. During Smoke Evacuation Mode the low limit controls are disabled and the static pressure safeties remain in effect.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

I. Unoccupied mode (Off Mode-Normal operation is occupied 24/7) :

OA, and EA dampers 100% closed, RA damper 100% open.
Supply and return fans shall be OFF.

J. Safeties:

1. The supply fan and all BAS Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit. BAS Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.
2. Shall stop the supply fan; cause the system valves and dampers to return to their normal positions.
3. A capillary freezestat shall initiate a low temperature alarm if the temperature drops below the freezestat's setpoint. Return to the normal mode of operation shall require manual reset at the freezestat. The BAS shall monitor the freezestat through auxiliary contacts and shall indicate an alarm condition when the freezestat trips.
4. Provide a software version of the low limit detector. When the supply air temperature drops below 38 deg. for 2 minutes, the fans shall be commanded off. This requires the operator to clear the alarm before restart can happen.
5. Duct smoke detectors, located as shown on the plans: Installation in ductwork and connection to control system shall be under Division 23. Detector furnished and wired to the fire alarm system by Division 26. Activated when products of combustion are detected in air stream.
6. SA high temperature limit is 105°F (adj) and low temperature limit is 50°F (adj).

1.8 RTU-2

A. Occupied mode:

1. The air handling unit shall be scheduled to run through central BAS programming.
2. With the H-O-A starter in the automatic position, system starts supply fan and return fan to run continuously.

B. A status signal is wired to the supply and return fan VFDs. The BAS shall use the status to confirm the fans are in the desired state (i.e. on or off) and generates an alarm if status deviates from BAS start/stop control.

1. Ensure that all coil controls have common inputs and do not overlap in function. Provide a deadband between heating and cooling stages.
2. Heating mode: Air handler 2-way control valve modulates to maintain SA setpoint (reset ability based on OA).
3. Cooling Mode:
 - a. System resets supply-air temperature set point from higher, subject to space temperature sensor farthest from setpoint. The control algorithm shall utilize the governing space temperature sensor as the master sensor and the supply temperature sensor as the sub master sensor. The algorithm shall include a configurable reset limit and reset rate.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. During occupied periods, when fan is running, system shall use a PID algorithm to control cooling to maintain supply-air temperature.
 - c. Chilled water: modulate 2-way control valve.
4. Economizer cooling:
- a. OA, RA and EA dampers modulate from set minimum positions to 100% OA and EA to maintain SA setpoint.
 - b. To save energy, economizer dampers shall be sequenced with chilled water cooling. To ensure proper sequencing, mixed air (MA) temperature shall not control the economizer. Instead, the dampers must be controlled by the same SA temperature controller used to control the mechanical cooling.
 - c. Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Integration can greatly extend economizer operation, reducing cooling costs. For instance, a non-integrated air economizer will only be able to reduce cooling energy when OA temps are below 55°F to 60°F, depending on required SA temp. Above those temps, mechanical cooling is required so the non-integrated economizer is shut off. If the economizer were integrated it could continue to operate, continuing to reduce mechanical cooling energy even though it cannot provide the entire cooling load. The integrated economizer can continue to operate until the high-limit setpoint is reached.
 - d. High Limit: Differential Enthalpy
 - 1) Setting: OA enthalpy exceeds RA enthalpy.
 - 2) Two enthalpy sensors shall be provided to compare total heat content of the indoor air and outdoor air to determine the most efficient air source when economizing. Differential enthalpy-based economizer change-over cycles require at least one enthalpy switch or sensor in the OA stream for the building or system and another switch or sensor in each air handling system's return air. The control strategy shall be arranged to change over from economizer mode to non-economizer mode if the actual measured enthalpy of its RA is less than the current OA enthalpy.
- C. Dehumidification: If the system is in the chilled water cooling mode and the return air relative humidity exceeds 60%; override the temperature sequence and open the chilled water coil and provide a dehumidification sequence.
- D. Variable Speed Drive Control
- 1. Supply fan VFD shall be set to operate at constant speed by the TAB technician to provide scheduled constant airflows to the spaces served.
 - 2. High and low static pressure switches located in intake and discharge ducts stops fan and signals alarm when static pressure rises above or below excessive-static-pressure set point.
 - 3. Upon initial startup of the air handling system, the supply and return fan speed slowly ramps to the desired set points. Upon shutdown of the air handling system, the supply and return fans variable frequency drives are stopped.
 - 4. VFDs shall be at minimum speed before energizing the fan (inherent in VFD's).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

E. Return Fan Control

1. The return fan shall start any time the supply fan proves operation.
2. The return fan VFD speed shall not drop below 20% (adj.); this is set into the VFD.
3. The return fan shall VFD shall modulate the return fan to track the supply fan, maintaining scheduled airflow offsets for the spaces served, as set by the TAB technician.
4. Air flow measuring: The controller shall measure the outside airflow and modulate the outside air dampers to maintain the proper minimum outside air ventilation, overriding normal damper control. On dropping outside airflow, the controller shall modulate the outside air dampers open to maintain the outside airflow setpoint (adj.).

F. Unoccupied mode:

1. OA, and EA dampers 100% closed, RA damper 100% open.
2. Supply and return fans shall be OFF.
3. Supply fan cycles on call for heat from any zone on the system.

G. Safeties:

1. The supply fan and all BAS Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit. BAS Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.
2. Shall stop the supply fan; cause the system valves and dampers to return to their normal positions.
3. A capillary freezestat shall initiate a low temperature alarm if the temperature drops below the freezestat's setpoint. Return to the normal mode of operation shall require manual reset at the freezestat. The BAS shall monitor the freezestat through auxiliary contacts and shall indicate an alarm condition when the freezestat trips.
4. Provide a software version of the low limit detector. When the supply air temperature drops below 38 deg. for 2 minutes, the fans shall be commanded off. This requires the operator to clear the alarm before restart can happen.
5. Duct smoke detectors, located as shown on the plans: Installation in ductwork and connection to control system shall be under Division 23. Detector furnished and wired to the fire alarm system by Division 26. Activated when products of combustion are detected in air stream.
6. SA high temperature limit is 105°F (adj) and low temperature limit is 50°F (adj).

1.9 TERMINAL UNITS

- A. The BAS shall use an optimal start algorithm for morning start-up of each air system. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
- B. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.10 OPERATING ROOM PRESSURE, TEMPERATURE, AND HUMIDITY CONTROL

A. Occupied Mode

1. VAV terminal unit modulates supply air to maintain constant airflow as scheduled.
2. Exhaust air dampers (one for each pair of OR's-EAD-1 and EAD-2) modulate to maintain differential space pressure at setpoint. Differential pressure shall be as measured with respect to outside air and shall average the two OR's. Setpoint shall be .015" wc.
3. On rise in space temperature above setpoint, as determined by temperature sensor located at the space, the reheat coil control valve shall close.
4. On drop in space temperature below setpoint, reheat coil control valve modulates open to maintain space temperature.
5. Electric humidifier (one for each pair of OR's) modulates through its package controller (interfaced with BAS) to maintain space humidity, as determined by exhaust duct mounted humidistat, at setpoint (30% RH, adj.). Humidity high limit switch de-energizes humidifier on rise in supply air humidity above high limit. Flow switch mounted at supply duct prohibits steam flow until proven airflow.

B. Unoccupied Mode

1. VAV terminal unit ramps back to reduce supply air to scheduled unoccupied constant flow.
2. Exhaust air dampers (one for each pair of OR's) modulate to maintain differential space pressure at setpoint. Differential pressure shall be as measured with respect to outside air and shall average the two OR's. Setpoint shall be .015" wc.
3. Hot water coil control valve modulates to maintain setback temperature.
4. Electric humidifier is disabled.

1.11 POST-OP, PRE-OP, AUTOCLAVE, CLEAN AREAS

A. Occupied Mode

1. VAV terminal units modulate supply air to maintain constant airflow as scheduled.
2. On rise in space temperature above setpoint, as determined by temperature sensor located at the space, the reheat coil control valve shall close.
3. On drop in space temperature below setpoint, reheat coil control valve modulates open to maintain space temperature.

B. Unoccupied Mode

1. VAV terminal unit ramps back to reduce supply air to scheduled unoccupied constant flow.
3. Hot water coil control valve modulates to maintain setback temperature.

1.12 ANCILLARY OR SUITE SPACE CONDITIONING

A. For spaces served by new VAV terminals:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. VAV terminal units modulate supply airflow and hot water control valve to maintain space temperature in occupied and unoccupied modes (refer to general requirements section below).
- B. For spaces served by constant volume reheat coils (existing):
1. In occupied mode, hot water coil control valve modulates to maintain occupied temperature setpoint.
 2. In unoccupied mode, hot water coil control valve modulates to maintain space at setback temperature setpoint.
- C. EAD-3
1. In occupied mode, the exhaust air damper modulates to maintain a calculated airflow as follows: $(VAV\ 1.1 + VAV\ 1.2 + VAV\ 1.3 + VAV\ 1.4 + VAV\ 1.5 + VAV\ 1.6 + VAV\ 1.7 + VAV\ 1.8 + VAV\ 1.12 - 575) \times .9$
 2. In unoccupied mode, the exhaust air damper modulates to maintain a calculated airflow as follows: $(VAV\ 1.1 + VAV\ 1.2 + VAV\ 1.3 + VAV\ 1.4 + VAV\ 1.5 + VAV\ 1.6 + VAV\ 1.7 + VAV\ 1.8 + VAV\ 1.12 - 300) \times .9$
- D. EAD-4 AND SAD-1
1. In occupied mode, SAD-1 and EAD-4 modulate to maintain constant flow as scheduled.
 2. In unoccupied mode, SAD-1 and EAD-4 shall remain closed unless a call for heat, when spaces fall below unoccupied setpoint, at which time both dampers shall open to maintain unoccupied setpoint until temperature is satisfied.
- 1.13 RTU-2 AIR TERMINALS
- A. Occupied Mode
1. For exam rooms served by new VAV boxes, VAV terminal units modulate supply air to maintain constant airflow as scheduled. On rise in space temperature above setpoint, as determined by temperature sensor located at the space, the reheat coil control valve shall close. On drop in space temperature below setpoint, reheat coil control valve modulates open to maintain space temperature.
 2. For ancillary areas served by new VAV terminals, VAV terminal damper and hot water control valve modulate to maintain space temperature.
 3. For areas served by existing reheat coils, hot water control valve modulates to maintain space temperature at setpoint.
- B. Unoccupied Mode
1. Air system is off. Refer to general VAV air terminal unit requirements below.
- C. SAD-2
1. In occupied mode, supply air damper modulates to maintain constant volume occupied flowrate as scheduled.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. In unoccupied mode, SAD-2 shall remain closed unless a call for heat, when spaces fall below unoccupied setpoint, at which time the damper shall open to maintain unoccupied setpoint until temperature is satisfied.

1.14 AIR TERMINAL UNITS (General Requirements for units scheduled to modulate airflow to provide space conditioning)

A. Occupied Mode

1. The BAS shall schedule the VAV to occupied mode. The central air handling unit must be running before the VAV will operate in the occupied mode.
2. Provide “dual maximum” control for maximum efficiency.
 - a. When the zone is in the cooling mode, the cooling loop output is mapped to the airflow setpoint from the cooling maximum to the minimum airflow setpoints. The hot water valve is closed.
 - b. When the zone is in the deadband mode, the airflow setpoint shall be the minimum airflow setpoint. The hot water valve is closed.
 - c. When the zone is in the heating mode, the heating loop shall maintain space temperature at the heating setpoint as follows:
 - 1) From 0%-50% loop signal, the heating loop output shall reset the discharge temperature from supply air temperature setpoint (e.g., 55°F) to 90°F. Note the upper temperature is limited to prevent stratification during heating.
 - 2) From 50%-100% loop signal, the heating loop output shall reset the zone airflow setpoint from the minimum airflow setpoint to the maximum heating airflow setpoint. The supply air discharge temperature remains at 90°F.
 - 3) The hot water valve shall be modulated using a PI control loop to maintain the discharge temperature at setpoint. Note that directly controlling the hot water valve from the zone temperature PI loop is not acceptable since it will not allow supply air temperature to be under control and limited in temperature to prevent stratification.
 - 4) The VAV damper shall be modulated to maintain the measured airflow at setpoint.
3. The BAS shall limit the maximum cooling setpoint to 78°F (adj.) and the minimum cooling setpoint to 74°F (adj.).
4. The BAS shall limit the maximum heating setpoint to 72°F (adj.) and the minimum heating setpoint to 65°F (adj.).
5. Tenant Override: When a VAV is in the Unoccupied Mode and a button on the room sensor is pushed, the BAS shall place the VAV in the Occupied Mode for 60 minutes (adjustable). The BAS shall command the appropriate central air handling unit and central plant equipment to on to provide the overridden VAV with the necessary comfort.
6. Operator Workstation: Display the following data:
 - a. Room/area served.
 - b. Room temperature, alarm high and low (2°F out of range)
 - c. Room temperature set point, occupied.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- d. Room temperature set point, unoccupied.
- e. VAV Supply box pressure
- f. VAV supply box CFM
- g. VAV box damper % open
- h. VAV box supply temperature (units with reheat coils)
- i. Heating coil control-valve position as percent open.
- j. CO2 Setpoint
- k. CO2 ppm

B. Unoccupied Mode

- 1. Hot water control valve modulates to maintain setback temperature. Damper is in minimum position for unoccupied heating.
- 2. For system which operate the air system in unoccupied mode, damper and coil control valve are closed with no call for heat.
- 3. For systems with central air handling unit off in unoccupied mode, the BAS shall command the VAV supply air damper closed. AHU supply fan is cycled on with a call for unoccupied heating.
- 4. When the central air handling unit is off, the BAS shall command the hot water valve closed.
- 5. If the room temperature falls below 60°F (adjustable), the BAS shall generate an alarm.

1.15 PERIMETER HEATING UNITS

- 1. Convectors Room Temperature:
 - a. Input Device: Electronic temperature sensor.
 - b. Output Device: Electronic control-valve operator.
 - c. Action: 2-position valve controlled to maintain space temperature.
- 2. Sequence in operation with AHUs with duct heating coils in same zone.

1.16 EXHAUST FANS

A. Scheduled (Time)

- 1. Sequence applies to the following fans:
 - a. Existing EF-1 + 2 shall operate continuously in occupied mode, off in unoccupied mode, interlocked with AHU-1 operation.
 - b. EF-4 shall operate continuously in occupied mode, off in unoccupied mode, interlocked with AHU-1 operation.
 - c. EF-5 shall operate continuously in both occupied and unoccupied modes, interlocked with AHU-1 operation.
 - d. EF-6 shall operate continuously in both occupied and unoccupied modes, interlocked with AHU-1 operation.
 - e. EF-7 shall operate continuously in both occupied and unoccupied modes, interlocked with AHU-1 operation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- f. EF-1 shall operate continuously in occupied mode, off in unoccupied mode, interlocked with AHU-2 operation.
 - g. EF-2 shall operate continuously in occupied mode, off in unoccupied mode, interlocked with AHU-2 operation.
 - h. EF-3 shall operate continuously in occupied mode, off in unoccupied mode, interlocked with AHU-2 operation.
 - i. Existing EF-8 shall operate continuously in occupied mode, off in unoccupied mode, interlocked with AHU-2 operation.
2. Fans shall be energized based on occupancy schedule. Fans schedules shall be coordinated with associated air system occupancy schedule.
- B. Display the following thru BAS:
1. Each fan status/failure (Generate an Alarm)

1.17 UNIT HEATERS

1. Unit Heater: On call for heat space thermostat starts fan and opens 2-way control valve on call for heat after pipe mounted aquastat setpoint (135°F) is satisfied. When space reaches setpoint the reverse happens.
 - a. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adj.).
 - b. Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F

END OF SECTION 230993

SECTION 231123 – FACILITY FUEL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 2 Sections.
 - 2. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 3. Division 23 Section "Common Work Results for HVAC"
 - 4. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.

1.2 SUMMARY

- A. This Section includes fuel gas piping, specialties, and accessories within the building. Currently the system is fed, temporarily from an LP service, to be converted to Natural Gas during the construction phase. Coordinate strictly with Eyecare Medical Group for the transition.

1.3 PROJECT CONDITIONS

- A. Gas System Pressure: Coordinate with gas supplier.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Corrugated, stainless-steel tubing systems. Include associated components.
 - 2. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
 - 4. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Maintenance Data: For natural gas specialties and accessories to include in maintenance manuals specified in Division 1.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 QUALITY ASSURANCE

- A. All work shall be performed by technicians holding a Maine Propane and Natural Gas Technician License: “Large Equipment Connection and Service Technician”
- B. Installations of propane and natural gas must also comply with all other applicable statutes or rules of the State and all applicable ordinances, orders, rules, and regulations of local municipalities.
- C. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. All work shall be per the following codes. Year edition of code shall be as recognized by the authority with jurisdiction
 - 1. NFPA 54 "National Fuel Gas Code".
 - 2. NFPA 30, Flammable and Combustible Liquids Code
- E. FM Standard: Provide components listed in FM's "Fire Protection Approval Guide" if specified to be FM approved.
- F. IAS Standard: Provide components listed in IAS's "Directory of A. G. A. and C. G. A Certified Appliances and Accessories" if specified to be IAS listed.
- G. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.
- H. American Society of Mechanical Engineers (ASME) Code CSD-1 Controls and Safety Devices for Automatically Fired Boilers, 2002 edition

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

- A. Make arrangements with local utility for gas service to the Owner’s distribution system. Provide service to the building as required by the Utility Company. Coordinate all activities between the Owner and Utility Company. The installation of the gas service shall comply with the published Utility Company standards. Pay all utility company charges; include charges in the base bid.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Corrugated, Stainless-Steel Tubing Systems:
 - a. Omega Flex, Inc.
 - b. Titeflex Corp.
 - c. Tru-Flex Metal Hose Corp.
 - d. Ward Manufacturing, Inc.
 2. Valves:
 - a. American Valve.
 - b. B&K Industries, Inc.
 - c. Brass Craft Manufacturing Co.
 - d. Conbraco Industries, Inc.; Apollo Div.
 - e. Crane Valves.
 - f. Grinnell Corp.
 - g. Honeywell, Inc.
 - h. Key Gas Components, Inc.
 - i. McDonald: A. Y. McDonald Mfg. Co.
 - j. Milwaukee Valve Co., Inc.
 - k. Nibco, Inc.
 - l. Mueller Co.; Mueller Gas Products Div.
 - m. Watts Industries, Inc.
 3. Electrically Operated Gas Valves:
 - a. ASCO General Controls.
 - b. Atkomatic Valve Co., Inc.
 - c. Automatic Switch Co.
 - d. Eclipse Combustion Inc.
 - e. Magnatrol Valve Corp.
 - f. Parker Hannifin Corp.; Climate & Industrial Controls Group; Skinner Valve Div.
 4. Meters:
 - a. American Meter Co.
 - b. Badger Meter, Inc.; Utility Products Div.
 - c. Equimeter, Inc.
 - d. National Meter.
 - e. Schlumberger Industries; Gas Div.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

5. Pressure Regulators:

- a. American Meter Co.
- b. Equimeter, Inc.
- c. Fisher Controls International, Inc.
- d. Maxitrol Co.
- e. National Meter.
- f. Richards Industries, Inc.; Jordan Valve Div.
- g. Schlumberger Industries; Gas Div.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

- A. Steel Pipe: ASTM A 106, ANSI/ASME B36.10, ASTM A 53; Grade B; Schedule 40; black.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
 3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
 4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
 5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
 6. Joint Compound and Tape: Suitable for natural gas.
 7. Steel Flanges and Flanged Fittings: ASME B16.5.
 8. Gasket Material: Thickness, material, and type suitable for natural gas.
- B. Corrugated Stainless Steel Tubing Systems: Gastite or approved equal; a corrugated stainless steel tubing complying with ANSI LC 1b "Fuel Gas Piping Systems Using CSST" and listed with CSA[®], ICBO and IAPMO. Manufacturing materials shall be: ASTM A240 type 300 corrugated stainless steel tubing with a minimum wall thickness of .010", jacketing of UV resistant polyethylene meeting the requirements of ASTM E84 for flame spread and smoke density. All mechanical tube fittings shall be SAE CA360 brass incorporating double wall flare sealing and Jacket Lock[®] jacket capturing for steel tubing protection.
1. Striker Plates: Steel, designed to protect tubing from penetrations.
 2. Manifolds: Malleable iron or steel with protective coating. Include threaded connections according to ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
- C. Transition Fittings: Type, material, and end connections to match piping being joined.
- D. Common Joining Materials: Refer to Division 23 Section "Common Work Results for HVAC" for joining materials not in this Section.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 PIPING SPECIALTIES

- A. Flexible Connectors: ANSI Z21.24, copper alloy.
- B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.
- C. Pressure gages shall conform to ASME B40.100, Type I, Class 1. Pressure-gage size shall be 3-1/2-inch nominal diameter. Case shall be corrosion-resistant steel conforming to any of the AISI 300 series of ASTM A 666, with a No. 4 standard commercial polish or better. All gages shall be equipped with adjustable red marking pointer and damper screw adjustment in inlet connection.

2.5 SPECIALTY VALVES

- A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.
- D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
- E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating. Tamperproof Feature: Include design for locking.
- F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating. Tamperproof Feature: Include design for locking.
- G. General-Duty Valves, NPS 2-1/2 and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125-psig pressure rating.
 - 1. Gate Valves: MSS SP-70, OS&Y type with solid wedge.
 - 2. Butterfly Valves: MSS SP-67, lug type with lever handle.
- H. Automatic Gas Valves: ANSI Z21.21, with electrical operator for actuation by appliance automatic shutoff device.
- I. Electrically Operated Gas Valves: UL 429, bronze, aluminum, or cast-iron body solenoid valve; 120-V ac, 60 Hz, Class B, continuous-duty molded coil. Include NEMA ISC 6, Type 4, coil enclosure and electrically opened and closed dual coils. Valve position shall normally be closed.
- J. Earthquake Valves: [FM approved or listed in IAS Directory as complying with ANSI Z21.70 and UL listed] [FM approved] [Listed in IAS Directory as complying with ANSI Z21.70 and UL listed]. Include mechanical operator.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 NATURAL GAS SERVICE METER AND PRESSURE REGULATOR

- A. Natural Gas Service Meter: Provided by gas supplier. Coordinate requirements and pay all fees.

2.7 PRESSURE REGULATORS

- A. Regulators may include vent limiting device, instead of vent connection to outside, if approved by authorities having jurisdiction. Provide venting as required by code.
- B. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.
- C. Appliance Pressure Regulators: ANSI Z21.18.
- D. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.
- B. Comply with ANSI Z223.1, "Prevention of Accidental Ignition" Paragraph.

3.2 SERVICE ENTRANCE PIPING

- A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
 - 1. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.
 - 2. Natural gas distribution system piping, service pressure regulator, and service meter are specified in Division 2 Section "Natural Gas Distribution."
- B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Refer to Division 23 Section "Common Work Results for HVAC" for dielectric fittings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 PIPING APPLICATIONS

- A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.
- B. Fuel Gas Piping: Use the following:
 - 1. NPS 1 and Smaller: steel pipe, malleable-iron threaded fittings, and threaded joints. Option: Corrugated, stainless-steel tubing may be used for runouts at individual appliances.
 - 2. NPS 1-1/4 to NPS 2: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 3. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.
- C. In-slab (within building) Fuel Gas Piping: Corrugated stainless steel tubing encased in containment conduit.
 - 1. Containment Conduits: Schedule 40, PVC solvent welded fittings, and joints.
 - 2. NPS 1-1/4 to NPS 2: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 3. Install in strict accordance with “National Fuel Gas Code.”
- D. Commercial Cooking Appliances. Commercial cooking appliances shall be connected in accordance with the connector manufacturer's installation instructions using a listed appliance connector complying with ANSI Z21.69, Connectors for Moveable Gas Appliances.
- E. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.
- F. Containment Conduits: Steel pipe, steel welding fittings, and welded joints.
- G. Gas Service Piping at Meters and Regulators: Steel pipe, steel welding fittings, and welded joints.

3.4 VALVE APPLICATIONS

- A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.
- B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.
- C. Appliance Shutoff Valves for Pressure 2 to 5 psig: Gas valve.
- D. Piping Line Valves, NPS 2 and Smaller: Gas valve.
- E. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.
- F. Valves at Service Meter, NPS 2 and Smaller: Gas valve.
- G. Valves at Service Meter, NPS 2-1/2 and Larger: Plug valve.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.5 PIPING INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for HVAC" for basic piping installation requirements.
1. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
 2. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.
 3. Install fuel gas piping at uniform grade of ¼" per 15 feet.
 4. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
 5. Connect branch piping from top or side of horizontal piping.
 6. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
 7. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
 8. Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.
 9. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
 10. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
 11. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.
- B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
 2. In Floors: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in floors, subject to approval of authorities having jurisdiction. Surround piping cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls. Exception: Tubing passing through partitions or walls.
5. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
6. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts. Exception: Accessible above-ceiling space specified above.

3.6 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."
- B. Support gas piping in accordance with NFPA 54. Steel pipe spacing of supports: ½" pipe = 6 feet; ¾" or 1" = 8 feet; 1-1/4" and larger = 10 feet.
- C. Refer to Division 23 Section "Seismic Restraints for Mechanical" for seismic-restraint devices.
- D. Support horizontal corrugated, stainless-steel tubing from structure according to manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.
- B. Install piping adjacent to appliances to allow service and maintenance.
- C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
- D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.8 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
 1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 2. Refer to Division 23 Section "Identification for HVAC" for nameplates and signs.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.9 PAINTING

- A. Use materials and procedures in Division 9 Section "Painting," "Exterior Paint Schedule" Article, "Ferrous Metal" Paragraph, "Full-Gloss, Alkyd-Enamel Finish" Subparagraph.
- B. Paint exterior piping, service meters, pressure regulators, and specialty valves. Color: Safety Yellow.
- C. Paint all exterior metal support brackets for piping. Color: Black.

3.10 FIELD QUALITY CONTROL

- A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.
- B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
- C. Report test results promptly and in writing to Architect and authorities having jurisdiction.
- D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.
- E. Verify correct pressure settings for pressure regulators.
- F. Verify that specified piping tests are complete.
- G. Verify that the gas piping has been grounded by Division 16 in accordance with NFPA requirements.

3.11 ADJUSTING

- A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 231123

SECTION 232113 – HYDRONIC HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Common Work Results for Mechanical"
 - 3. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.
 - 4. Division 23 Section "Thermometers and Pressure Gages"
 - 5. Division 23 Section "Mechanical Identification" for labeling and identifying hydronic piping.
 - 6. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
 - 7. Division 23 Section – "Vibration and Seismic Controls For HVAC Piping and Equipment"
 - 8. Division 23 controls section for temperature-control valves and sensors.

1.2 SUMMARY

- A. This Section includes piping, special-duty valves, and specialties for hydronic HVAC piping.

1.3 SUBMITTALS

- A. Product Data: Provide manufacturer's standard submittal cut sheets. For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Welding Certificates: Copies of certificates for welding procedures and personnel.
- C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- D. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.4 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Qualify soldering processes, procedures, and solderers for copper and copper alloy pipe and tube in accordance with ASTM B 828.
- C. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.5 COORDINATION

- A. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.
- B. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- C. Coordinate pipe sleeve installations for foundation wall penetrations.
- D. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.
- E. Coordinate pipe fitting pressure classes with products specified in related Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Refer to Division 23 Section "Common Work Results for Mechanical".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grooved Mechanical-Joint Fittings and Couplings:
 - a. Victaulic Company of America.
 - b. Anvil
 - c. Grinnell Corporation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Balancing Valves:
 - a. Griswold Controls.
 - b. ITT Bell & Gossett
 - c. Taco, Inc.
 - d. Tour & Anderson
 - e. Flow Design, Inc.
 - f. Griswold Controls
 - g. Watts Industries Inc.
3. Hydronic Pressure-Reducing Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT Bell & Gossett
 - e. Spence Engineering Company, Inc.
 - f. Watts Industries, Inc.
4. Safety Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT McDonnell & Miller.
 - e. Kunkle Valve Division.
 - f. Spence Engineering Company, Inc.
 - g. Watts Industries Inc.
5. Expansion Tanks, Air Separators, and Hydronic Specialties:
 - a. Amtrol, Inc.
 - b. Woods
 - c. ITT Bell & Gossett
 - d. Taco, Inc.
 - e. Aurora
 - f. Watts Industries Inc.
6. Air Vents and Vacuum Breakers:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. ITT Hoffman
 - d. Johnson Corp. (The).
 - e. Spirax Sarco, Inc.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A-53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40 and 80, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 and larger: ASTM A-53, Type E (electric-resistance welded), Grade B, Schedule 40 and 80, black steel, plain ends.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- F. Wrought-Steel Fittings: ASTM A-234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt-welding.
 - 3. Facings: Raised face.
- H. Mechanically formed copper or steel tee connections are not acceptable.
- I. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and thredolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ANSI B16.11 may be used for drain, vent and gage connections.
- J. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- K. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 PVC PIPE AND FITTINGS

- A. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D 1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Fittings shall conform to ASTM D 2665.

2.6 HYDRONIC VALVES

A. Gate Valves

1. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB617, Nibco T-124/134, Stockham B105, Milwaukee 1152 or equal.
2. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Hammond IR1140, Nibco F617-0, Stockham G623, Milwaukee F2885 or equal.
3. Solder Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB648, Nibco S134, Stockham B115, Milwaukee 1169 or equal.
4. Comply with the following standards: Cast Iron Valves: MSS SP – 70; Bronze Valves: MSS SP – 80.

B. Ball Valves

1. [Ball valves at PICV's refer to Section 230900, Paragraph 2.7.E.]
2. Threaded Ends 4" and Smaller: 150 psi WP and 600psi non-shock CWP, forged brass full-port or cast bronze two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBV-3C series/B6080 series, Hammond 8501, Nibco T-585-70, Milwaukee BA100, Apollo 70-Series, or approved equal.
3. Soldered Ends 3" and Smaller: 150 psi WP and 600psi non-shock CWP, full-port cast bronze or forged brass two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBVS-3C series/B6081 series, Hammond 8511, Nibco S-585-70, Milwaukee BA150, Apollo 70-Series, approved or equal.
4. Aquatherm Climatherm: Valves shall be manufactured in accordance with the manufacturer's specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
5. Comply with MSS SP-110.

C. Butterfly Valves

1. Basis of Design: Center Line Series 200; Lug Type, cast iron, drilled and tapped lug body, ductile iron disc, 416SS shaft, bronze bushing, EPDM seat.
2. Valve bodies shall have extended necks to provide for 2-1/4" insulation as needed.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Comply with MSS SP-67.
 4. Compatible with ANSI 125/150 flanges. Dead-end capacity to 200 psi.
 5. Operators: 6" and smaller: handle with infinite adjustment; 8" and larger: gear w/balance-stop hand wheel. Valves located 7 feet or higher: provide gear/chain wheel.
 6. Approved Manufacturers: Watts, Hammond, Nibco, Milwaukee, or approved equal.
- D. Wafer Check valves: Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between two standard Class 125 flanges. Construct iron body valves with pressure containing parts of valves with materials conforming to ANSI/ASTM A 126, Grade B. Support hanger pin by removable side plug; Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal., Watts BF/DBF series, Metraflex 700 Series, Nibco W920-W, Stockham WG970, Hammond 9253, Milwaukee 1400, or approved or equal.
- E. Swing check valves:
1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B
 2. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71.
 3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
 4. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413Y, Stockham B320T, Milwaukee 509 or approved equal.
 5. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-Y, Stockham B310T, Milwaukee 511 or approved equal.
 6. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Hammond IR1124, Nibco F918-B, Stockham G931, Milwaukee F2974 or approved equal.
- F. Calibrated Balancing Valves, Watts CSM-61/81 series, Taco Accu-Flo, or approved equal.
1. Accuracy 4-5 times greater than variable orifice balancing valves.
 2. Flow measurement independent of stem and ball position.
 3. Calibrated nameplate: Easy to read. Memory stop is tamper resistant and has a fast and accurate resetting if shut-off feature is used. Calibrated to aid in pre-balancing flow loop.
 4. Tamper resistant memory- stop for accurate resetting; positive shut-off; ability to read low flows.
 5. Schrader style pressure ports
 6. Bronze Body rated to: 300 PSI, 250°F;
 7. Cast Iron Body: Class 125
 8. Modified venturi design; blowout-proof stem held secure by valve body; ball valve construction with Teflon seats; built-in drain port; all brass interior parts.
 9. Provide a closed cell polyethylene foam insulation kit with each valve.
- G. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.
- H. ASME Safety Relief Valves: Bell & Gossett A-434D, or equal; diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV. The fluid shall not discharge into the spring chamber. The valve shall have a low blow-down differential. The valve seat and all moving parts exposed to the fluid shall be of non-ferrous material.

- I. Automatic Flow-Control Valves: Watts Automatic Control/ACV, Griswold, Flow Design, Inc., or approved equal. Automatic flow control valve cartridges shall automatically control flow rates with $\pm 5\%$ accuracy over an operating pressure differential range of at least 14 times the minimum required for control. Four operating pressure ranges shall be available with the minimum range requiring less than 3 PSID to actuate the mechanism.
 1. Valve internal control mechanism shall consist of a stainless steel one-piece cartridge with segmented port design and full travel linear coil spring.
 2. All flow control valve cartridges shall be warranted by the manufacturer for five years from date of sale.
 3. Griswold Isolator-Y series valves, sizes 1/2" through 1-1/2", shall have an ASTM brass alloy body, rated at no less than 400PSI/250°F. Isolator series valves, sizes 1-1/2" Large through 3", shall have a CAST brass alloy body, rated at no less than 275PSI/250°F. These sizes shall be constructed in a one-piece body to include a handle ball valve, a flow control cartridge assembly, dual pressure or pressure/temperature test valves for verifying accuracy of flow performance for all sizes combined with a manual air vent, and a union end which will accept various end pieces. The IY shall include a removable 20 mesh stainless steel strainer. Available flow rates shall be from 0.25 GPM to 160.0 GPM.
 4. The body design shall allow inspection or removal of cartridge or strainer without disturbing piping connections.
 5. The body design shall allow inspection or repair of handle operated stem without disturbing piping connections. The repairable stem shall include two Teflon seals and one EPDM o-ring for protection against chemicals and modulating temperature.
 6. The valve shall come fully assembled and be permanently marked to show direction of flow; shall have a body tag to indicate flow rate and model number

2.7 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.
- B. Automatic Air Vent: designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection. Seton, Brady, or approved equal.
- C. Expansion Tanks: Taco Model CA, or approved equal. Construction: Welded steel, designed, tested and stamped in accordance with ASME (BPV code sec VIII, div 1); supplied with National Board Form U-1, rated for working pressure of 150 psi, with flexible heavy duty butyl rubber bladder. Bladder shall be able to accept the full volume of the expansion tank and shall be removable and replaceable. Bladder shall be NSF 61 rated for potable water service and shall be manufactured with FDA approved materials.
 1. Expansion tank isolation valves: Provide valve lockouts: shall meet OSHA requirements to ensure ball valves are locked securely and effectively; for use on 1/4-turn valves to

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

prevent tampering; polypropylene material resists chemicals, solvents, cracking & rust; provide padlock locking mechanism. Seton, Brady, or approved equal.

2. Accessories: Pressure gage (field installed by others) and air-charging fitting.
3. Automatic Cold Water Fill Assembly (field installed by others): Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

D. Air Separator

1. Furnish and install air removal devices of the size and type as shown on the plans. Air separation devices shall be Taco Model AC, or approved equal.
2. Air separator shall be constructed of steel designed and fabricated per Section VIII Division 1 of the A.S.M.E. Boiler and Pressure Vessel Code with a maximum working pressure rating of (125 / 150) psi at 375°F. Units up to 2.5 inch in size shall be provided with threaded system connections as standard. Units 3 inch and larger shall be provided with flanged system connections as standard.
3. Each air separator shall be equipped with a stainless steel removable strainer. The perforations in the strainer shall be 3/16" diameter and combine for a total free area of not less than five times the cross-sectional area of the connecting pipe
4. Air separator shall have separate threaded connections located on the top of the tank for connection to system expansion tank and air vent. Air separator shall also have separate threaded connection on the bottom of the tank for a blow down valve.
5. Units 10 inch and larger shall be provided with a steel base ring designed for floor mounting and units 12" and larger shall be provided with two welded lifting lugs on the top of the tank for ease of installation.

E. Air and Dirt Separator

1. Furnish and install air and dirt removal device(s) of the size and type as shown on the plans. Air and dirt separation devices shall be Taco 4900 Series or approved equal by Spirovent or Bell & Gossett.
2. Air and dirt removal device shall be constructed of steel designed and fabricated per Section VIII Division 1 of the A.S.M.E. Boiler and Pressure Vessel Code with a maximum working pressure rating of (125 / 150) psi at 270°F. Units up to 3 inch in size shall be provided with (threaded / flanged) system connections. Units 4 inch and larger shall be provided with flanged system connections as standard.
3. Each air & dirt separator shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. Air vent shall be furnished with a closeable port to prevent vent clogging during system fill. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and the removal of floating impurities from the air / system fluid interface within the separator. A blowdown valve shall be provided by the unit manufacturer on the bottom of each air and dirt separator to allow cleaning as required.
4. The air & dirt separator shall employ the use of high surface area, stainless steel pall rings to achieve optimal separation of (air / air & dirt) from the system fluid. Screens made of 304-stainless steel are provided on the inlet and outlet of each separator to isolate the internals from the system. Units installed in open systems shall be provided with a removable top head for removal and cleaning of the internal coalescence media.
5. The supplier of the air & dirt separator shall furnish to the design engineer the results of independent air & dirt testing of a representative unit from the suppliers' standard

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

product offering. Suppliers not providing these independent performance test results will not be accepted.

- F. Chilled water buffer tanks shall be as manufactured by Cemline Corporation or approved equal. Tanks shall be ASME Code constructed and stamped in accordance with Section VIII of the ASME Code. Tank shall be registered with the National Board of Boiler and Pressure Vessel Inspectors and a certificate of shop inspection shall be furnished. ASME working pressure shall be 125 psi. Material of construction shall be Carbon Steel. Tank shall be furnished with an air vent, a 1/2" flexible, elastomeric thermal insulation black in color, and internal baffle to water flow. Tank shall be supplied with four (4) angle legs welded 6" on the shell of the pressure vessel. Legs shall meet seismic zone 4 requirements. Tank shall be Model V300CWB-2N. 36 " diameter x 72" length 300 Gallon Capacity with NPT or flanged connections (size of system piping).
- G. Bypass Chemical Feeder: Neptune Model DBF, J. L. Wingert Company, or approved equal; welded steel construction; rated for 300 psi at 180°F; 5-gallon capacity; with 4" fill cap; and inlet, outlet, and drain valves.
 - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- H. Flexible Connectors: Refer to Section 230500 "Common Work Results for HVAC".
- I. Y-Pattern Strainers: Strainers shall be Y-type with removable basket. Body shall have cast-in arrows to indicate direction of flow. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 corrosion-resistant steel. Provide fine-mesh start-up strainers.
 - 1. Strainers in sizes 3-inch and smaller shall have screwed ends; Hammond 3010, or approved equal. Body material shall be cast bronze conforming to ASTM B584-C84400. Strainer bodies fitted with screwed screen retainers shall have straight threads and shall be gasketed with nonferrous metal. Strainer screens shall have perforations not to exceed 1/32".
 - 2. In sizes 4 and larger, strainers shall have flanged ends; Hammond 3030, or approved equal. Body material shall be cast iron conforming to ASTM A126 Class B. Strainer bodies fitted with bolted-on screen retainers shall have offset blowdown holes. Strainer screens shall have perforations not to exceed 1/16" (4" size); 1/8" (5" size and larger).

2.8 PROPYLENE GLYCOL

- A. DuPont Dowfrost HD or approved equal; the propylene glycol fluid to be used in such a system shall meet the following requirements:
 - 1. **The project scope shall completely evacuate and remove from the project site, the entire chilled water loop solution currently contained within the facility, flush the entire system, and re-charge with a new propylene glycol solution, 30% strength.**
 - 2. The fluid shall be industrially inhibited propylene glycol (phosphate-based).
 - 3. The fluid shall be easily analyzed for glycol concentration and inhibitor level, and easily re-inhibited using inhibitors readily available from the fluid manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. The fluid shall pass ASTM D1384 (less than 0.5 mils penetration per year for all system metals).
5. The fluid shall be dyed bright yellow to aid in leak detection

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS – ABOVE GROUND

- A. Hot Water, NPS 2 and Smaller: Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.
- B. Hot Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded or welded and flanged joints.
- C. Chilled Water, NPS 2 and Smaller: Aquatherm or Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.
- D. Chilled Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded or welded and flanged joints or grooved mechanical-joint couplings.
- E. Makeup water piping, downstream of backflow preventer: Type L, drawn-temper copper tubing.
- F. Drain Lines: 3/4" minimum diameter; PVC or DWV Copper Tubing: ASTM B 306, Type DWV.

3.2 HYDRONIC PIPING APPLICATIONS – BELOW GROUND

- A. Hydronic piping within slabs, use Aquatherm or Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.
- B. Refer to Section 232113.13 for underground piping outside the building

3.3 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 VALVE APPLICATIONS

- A. Hydronic Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Ball and butterfly valves.
 - 2. Throttling Duty: Globe, ball, and butterfly valves.
 - 3. [Shutoffs at PICV's refer to Section 230900, Paragraph 2.7.E.]
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of terminal units [as indicated] [as required to facilitate system balancing].
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.5 HYDRONIC PIPING INSTALLATIONS

- A. Refer to Division 23 Section "Common Work Results for Mechanical" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Refer to Division 23 Section "Common Work Results for Mechanical" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.
- D. Hydronic piping systems shall be provided to permit the system to be drained. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and hose-end fitting with cap, at low points in piping system mains and elsewhere as required for system drainage.
- E. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- F. Pipe size at connections to equipment shall be distribution main size, not connection size.
- G. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- H. Provide dielectric fittings as specified in Section 230500.
- I. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- J. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. [Unions at PICV's specified in Section 230900.]
- K. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- L. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, and elsewhere as indicated or recommended by component manufacturer to have strainer protection.
 - 1. Provide valved drain and hose connection on strainer blow down connection.
 - 2. Install with provisions for service clearance.
 - 3. Remove and clean strainer after 24 hours of operation and after 30 days of operation.

3.6 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."
- B. [Provide seismic restraints in accordance with Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment".]

3.7 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- B. Air separator and expansion tank to be installed on the suction side of the system pumps. Expansion tank to be tied into system piping in close proximity to air separator and system fill line. Install piping to expansion tank with a 2 percent upward slope toward tank.
- C. Install expansion tanks on concrete pad. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements. Do not install drain valve.
- D. Hydraulic Separators:
 - 1. The primary loop shall be purged of air with the secondary terminal loop shutoff valves closed.
 - 2. The primary loop shall be cleaned of debris by starting the primary pumps and continuously circulating water in the primary loop. The system shall be cleaned by frequently cleaning the start-up screens in the primary pump suction diffusers until the screens do not collect any more debris.
 - 3. Once the suction diffuser start-up screens are clean then the shutoff valves to the secondary terminal loops can be opened.
 - 4. The secondary terminal loops shall be purged of air by opening the manual air vents on the terminal units.
 - 5. When the secondary terminal unit piping is purged of air then the circulators can be started.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.8 CONTROL VALVE INSTALLATION

- A. Perform the following as directed by the BAS contractor:
 - 1. Install modulating control valves with minimum of 10 pipe diameters straight pipe at inlet and 5 pipe diameters straight pipe at outlet.
 - 2. Installation of immersion wells and pressure tappings, along with associated shut-off cocks.
 - 3. Installation of flow switches.
 - 4. Setting of automatic control valves or other control devices.
- B. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- C. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- D. Valves shall be installed in accordance with the manufacturer's recommendations.
- E. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- F. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.

3.9 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Arrange piping with offsets to allow for expansion, as well as terminal unit removal.

3.10 CLEANING AND FLUSHING

- A. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet/second if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean.

B. Glycol Loops (chilled water only):

1. Provide glycol feed system per manufacturers recommendations.
2. Provide 30% Provide inhibited propylene glycol. Perform tests determining strength of glycol and water solution and submit written test results.
3. Clean with a 1% to 2% solution of trisodium phosphate in water prior to the installation of industrially inhibited propylene glycol fluid. Use only good quality water in solution with the propylene glycol fluid. Use water with low levels (less than 25 ppm) of chloride and sulfate, and less than 50 ppm of hard water ions (Ca⁺⁺, Mg⁺⁺). Distilled or deionized water is recommended. If good quality water is unavailable, purchase pre-diluted solutions of industrially inhibited propylene glycol fluid from the fluid manufacturer or, if available, from the distributor.
4. Circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

C. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

D. Close and fill system as soon as possible after final flushing to minimize corrosion.

E. Chemical Treatment

1. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.
2. Fill system and perform initial chemical treatment.
3. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
4. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

3.11 FIELD QUALITY CONTROL

A. Prepare piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, un-insulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure but not less than 100 psi. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix-A of ASME B31.9, "Building Services Piping."
4. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
5. Prepare written report of testing.

C. Check expansion tanks to determine that they are not air bound and that system is full of water.

3.12 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
 1. Open valves to fully open position.
 2. Check pump for proper direction of rotation.
 3. Set automatic fill valves for required system pressure.
 4. Check air vents at high points of system and determine if all are installed and operating and bleed air completely.
 5. Set temperature controls so all coils are calling for full flow.
 6. Check operation of automatic bypass valves.
 7. Lubricate motors and bearings.

3.13 CLEANING

- A. Flush piping systems with clean water.
- B. Remove and clean or replace strainer screens.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. After cleaning and flushing hydronic-piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers, and replace with the permanent stainless steel screens.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC"
 - 2. Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment"

1.2 SUMMARY

- A. This Section includes
- B. Hydronic pumps and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

- A. Concrete Bases: Refer to Section 230500.
- B. Coordinate electrical power with Division 26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Hydronic Pumps
 - 1. Taco
 - 2. Armstrong
 - 3. Bell & Gossett ITT
 - 4. PACO
 - 5. Grundfos
 - 6. Patterson
 - 7. Wilo

2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve.
- C. Motors Indicated to be premium efficiency: Refer to Section 230500 for minimum efficiencies.
- D. Motors shall be inverter duty.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.3 IN-LINE PUMPS

- A. Furnish and install horizontal inline centrifugal single stage pumps with the capacities and characteristics as shown on the plans. Pump shall be equal to Grundfos as scheduled on drawings.
1. All pump casings shall be centerline discharge of bronze designed for line mounting. All pumps are to be provided with companion flanges. Units shall have a maximum operating pressure of 175 psig at a maximum operating temperature of 300° F.
 2. Pumps shall have a cast bronze impeller and shall be dynamically balanced. Suction and discharge flanges shall be provided with drilled and tapped gauge ports.
 3. The pump shaft shall be hardened alloy steel with removable cupro-nickel shaft sleeve. If no shaft sleeve is furnished, the shaft shall be stainless steel. Vent and drain openings and a water slinger integral to the shaft sleeve shall be provided between the mechanical seal and bearing area.
 4. Pumps shall have a two piece mechanical seal assembly replaceable without the use of special tools.
 5. Pump shall be furnished with EPT Ceramic seals / EPT Ni-Resist seals rated to 250° F.
 6. Pump shall be furnished with sleeve bearings and a disc type lubrication system with the bearing assembly removable in one piece. One bearing assembly shall be suitable for all size units. Sump oil temperature shall not exceed 180° F when pumping 250° F fluid at 90° F ambient temperature. A dip stick for inspection and a drain plug for draining the oil shall be provided.
 7. A flexible non-metallic coupler shall connect the pump to the motor. Motors shall be oil lubricated resilient mounted NEMA Standard open drip proof (ODP). All single phase motors shall have thermal overload protection.

2.4 VERTICAL PUMPS

- A. Furnish and install centrifugal in-line single stage pumps with capacities and characteristics as shown on the plans.
- B. Vertical Close Coupled Pumps.
1. Pumps shall be equal to Grundfos as scheduled on drawings. The pumps shall be single stage end suction rear pull out design. The seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.
 2. Pump casing shall be constructed of ASTM A48 class 30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided with that pump to allow servicing.
4. The pump shall have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.
5. The impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.
6. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable bronze SAE 660 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.
7. The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. The entire pump line shall use no more than three different sizes of seals.
8. The pump shall be close coupled to a NEMA standard JM frame motor

2.5 PUMP SPECIALTY FITTINGS

- A. Pump Suction Diffuser: Taco RSP; full length straightening vane assembly ensures uniform flow to the suction inlet of the pump; oversized body cylinder ensures minimal pressure drop; metering port allows for the monitoring of system conditions; disposable fine mesh start-up strainer promotes cleaner, more trouble-free system; removable cover plate and reusable “O” ring allows for easy access and maintenance of permanent strainer; blow down port allows for routine maintenance and removal of sediment and debris; ductile iron body; provide the optional magnetic insert to trap small metallic particles; Class 125 flanges or grooved connections.
- B. Pumps without VFD’s shall be fitted with a discharge multi-purpose balancing valve or other means of providing system balance, isolation, and check feature for reverse flow. The valve shall be straight or angle pattern and shall be field convertible between the two. The valve shall be ductile iron and rated for 250 psi working pressure. The valve flanges shall be matched to suit the working pressure of the piping components on the job; with either ANSI class 125 psi flanges or ANSI class 250 flanges. The valve shall include the following components; non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation. Valve shall be serviceable under full system pressure. The valve shall be a Taco model MPV Plus Two multi-purpose valve or equivalent.
- C. Pumps with VFD’s shall have a check valve and shutoff valve instead of the multi-purpose valve.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations for compliance with requirements for installation. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps and equipment according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings. If necessary to meet this requirement, provide additional pipe supports and flex connectors.
- D. Pumps shall **NOT** be run dry to check rotation.

3.3 INLINE PUMPS

- A. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles. Install fittings and specialties as detailed on the plans.
- E. Provide a single gage with three-input selector valve; locate at pump suction and discharge tappings, also strainer.
- F. Install electrical connections for power, controls, and devices. Electrical power and control wiring and connections are specified in Electrical Specification Sections. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.5 COMMISSIONING

- A. Verify that pumps are installed and connected according to the Contract Documents.
- B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- C. Perform the following preventive maintenance operations and checks before starting:
 - 1. Lubricate bearings.
 - 2. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 - 3. Verify that pumps are free to rotate by hand. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
 - 4. Check suction piping connections for tightness to avoid drawing air into pumps.
 - 5. Clean strainers.
 - 6. Verify that pump controls are correct for required application.
- D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
 - 1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
 - 2. Open sealing liquid-supply valves if pumps are so fitted.
 - 3. Start motors with suction valves open and discharge valve closed. Open discharge valves slowly.
 - 4. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
 - 5. Check general mechanical operation of pumps and motors.
 - 6. Follow manufacturers recommended procedures.
- E. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
 - 2. Review data in maintenance manuals.

END OF SECTION 232123

SECTION 233113 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 8 for Access Doors
 - 2. Division 23 Section "Common Work Results for Mechanical"
 - 3. Division 23 Section "Mechanical Insulation"
 - 4. Division 23 Section "Air Terminals"
 - 5. Division 23 Section "Diffusers, Registers, and Grilles."
 - 6. Division 23 Control Section
 - 7. Division 23 Section "Testing, Adjusting, and Balancing".

1.2 SUMMARY

- A. This Section includes metal ducts and accessories for heating, ventilating, and air-conditioning systems.

1.3 SYSTEM DESCRIPTION

- A. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions, which maybe altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
- B. The contractor must comply with the enclosed specification in its entirety. If on inspections, the engineer finds changes have been made without prior written approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.
- C. At the discretion of the engineer, sheet metal gauges, and reinforcing may be randomly checked to verify all duct construction is in compliance.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC

Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", ASCE/SEI 7, and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
 - 3. Seismic-restraint devices.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
- D. Ductwork Specialties Product Data; provide for the following:
 - 1. Sealant
 - 2. Duct Liner
 - 3. Duct-mounted access doors and panels.
 - 4. Flexible ducts.

5. Backdraft dampers.
6. Manual-volume dampers: Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval.
7. Fire dampers: Provide complete submittal information (including installation instructions) and the manufacturer's certification of compliance with these specifications for approval prior to bidding. Contractor shall include damper manufacturer's Installation Instructions as part of the submittal. These instructions shall describe the applicable requirements for damper sleeve thickness, retaining angles, and methods of attachment, duct-to-sleeve connections, preparation of wall or floor openings, and all other requirements to provide an installation equivalent to that tested by the damper manufacturer during the UL Standard 555 qualification procedures. Contractor shall detail any proposed installations that deviate from these manufacturer's instructions and explain the needed deviations.
8. Duct Silencers: The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dimensions, weights, dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer. Silencer performance must have been substantiated by laboratory testing according to ASTM E-477-99 and so certified when submitted for approval.
9. Louvers: Include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals. For units with factory-applied color finishes, provide color chart. Provide product test reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.6 INFORMATIONAL SUBMITTALS

- A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- B. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.8 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

- C. National Fire Protection Association (NFPA):
 - 1. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
 - 2. 96-2008: Ventilation Control and Fire Protection of Commercial Cooking Operations
- D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 1. 3rd Edition: 2005 HVAC Duct Construction Standards, Metal and Flexible
 - 2. 1st Edition: 1985 HVAC Air Duct Leakage Test Manual

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and fire stopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Deliver, store and handle materials according to manufacturer's written recommendations.
- C. All ductwork, equipment, and fittings delivered and stored on the job site must be capped to prevent the entry of moisture, construction dust or other debris.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 or G90 as indicated.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of un-braced panel area, unless ducts are lined. All large ducts must be braced as required to prevent drumming.
- E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fig. 2-3 Rectangular Elbows: Type RE2 square throat with vanes, Type RE1 radius, or Type RE5 dual radius.
 2. Vane support in elbows: Fig 2-4. Turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically. Tab spacing shall be as specified in Figure 2-3 of the 1995 SMACNA Manual, "HVAC Duct Construction Standards, Metal & Flexible" Second Edition standard. Rail systems with non-standard tab spacing shall not be accepted. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer's instructions.
 3. Fig. 2-5 Rectangular Divided Flow Branches: Type 1, Type 2, Type 4A, or 4B.
 4. Fig. 2-6 Branch Connections: 45-degree entry, 45-degree lead-in, bell-mouth or spin-in (single diffuser supply only).
 5. Fig. 2-7 Offsets and Transitions. Use gradual offsets as shown, 90-degree offsets shall be avoided.
 6. Fig 2-9 Duct Coils: Hot water heating coils with transitions and access door as shown.

2.3 ROUND DUCT FABRICATION

- A. Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" latest edition.
- B. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Exposed Round Ducts: Shall be Spiral Seam (RL-1 seam) at 2-inch wg construction.
 - 2. Concealed Round Ducts: Shall be longitudinal Grooved Seam Flat lock (RL-5 seam) at 2-inch wg construction.
 - 3. Snap lock seams shall not be used for this project.
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Supports For Roof Mounted Items:

1. Equipment rails shall be galvanized steel, minimum 18-gauge, with integral baseplate, continuous welded corner seams, factory installed 2x4 treated wood nailer, 18-gauge galvanized steel counter flashing cap with screws, built-in cant strip; minimum height 11 inches. Provide raised cant strip to start at the upper surface of the insulation.
2. Pipe/duct pedestals: Provide a galvanized unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.

2.5 SEALANT MATERIALS

- A. Joint Sealant/Mastic: Shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air and moisture into the duct system. Sealer shall be UL 723 and UL 181 listed and meet NFPA 90A requirements.

1. Maximum 5 flame spread and 0 smoke-developed (ASTM E-84 Tunnel Test).
2. Generally provide liquid sealant for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger.
3. Resistance to mold, mildew and water: Excellent
4. Color: Gray
5. Duct sealant/mastic shall meet requirement for “LEED IEQ Credit 4.1: Low Emitting Materials: Adhesive and Sealant”. ITW TACC Miracle Kingco water-based sealants, or approved equal.

- B. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

- C. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized or ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.7 FITTINGS

- A. Tees, Laterals, and Conical Tees: Use 45 degree; fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Diameters 3 through 8 inches shall be two-section die stamped; all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
- D. Low-point drains: Ductmate moisture drain with funnel collection design; 3/4" connection with drain fitting and cap.

2.8 LOUVERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ruskin Company
 - 2. American Warming and Ventilating, Inc.
 - 3. Arrow United Industries.
 - 4. Cesco Products.

5. Construction Specialties, Inc.
 6. Greenheck.
- B. Louvers shall be AMCA Licensed. Louvers shall comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- C. Extruded Aluminum Stationary Louvers
1. Provide minimum free area and performance as scheduled.
 2. Construction: 6063-T5 extruded aluminum alloy construction, drainable blades, factory-assembled, all-welded, drain gutters in head frame and each blade; downspouts in jambs to drain water from louver for minimum water cascade from blade to blade; hidden vertical supports to allow continuous line appearance up to 120 inches; steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.
 3. Based on Ruskin ELF375DX, or approved equal; 4 inch depth, 0.081" frame and blade wall thickness, 37.5 degree angles blades, 5-3/32" blade centers.
 4. Based on Ruskin ELF6375DX, or approved equal; 6 inch depth, 0.081" frame and blade wall thickness, 37.5 degree angles blades, 5-29/32" blade centers.
 5. Bird Screen: aluminum, 1/2" mesh, removable frame, re-wireable.
 6. Louver Finish
 - a. Standard mill finish.
 - b. Prime Coat: Louvers shall receive prime coating following thorough cleaning and pretreatment of metal. Field topcoat with epoxy, vinyl, urethane or other heavy-duty coating within six months of application. Prime coat shall be a minimum of .3 ± .1 mils thick.
 - c. Clear Anodize Finish: Louvers shall receive a 204-R1 clear anodize finish complying with Aluminum Association Code AA-C22A31. Finish shall be applied to chemically etched and pretreated aluminum to 0.4 mils minimum surface depth by a 30 minute anodizing process. Louvers shall receive a 215-R1 clear anodize finish complying with Aluminum Association Code AA-C22A41. Finish shall be applied to chemically etched and pretreated aluminum to 0.7 mils minimum surface depth by a 60 minute anodizing process.
 - d. Baked Enamel Finish: Louvers shall receive factory applied, baked-on 50% Kynar or Hylar based color coating following thorough cleaning and pretreatment of metal. The finish shall be applied at 1.2 mils total dry film † thickness in accordance with AAMA 2604-98 Section 4.2 and 4.3. Color shall be RUSKIN (specify color name and number).
 - e. Premium Kynar Paint Finish: Before paint application, louvers shall be thoroughly cleaned and pretreated. Cleaning includes complete submersion in alkali cleaner, detergent deoxidization, amorphous chrome phosphate conversion ® ® coating and acidulated final rinse. Kynar 500 or Hylar 5000 finish shall be applied to provide 1.2 mils factory applied, baked-on film build in accordance with AAMA 2605-98* "Voluntary Specification Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Architectural Extrusions and Panels". Color shall be RUSKIN as selected by the Architect.

7. Accessories
 - a. Aluminum Insect Screen

2.9 MANUAL-VOLUME DAMPERS

- A. Manual balancing dampers meeting the following specifications shall be furnished and installed on all branch ducts and where shown on plans. Testing and ratings to be in accordance with AMCA Standard 500-D.
- B. Single-Blade Rectangular Dampers shall consist of: an 18 ga. galvanized steel frame with 3-1/2 in. depth; blades fabricated from 20 ga. galvanized steel; integral 1/2 in. dia axles. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD-10.
- C. Multi-Blade Rectangular Dampers shall consist of: a 16 ga. galvanized steel hat channel frame with 5 in. depth; triple V type blades fabricated from 16 ga. galvanized steel; 1/2 in. dia. plated steel axles; external (out of the airstream) blade-to-blade linkage. Damper suitable for pressures to 4.0 in. w.g. (996 Pa), velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD15.
- D. Round dampers shall consist of: a 20 ga. galvanized steel frame with 6 in. depth; blades fabricated from 20 ga. galvanized steel; 3/8 in. square plated steel axles turning in acetal bearings. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBDR50.

2.10 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Air Balance Inc.
 2. Cesco Products
 3. Greenheck Fan Corporation.
 4. METALAIRE, Inc.
 5. Nailor Industries Inc.
 6. Prefco
 7. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555S by an NRTL.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- J. Provide the grille option for curtain style fire dampers provides mounting flanges on the sleeve to ease installation of grilles in the field (Grilles specified in Section 233713). The flanges shall be made out of 20 gauge galvanized steel (3/4 inch x 2 in. long) with .149 in. diameter hole for fastening of grille. The flanges are concealed when the grille is installed.

2.11 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. McGill Air Flow LLC.
 - 4. Nailor Industries Inc.
 - 5. Cesco
 - 6. Buckley
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular; rated for up to 4.5" static pressure.
 - b. Door panel filled with 1" fiberglass insulation; ¾ lb. density.
 - c. Hinges and Latches: 1-by-1-inch continuous piano hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs.
 - 3. Provide 1/8" thick neoprene gaskets.
 - 4. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two cam locks.

- b. Access Doors up to 24 Inches Square: One hinge and cam locks.
- c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches

2.12 FLEXIBLE CONNECTORS

- A. Provide for all air moving equipment. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 0 or 1. Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts. Duro-Dyne, Hardcast, or approved equal.
- B. Indoor Flexible Connector Fabric: Glass fabric double coated with polychloroprene or neoprene. Minimum Weight: 26 oz. /sq. yd. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.
- C. Outdoor Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber or hypalon, white color; weatherproof coating resistant to the sun's ultraviolet rays and ozone environment. Minimum Weight: 24 oz. /sq. yd. Tensile Strength: 530 lbf/inch in the warp, and 440 lbf/inch in the filling.

2.13 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 0 Or 1. Flame Spread: Less than 25; Smoke Developed: Less than 50.
- B. All products shall be certified by Greenguard Environmental Institute; independent testing of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Greenguard provides independent, third-party certification of IAQ performance. Certification is based upon criteria used by EPA, OSHA and WHO.
- C. Rated Positive Pressure: 10" w.g. per UL-181. Maximum negative pressure: 3/4".
- D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass-fiber insulation around a continuous inner liner.
 - 1. Thickness: 1", R4.2, Basis of Design: Atco #80
 - 2. Reinforcement: Steel-wire helix encapsulated in inner liner.
 - 3. Outer Jacket: Polyethylene film.
 - 4. Inner Liner: Polyethylene film.
- E. Flexible Ducts, Un-insulated: A triple lamination of metallized polyester, aluminum foil, and polyester shall encapsulate a steel wire helix. Basis of Design: Atco #50
- F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- G. Hangers shall be band type, 1" wide minimum.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts and accessories according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Construct and install each duct system for the specific duct pressure classification indicated.
- D. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.
- E. Install ducts in lengths not less than 12 feet, unless interrupted by fittings. Install ducts with fewest possible joints.
- F. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- G. Install couplings tight to duct wall surface with a minimum of projections into duct.
- H. Install ductwork to allow maximum headroom. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- K. Coordinate layout with suspended ceiling, lighting layouts, and similar finished work.
- L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Hangers Exposed to View: Threaded rod and angle or channel supports.

- C. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- D. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- E. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- F. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 MATERIALS

- A. Hangers, accessories, and dampers shall be same material as parent duct.
- B. Refer to Specification Section 230700 for sheet metal covering of rigid insulation for protection from maintenance personnel crossing insulated ductwork in mechanical spaces.
- C. All ducts shall be G60 galvanized steel except as follows:
 - 1. Un-insulated exterior ductwork: G90 galvanized steel.
 - 2. Exterior ductwork: Hangers and attachments shall be electro-galvanized, all-thread rod or galvanized rods with threads painted after installation. Refer to SMACNA Fig. 5-3. All ductwork shall be pitched or sloped to prevent “ponding” of water.
 - 3. Exposed Ductwork: Galvaneal (ready for paint)
 - 4. Range Hood Exhaust Ducts: Comply with NFPA 96.
 - a. Concealed: Carbon-steel sheet; 16-gauge minimum thickness.
 - b. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
 - c. Weld and flange seams, joints, and penetrations.
 - 5. Plenums at outside louvers: G90 galvanized steel, water-tight, pitched to drain. Provide low-point drain fittings at low points.
 - 6. Locker Room Shower area exhaust ductwork: Aluminum
 - 7. Supply, return, and recirculated air ductwork connected to inlet or outlet devices installed in surgical operating, surgical scrub-up, surgical recovery and surgical work rooms. Use AISI Type 302 or 304 stainless steel.

3.4 DUCT CLASSIFICATIONS AND SEALING

- A. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:
 - 1. Supply duct upstream of VAV terminal units: 3 in. w.g.
 - 2. Supply Ducts downstream of VAV terminal units: 2-inch wg.
 - 3. Return Ducts: 2-inch wg, negative pressure.
 - 4. Exhaust Ducts: 2-inch wg, negative pressure.

5. Rooftop air handlers and RTU's: The first 20 feet of ductwork (supply and return) shall be fabricated and installed in a stiff and rigid manner, with cross bracing for minimal "drumming"; minimum 6-inch pressure class.

B. Seam And Joint Sealing

1. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
2. Seal to SMACNA Class A; all joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, or duct sealant. Exceptions:
 - a. Continuously welded and locking-type longitudinal joints and seams on ducts operating at less than 2 in. wg pressure classification.
 - b. Exposed exhaust or return ducts operating at less than 2 in. wg pressure classification.
 - c. Exposed supply ducts in the space that the duct serves.
3. Seal externally insulated ducts before insulation installation.

3.5 DUCT PENETRATIONS

- A. Fire or Smoke Rated Penetrations not requiring a fire and/or smoke damper: Where ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and fire dampers are not required, the opening in the construction around the duct shall be as follows:
 1. Not exceeding a 1" average clearance on all sides.
 2. Filled solid with firestopping material as specified in Section 230500.
- B. Fire-Rated Penetrations – Fire Damper: Provide fire damper as specified under Duct Accessories paragraph.
- C. Smoke-Rated Penetrations – Smoke Damper: Provide smoke damper as specified under Duct Accessories paragraph.
- D. Non-Fire-Rated Exposed Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
- E. Non-Fire-Rated Concealed Penetrations: Provide insulation infill and acoustical sealant around gaps. Tightly seal to prevent sound transmission. Neatly finish.
- F. Mechanical room floor penetrations: Provide 4-inch high concrete curbs or other sealing method to prevent leakage from mechanical room into floor penetration.
- G. Roof penetrations by ducts shall use counter-flashed curbs.
- H. Flexible air ducts or connectors shall not pass through any wall, floor, or ceiling.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension,

3.7 FLEXIBLE DUCT

- A. Provide in accordance with manufacturer's and Air Diffusion Council recommendations.
- B. Flexible ducts shall be supported at manufacturer's recommended intervals, but at no greater distance than 5 feet. Maximum permissible sag is 1/2" per foot of spacing between supports.
- C. Install duct fully extended; do not install in the compressed state or use excess lengths.
- D. Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes, conduits, or hot equipment. Radius at centerline shall not be less than one duct diameter.
- E. Hanger or saddle material in contact with the duct shall be at least 1-1/2" wide.
- F. Provide at least 2 duct diameters of straight duct at the entrance to register, grilles, and diffusers.

3.8 DUCT ACCESSORIES INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible".

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards
- C. Each register, grille, or diffuser shall have a means of air flow adjustment. Provide volume damper in branch duct if not furnished with the RGD.
- D. Adjust operable devices for proper action.

- E. Perform the following as directed by the controls contractor:
 - 1. Installation of:
 - a. Automatic control dampers.
 - b. Smoke control dampers.
 - c. Smoke detectors.
 - d. Necessary blank off plates.
 - 2. Access doors where indicated and as required.
- F. Install duct access panels for access components that require servicing.
 - 1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining per equipment manufacturers' requirements.
 - 2. Install access panels on side of duct where adequate clearance is available.
 - 3. Locate panel upstream and/or downstream as recommended by manufacturer.
 - 4. Locations:
 - a. On both sides of duct coils.
 - b. Upstream from duct filters.
 - c. At outdoor-air intakes and mixed-air plenums.
 - d. At drain pans and seals.
 - e. Downstream from control dampers and equipment.
 - f. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - g. Control devices requiring inspection.
 - h. Elsewhere as indicated or required by duct accessory manufacturer
 - 5. Inspect locations of access doors and verify that purpose of access door can be performed.
- G. Control Damper Installation
 - 1. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.

2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
3. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 1/8 in. of each other.
4. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
5. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
6. Provide a visible and accessible indication of damper position on the drive shaft end.
7. Support ductwork in area of damper when required to prevent sagging due to damper weight.
8. After installation of low-leakage dampers with seals, caulk between frame and duct opening to prevent leakage around perimeter of damper.

H. Fire Damper Installation

1. Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected
2. Install dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.
3. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.
4. Install dampers square and free from racking.
5. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.
6. Do not compress or stretch the damper frame into the duct or opening.
7. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.
8. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.
9. Tests and Inspections: Operate dampers to verify full range of movement and verify that proper heat-response device is installed.

3.9 LOUVER INSTALLATION

- A. Louvers to be furnished by Division 23; mounted and installed by the contractor responsible for the outside wall construction. Ductwork shall be connected to the louvers by Division 23.
- B. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings. For new construction, or where field measurements cannot be made without

delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

C. Installation

1. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
2. Pitch horizontal ducts and plenums connected to louvers downward toward louvers not less than 1 inch in 10 feet. Connect to louver to allow drainage to exterior. Seal duct water-tight.
3. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
4. Form closely fitted joints with exposed connections accurately located and secured.
5. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
6. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
7. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather tight louver joints are required.

D. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

E. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

3.10 FIELD QUALITY CONTROL

- A. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- B. HVAC systems shall not be operated during construction.
- C. Upon completion of installation duct systems and before HVAC system start-up, visually inspect the ductwork proper installation
- D. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork. Turn the HVAC system on and allow it to run until steady state operation is reached. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. All ductwork shall be provided with temporary enclosures to keep the HVAC system free of dust and construction debris. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire duct from the points where the air enters the system to the points where the air is discharged from the system.
- F. Check all filters in accordance with their manufacturer's instructions. Use specified grade of filters at all times that system is operating.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Outdoor Air Ducts: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - b. Ducts with a Pressure Class 3-Inch wg or higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 233113

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC"
 - 2. Division 23 Controls Section for control devices installed on air terminals.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single-duct air terminals.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.
- C. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- E. Maintenance Data: List of parts for each type of air terminal and troubleshooting maintenance guide.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."
- D. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- E. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- F. Comply with NFPA 70 for electrical components and installation.

PART 2 - PRODUCTS

2.1 AIR MONITORING STATION WITH INTEGRAL CONTROL DAMPER

A. Manufacturer

1. Ruskin Manufacturing, AMS 050.

B. Fabrication:

1. Model: AMS50.
2. Frame: Nominal 4 inches x 1 inch x minimum 0.081 inch (102 x 25 x minimum 2 mm) 6063-T5 extruded aluminum channel control damper frame. Mounting flanges on both sides of frame.
3. Blades:
 - a. Control Damper: Airfoil-shaped, heavy gage, 6063-T5 extruded aluminum.
 - b. Airflow Monitoring: Airfoil-shaped, heavy gage, anodized 6063-T5 extruded aluminum. Fixed in 10 inches x minimum 16 gage (254 x minimum 1.5 mm) galvanized steel frame.
4. Seals:
 - a. Jamb: Flexible metal compression type along control damper sides.
 - b. Blade: Ruskiprene seal along control damper blade edges.
5. Bearings: Molded synthetic.
6. Linkage: Galvanized steel, concealed in frame.
7. Axles: Minimum 1/2 inch (13 mm) diameter plated steel, hex-shaped, mechanically attached to blade.
8. Operating Temperature: -22 to 140 degrees F (-30 to 60 degrees C).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

9. Air Straightener Section: 3000 series aluminum alloy honeycomb. Contained in 5 inches (127 mm) long, 16 gage (1.5 mm) galvanized steel sleeve attached to monitoring blade frame. Flanged as required.
10. Mounting Style: Flanged.
11. Finish: Galvanized.
12. Assembly: Factory assemble air monitoring station, actuator, options, and accessories.

C. Performance Data:

1. Airflow Range: 400 to 5,000 feet per minute (122 to 1,524 m/min) face velocity.

D. ACTUATOR

1. Electric actuator provided under Section 15900, Automatic Temperature Controls. Coordinate as required for field mounting of Johnson Controls VMA controller.

2.2 SINGLE-DUCT AIR TERMINALS

A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:

1. Trane
2. Carrier Corp.
3. Environmental Technologies.
4. Price
5. Metal Aire
6. Krueger

B. All terminal units shall be ARI 880 - 98 certified and UL Listed.

C.

D. The unit casing shall be comprised of 22 gauge galvanized steel. Outlet connection shall be slip and drive. Basis of Design: Trane VariTrane Single-Duct VCCF – Cooling Only or Trane VCWF – With Hot Water Coil

E. Casings: 22 gauge galvanized steel. Maximum casing leakage: 7 cfm at 1-inch wg inlet static pressure.

F. The interior surface of the unit casing shall be acoustically and thermally lined with 3/8-inch, 4.4 lb/ft³ closed-cell insulation. The insulation shall be UL listed and meets NFPA-90A and UL 181 standards. The insulation shall have an R-Value of 1.4. There shall be no exposed edges of insulation (complete metal encapsulation).

G. The air inlet connection shall be an 18 gauge galvanized steel cylinder sized to fit standard round duct. A multiple point, averaging flow sensing ring shall be provided with balancing taps for measuring within +/- 5% of unit cataloged airflow. Airflow versus pressure differential calibration chart shall be provided. The damper blade shall be constructed of a closed cell foam

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

seal mechanically locked between two 22 gauge galvanized steel disks. The damper blade assembly shall be connected to a cast zinc shaft supported by self lubricating bearings. The shaft shall be cast with a damper position indicator. The valve assembly shall include a mechanical stop to prevent over stroking. At 4.0" wg air valve leakage does not exceed 1% of cataloged airflow.

H. Accessories

1. Attenuator Section: Line with 2-inch- thick, neoprene- or vinyl-coated, fibrous-glass insulation.
2. 2 Row Water Coil: Factory mounted on outlet. Provide full fin collars provided for accurate fin spacing and maximum fin-tube contact. The seamless copper tubes shall be mechanically expanded into the fin collars. Coils shall be proof tested at 450-psi and leak tested at 300-psi air pressure under water. Coil connections shall be sweat with left hand or right hand coil connections as per field constraints. Coils shall be provided with an access for cleaning.
3. A 50 VA transformer shall be factory mounted in an enclosure with 7/8" knockouts to provide 24 VAC for controls.

I. Controls

1. The terminals will have pressure independent direct digital controls supplied and mounted by the control contractor.
2. Terminals shall be furnished with a pneumatic inlet velocity sensor. The sensor shall be multi-point center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03" wg. at an inlet velocity of 500 fpm.
3. Flow measuring taps and flow curves shall be supplied with each terminal for field balancing airflow.
4. All pneumatic tubing shall be UL listed fire retardant (FR) type.
5. Each terminal shall be equipped with labeling showing unit location, size, and scheduled cfm.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards.
- B. Allow adequate clearance to meet NEC on control box side of unit to meet NEC.
- C. Support in accordance with SMACNA and manufacturer recommendations.
- D. Connect ductwork to air terminals according to Division 23 ductwork Sections. Slip each inlet duct over the inlet collar of the terminal. Fasten and seal the connection airtight. The diameter of the inlet duct must be equal to the listed size of the terminal; e.g. a duct that actually measures 8 inches must be fitted to a size 8 terminal.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Inlet and outlet duct must be installed in accordance with SMACNA guidelines. Provide a minimum of 2.5 equivalent duct diameters of straight duct at the inlet.

3.2 CONNECTIONS

- A. Install piping adjacent to air terminals to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Electrical: Comply with applicable requirements in Division 16 Sections. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.5 COMMISSIONING

- A. Verify that installation of each air terminal is according to the Contract Documents.
- B. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.
- C. Check that controls and control enclosure are accessible.
- D. Verify that control connections are complete.
- E. Check that nameplate and identification tag are visible.
- F. Verify that controls respond to inputs as specified.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance. Review data in the maintenance manuals. Refer to Division 1.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC"
 - 2. Division 23 Section "Ductwork"
 - 3. Division 23 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers, and grilles.

1.2 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.3 DEFINITIONS

- A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.
- C. Register: A combination grille and damper.

1.4 SUBMITTALS

- A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Owner's representative of problems prior to shop drawing submittal.
- B. Pressure drop, airflow and noise criteria selection is based on design equipment. Manufacturers not submitting design makes must provide written certification in front of submittal that equipment submitted has been checked against and performs equal to the design make.
- C. Product Data: For each model indicated, include the following:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
- D. Coordinate locations with reflected ceiling plans and wall elevations as applicable.
- E. Coordinate mounting frame with associated mounting surface.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."
- C. Sound pressure levels shall be determined by using AHRI Standard 885-2008 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Outlets".

PART 2 - PRODUCTS

2.1 GENERAL

- A. Diffusers, registers, and grilles are scheduled on Drawings.
- B. Mounting type shall match the mounting surface. Coordinate with mounting conditions.
- C. Material shall match the specified ductwork. Coordinate with Section 233113 "Ductwork".
- D. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- E. Grilles shall be finished in White Powder Coat, unless noted otherwise.
- F. Manufacturers
1. Price
 2. Titus
 3. Metal-Aire
 4. Anemostat
 5. Nailor

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.2 RETURN OR EXHAUST

- A. Return/Exhaust Grille, 45-degree deflection
 - 1. Material: steel (Price 530 Series) or aluminum (Price 630 Series)
 - 2. Provide damper as scheduled.
 - 3. Grilles of the sizes indicated on the plans. Grilles shall be 45 degree deflection fixed louver type with blades spaced 3/4" on center. The blades shall run parallel to the long dimension of the grille.

2.3 SUPPLY

- A. Square ceiling diffusers, Fixed pattern
 - 1. Material: steel (Price Model SCD) or aluminum (Price Model ASCD)
 - 2. Diffusers shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.
 - 3. The diffuser shall integrate with all duct sizes shown on the plans without affecting the face size and appearance of the unit. An inner cone assembly shall consist of 3 cones (or optional 4 cones) which drop below the ceiling plane to assure optimal VAV air diffusion performance.
 - 4. The inner cone assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.

2.4 OPERATING ROOM AIR SYSTEM

- A. Supply and install Price HORD air systems in each operating room of the sizes and capacities as indicated on the drawings or diffuser schedule.
- B. Each operating room air system shall consist of modular slot diffusers which shall provide a protective air curtain around the operating area and laminar flow diffusers which shall provide a supply of sterile air over the operating table area.
- C. The slot diffuser, Model HORD, and laminar flow diffuser, Model LFD, shall be of aluminum construction.
- D. The slot diffusers shall consist of a .064" aluminum plenum with continuous welded joints and radiused corners to facilitate cleaning, extruded aluminum frames, formed aluminum diffuser face with two slots and fixed pattern deflectors. Plenums shall have formed aluminum inlet collars complete with dampers, removable from plenum face. The removable dampers shall be opposed blade type of stainless steel construction. Damper shall be adjusted without removing face of HORD. The diffuser face shall be attached by quick-release fasteners and safety cable for easy removal and replacement. Entire plenum and diffusers shall have a B11 Sterile White - Thermal Setting finish which meets special requirements for hospital use and will be subjected to regular cleaning with high concentration cleaning solutions and agents for sterilization purposes.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. The laminar flow diffusers, Model LFD, shall have components of aluminum and plated steel to inhibit corrosion. The perforated face plate, perforated damper deflector using interior baffles and diffuser back pan plenum assembly shall be of 0.040" aluminum. The volume control damper shall be a steel construction full flow type damper. The perforated face plate shall open easily with 1/4 turn fasteners and safety cable for damper adjustment and cleaning. Diffusers shall have a B11 Sterile White - Thermal Setting finish which will withstand cleaning with high concentration cleaning solutions and agents.
- F. Return Grilles: The hospital operating room return grilles shall be of stainless steel construction. The core of the return grille will consist of 45-degree louvers, 3/4" on center (Price model 730H). The grille border shall have a #4 finish. The grille shall use quick-release fasteners to mount to a separate stainless steel wall mounting frame, provided with the unit, thereby allowing easy removal for cleaning. Volume dampers shall be opposed blade-type constructed of stainless steel.
 - 1. Bottom of grilles shall be approximately 8" AFF (per ASHRAE 170-2008).
- G. Performance: The operating room system shall consist of the above mentioned air curtain system, laminar flow diffuser and low level exhaust registers/grilles and shall, when in operation, provide a zone of air which exceeds the American College of Surgeons requirements for Class I at the work site.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- B. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connection to ducts.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.
- B. Adjustable outlet diffuser: adjust pattern for draft-free air distribution.

3.4 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes packaged, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
- C. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. Heat Exchanger: 10 years from date of Substantial Completion.
 - b. Heat-Exchanger Corrosion: Non-prorated for ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONDENSING BOILERS

Manufacturer: Viessmann Vitodens to match existing.

- A. Boilers shall be capable of full modulation firing down to 20% of rated input with a turndown ratio of 5:1. Boilers shall be constructed in accordance with State of Maine requirements.
- B. Boilers shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The 316L stainless steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly.
- C. Boilers shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. Boilers shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the BTS2000 Standard. Boilers shall operate at a minimum of 93% thermal efficiency at full fire. All models shall operate up to 98% thermal efficiency with return water temperatures at 100°F or below. Boilers shall be certified for indoor installation. Boiler Thermal Efficiency shall be verified through third party testing by the Hydronics Institute Division of AHRI and listed in the AHRI Certification Directory.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Boilers shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. Boilers shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. Boilers shall operate in a safe condition at a de-rated output with gas supply pressures as low as 4 inches of water column.
- E. Boilers shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. Boilers shall be equipped with; a temperature/pressure gauge, high limit temperature control certified to UL353, ASME certified pressure relief valve, outlet water temperature sensor, return water temperature sensor, a UL 353 certified flue temperature sensor, outdoor air sensor, low water flow protection and built-in adjustable freeze protection.
- F. Boilers shall feature an integral control with a Multi-Colored Graphic LCD display with Navigation Dial and Soft Keys for, password security, three loop temperature setpoints with individual outdoor air reset curves, pump delay with adjustable freeze protection, pump exercise, domestic hot water prioritization with DHW modulation limiting and USB PC port connection. Boilers shall have the capability to accept a 0-10 VDC input connection for plant controller automation for modulation or setpoint, enable/disable of the boiler, variable system pump signal and a 0-10VDC output of boiler modulation rate. Supply voltage shall be 120 volt / 60 hertz / single phase.
- G. Boilers shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 42 data points for safety and operating controls, i.e., Auxiliary Relay, Auxiliary Proving Switch, Alarm Contacts, Runtime Contacts, Manual Reset Low Water Cutoff, Flow Switch, High and Low Gas Pressure Switches, Tank Thermostat, Three Wall Thermostat/Zone Controls, System Supply Sensor, Outdoor Sensor, Building Management System Signal, Modbus Control Contacts and Cascade Control Circuit. A high voltage terminal strip shall be provided for supply voltage. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump.
- H. Boilers shall be installed and vented with a Vertical Direct Vent system with a vertical termination of both the vent and combustion air. The flue vent and combustion air shall terminate above the roof using manufacturers specified vent termination. The boiler's total combined air intake and flue vent length shall not exceed manufacturer's specifications.
- I. Boilers shall have an independent laboratory rating for Oxides of Nitrogen (NO_x) of 20 ppm or less corrected to 3% O₂. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.
- J. Boilers shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

K. Provide Options:

1. Concentric Vent Kit
2. Condensate Neutralization Kit
3. Low Water Cutoff w/Manual Reset & Test
4. The Firing Control System shall meet CSD-1 and FM requirements.

2.2 BOILER PLANT CONTROLLER – CASCADE CONTROL

- A. The new boilers shall interface with the existing boiler plant controller such that the entire plant operate as one, providing cascading control with domestic water prioritization for all 5 heating boilers. The entire plant control system shall include provisions for integration with the facility BAS system, via Bacnet interface card.
- B. Each boiler shall run subject to its own internal safeties and controls.
- C. Upon a call for heat, the boiler controller shall turn on the appropriate pumps (boiler pump for space heating call; DHW pump for DHW call).
- D. For space heating, the temperature control will be based on a system supply sensor. The boiler controller is programmed at the factory to control the temperature of the outlet sensor. The control will automatically switch to the system supply sensor once it is connected.
- E. Cascade Control (Note: much of this sequence is part of the boilers' cascade control system. Provide wiring, sensors, devices, piping, and other components for a complete and functioning system.)
 1. The boilers will be wired together in a cascade sequence. In this application one boiler will be designated as the Leader control and all others will be designated as Member controls. Once the Leader boiler receives a call for heat from a room thermostat, the control will determine what the set point will be.
 2. Outdoor air reset shall be controlled by the boiler controller. Provide a signal from a sun-shielded outside air temperature sensing element and transmitter. Connect the outdoor air sensor to the terminals on the Low Voltage Connection Board on the Leader boiler. The set point will be calculated based on the programmed reset curve parameters.
 3. If the water temperature at the system supply sensor is less than the set point + the turn-off offset - the off-on differential, then the control will initiate a call for heat on the Cascade. The Leader will energize the lead boiler on the Cascade. For a new startup this will be the Leader boiler. The boiler will fire at its ignition speed and will then modulate its firing rate to maintain the set point. If the first boiler reaches 100% of its firing rate, the Leader will calculate at what point the second boiler could fire at 20% of its firing rate. At this point, the Leader will fire the second boiler on the Cascade. For a new startup, this would be the first Member boiler. The boiler will fire at its ignition speed and will then modulate its firing rate to maintain the set point. If the set point still cannot be met, the Leader will continue firing more Members until either the heat demand is met or all boilers on the Cascade are firing.
 4. As the heat demand decreases, the last boiler on will modulate down to 20% of its firing rate. Once the demand for that boiler is zero, it will shut down. As the heat demand decreases further, the second to last boiler will modulate down and shut off. This will continue until the demand is satisfied and all boilers are shut off.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

5. To equalize the run time of all boilers on the Cascade, the firing sequence will automatically be changed at set intervals (change every 24 hours).
6. The boiler controller DHW Mode is programmed to heat an indirect domestic hot water tank. For DHW operation any boilers in the Cascade can be selected to provide heat for a DHW call. B-1 is designated as the DHW boiler. Connect the DHW thermostat to the terminals on the Low Voltage Connection Board marked for the DHW Thermostat. When the boiler receives a DHW call, the Leader control will take that boiler out of the Cascade sequence. If another boiler is available, the Leader will start it up to take its place.
7. The DHW boiler will adjust its set point to the programmed DHW set point and will adjust its firing rate to maintain this. Once the DHW call has been satisfied, the Leader control will place that boiler back into the Cascade sequence.
8. Switching of the boiler between DHW operation and space heating operation when there is a call for both does not occur. The boiler will provide heat for the DHW demand until it is satisfied.
9. Night Setback operation of the boilers within the Cascade shall be provided. Programming of the Night Setback shall be done through the Leader boiler.

F. Operator Workstation: Display the following data:

1. Outside temperature.
2. Heating-water supply & return temperatures.
3. Heating-water supply temperature set point.
4. Boiler status/alarm for each boiler.
5. Domestic hot water generation pump status/failure
6. Domestic hot water supply to building temperature
7. Pumps status/failure
8. System pumps VFD status
9. System pumps VFD fault
10. System pumps VFD Hz.

2.3 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Install gas-fired boilers according to NFPA 54 and NFPA 58. Boilers will fire LP gas initially, easily convertible for operation on natural gas in the first year of operation.
- B. Assemble and install boiler trim.

3.3 BOILER PLANT WIRING

- A. Gas-fired boilers shall be wired in accordance with NFPA 54 requirements.
- B. Wire the cascade controls in accordance with manufacturer's recommendations. Coordinate work with Section 230993.
- C. Install electrical devices furnished with boiler but not specified to be factory mounted.
- D. Install control wiring to field-mounted electrical devices.
- E. A flow switch is used to guarantee flow through the boiler before allowing it to fire. The flow switch shall be installed at the boiler outlet.
- F. Ground equipment according to Division 26 requirements.
- G. Connect wiring according to Division 26 requirements.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Provide pressure regulator to provide proper gas pressure to boilers. Provide straight piping at inlet and outlet of pressure regulator.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Connect ½” PVC drain piping to the boiler, rout to the neutralizer kit. Install the 1/2 inch PVC tee assembly (shipped with the unit). Leave the top of the 1/2 inch tee open. This is needed as a vacuum break. Pipe to the nearest floor drain.

3.5 INSTALLATION OF VENTS

- A. Provide in accordance with manufacturers’ recommendations.
- B. All joints must be sealed. Provide cementing as per CPVC manufacturer’s and boiler manufacturer’s recommendations.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Pitch venting toward boiler at ¼” per foot to allow for drainage of condensate.
- E. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes. Clean vents internally, during and after installation, to remove dust and debris
- F. Provide temporary closures at ends of vents and chimneys that are not completed or connected to equipment.

3.6 FIELD QUALITY CONTROL

- A. Thoroughly flush the system (without boiler connected) to remove sediment.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and [water temperature] [steam pressure].

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Prepare test and inspection reports.
- G. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- H. Performance Tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.
 - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 - 7. Notify Architect in advance of test dates.
 - 8. Document test results in a report and submit to Architect.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 1 "Demonstration and Training."

END OF SECTION 235216

SECTION 236426 – AIR COOLED WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Packaged, air-cooled chillers.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
- E. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW) at any given set of rating conditions.
- F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Site Altitude: Chiller shall be suitable for altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
1. Performance at ARI standard conditions and at conditions indicated.
 2. Performance at ARI standard unloading conditions.
 3. Minimum evaporator flow rate.
 4. Refrigerant capacity of chiller.
 5. Oil capacity of chiller.
 6. Fluid capacity of evaporator.
 7. Characteristics of safety relief valves.
 8. Fluid capacity of condenser.
 9. Minimum entering condenser-fluid temperature.
 10. Performance at varying capacities with constant-design entering condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F (3 deg C) increments.
 11. Minimum entering condenser-air temperature.
 12. Maximum entering condenser-air temperature.
 13. Performance at varying capacities with constant-design entering condenser-air temperature. Repeat performance at varying capacities for different entering condenser-air temperatures from design to minimum in 10 deg F (6 deg C) increments.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Structural supports.
 2. Piping roughing-in requirements.
 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
- D. Source quality-control reports.
- E. Startup service reports.
- F. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
- G. Warranty: Sample of special warranty.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 QUALITY ASSURANCE

- A. ARI Certification: Certify chiller according to ARI 550 and ARI 590 certification programs.
- B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.
- C. ASHRAE Compliance:
 - 1. ASHRAE 15 for safety code for mechanical refrigeration.
 - 2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- E. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.
- F. Comply with NFPA 70.
- G. Comply with requirements of UL and UL Canada and include label by a qualified testing agency showing compliance.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
- B. Ship each oil-lubricated chiller with a full charge of oil.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.
 - 1. Extended warranties include, but are not limited to, the following:
 - a. Complete chiller including refrigerant and oil charge.
 - b. Parts and labor.
 - c. Loss of refrigerant charge for any reason.

2. Warranty Period: [**Two**] [**Five**] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED AIR-COOLED CHILLERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. Trane
 2. Carrier Corporation; a United Technologies company.
 3. Dunham-Bush.
 4. McQuay International.
 5. YORK International Corporation.
- B. **General:** Units shall be leak and pressure tested at 390 psig high side, 250 psig low side, then evacuated and charged. Chillers shall be factory tested prior to shipment. Packaged units ship with a full operating charge of oil and refrigerant. Unit panels, structural elements and control boxes shall be constructed of galvanized steel and mounted on a welded structural steel base. Unit panels and control boxes shall be finished with a baked on powder paint, and the structural base with an air-dry paint. All paint shall meet the requirement for outdoor equipment of the US Navy and other federal government agencies.
- C. **Evaporator:** The evaporator is a tube-in-shell heat exchanger design with internally and externally finned copper tubes roller expanded into the tube sheet. The evaporator is designed, tested and stamped in accordance with ASME for a refrigerant side working pressure of 200 psig. The evaporator is designed for a water side working pressure of 150 psig. Water connections shall be grooved pipe. Each shell includes a vent, a drain and fittings for temperature control sensors and is insulated with 3/4-inch equal insulation (K=0.26). Evaporator heaters with thermostat shall be provided to help protect the evaporator from freezing at ambient temperatures down to -20°F.
- D. **Condenser and Fans:** Air-cooled condenser coils have aluminum fins mechanically bonded to internally-finned seamless copper tubing. The condenser coil has an integral subcooling circuit. Condensers shall be factory proof and leak tested at 506 psig. Direct-drive vertical discharge condenser fans shall be dynamically balanced. Three-phase condenser fan motors with permanently lubricated ball bearings and internal thermal overload protection shall be provided. Units will start and operate between 25 to 115°F ambient.
- E. **Compressor and Lube Oil System:** The rotary screw compressor is semi-hermetic, direct drive, 3600 rpm, 60 Hz, with capacity control slide valve, a load/unload valve, rolling element bearings, differential refrigerant pressure oil pump and oil heater. The motor is a suction gas cooled hermetically sealed, two-pole squirrel cage induction motor. Oil separator and filtration devices shall be provided separate from the compressor. Check valves in the compressor discharge and lube oil system and a solenoid valve in the lube system shall also be provided.
- F. **Refrigeration Circuits:** Each unit shall have two refrigerant circuits, with one or two rotary screw compressors per circuit. Each refrigerant circuit includes a compressor suction and discharge service valve, liquid line shutoff valve, removable core filter, liquid line sight glass

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

with moisture indicator, charging port and an electronic expansion valve. Fully modulating compressors and electronic expansion valves shall provide variable capacity modulation over the entire operating range.

- G. **Unit Controls;** All unit controls shall be housed in an outdoor rated weathertight enclosure with removable plates to allow for customer connection of power wiring and remote interlocks. All controls, including sensors, shall be factory mounted and tested prior to shipment. Microcomputer controls provide all control functions including start-up and shut down, leaving chilled water temperature control, compressor and electronic expansion valve modulation, fan sequencing, anti-recycle logic, automatic lead/lag compressor starting and load limiting. The unit control module, utilizing Adaptive Control™ microprocessor, automatically takes action to avoid unit shutdown due to abnormal operating conditions associated with low refrigerant pressure, high condensing pressure and motor current overload. Should the abnormal operating condition continue until a protective limit is violated, the unit will be shut down. Unit protective functions include loss of chilled water flow, evaporator freezing, loss of refrigerant, low refrigerant pressure, high refrigerant pressure, reverse rotation, compressor starting and running over current, phase loss, phase imbalance, phase reversal, and loss of oil flow. A digital display indicates chilled water setpoint and leaving chilled water temperature as standard. While current limit setpoint, evaporator and condenser refrigerant pressures, and electrical information shall be an option. Both standard and optional displays can be viewed on the unit without opening any control panel doors. Standard power connections include main three phase power to the compressors, condenser fans and control power transformer and optional connections shall be available for the 115 volt/60 Hz single phase power for freeze protection on the evaporator heaters.
- H. **Starters:** Starters shall be housed in a weathertight enclosure with removable cover plate to allow for customer connection of power wiring. Across-the-line starters are standard on all 380-575/60 and 400/50 volt units. Wye Delta closed transition starters (33 percent of LRA inrush) are optional on 380-575/60 and 400/50 volt units and standard on 200-230/60 Hz volt units. Typically, Trane helical-rotary screw compressors shall be up to full speed in one second when started across-the-line and have equivalent inrush with similar size reciprocating compressor with part wind starters.
- I. **Chilled Water Reset:** This provides the control logic and factory installed sensors to reset leaving chilled water temperature. The setpoint can be reset based on ambient temperature or return evaporator water temperature.
- J. **Flow Control:** This provides the control logic and relays to turn the chilled water flow on and off as the chiller requires for operation and protection. This function is a requirement on the Air-Cooled Series R Chiller.

2.2 SOURCE QUALITY CONTROL

- A. Perform functional tests of chillers before shipping.
- B. Factory run test each air-cooled chiller with water flowing through evaporator.
- C. Factory performance test air-cooled chillers, before shipping, according to ARI 550/590.
 - 1. Test the following conditions:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Design conditions indicated.
 - b. Reduction in capacity from design to minimum load in steps of 10 with condenser air at design conditions.
 - c. At four point(s) of varying part-load performance to be selected by Owner at time of test.
2. Allow Owner access to place where chillers are being tested. Notify Architect 14 days in advance of testing.
 3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- D. Factory sound test air-cooled chillers, before shipping, according to ARI 370.
1. Test the following conditions:
 - a. Design conditions indicated.
 - b. Chiller operating at calculated worst-case sound condition.
 - c. At four point(s) of varying part-load performance to be selected by Owner at time of test.
 2. Allow Owner access to place where chillers are being tested. Notify Architect 14 days in advance of testing.
 3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- E. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- F. For chillers located outdoors, rate sound power level according to ARI 370.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine chillers before installation. Reject chillers that are damaged.
- B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
 1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

- A. Install chillers on support structure indicated using elastomeric pads.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Maintain manufacturer's recommended clearances for service and maintenance.
- C. Charge chiller with refrigerant and fill with oil if not factory installed.
- D. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Pipe Connections: Provide as per manufactures' instructions and details on the plans.
- D. Make connections to chiller with a mechanical coupling.
- E. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect vent to chiller pressure relief device with flexible connector and dirt leg with drain valve.
- F. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
 - 3. Verify that pumps are installed and functional.
 - 4. Verify that thermometers and gages are installed.
 - 5. Operate chiller for run-in period.
 - 6. Check bearing lubrication and oil levels.
 - 7. For chillers installed indoors, verify that refrigerant pressure relief device is vented outdoors.
 - 8. Verify proper motor rotation.
 - 9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
 - 10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
 - 11. Verify and record performance of chiller protection devices.
 - 12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
- C. Prepare test and inspection startup reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION 236426

SECTION 237313 – MODULAR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes
 - 1. Outdoor Air Handlers

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.
- C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- D. Unit sound performance data shall be provided using AHRI Standard 260 test methods and reported as sound power. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 - 1. AHU-1 Acoustical Performance, sound levels shall not exceed:
 - 2. AHU-2 Acoustical Performance, sound levels shall not exceed:

1.4 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 4. Certified coil-performance ratings with system operating conditions indicated.
 5. Dampers, including housings, linkages, and operators.
 6. Filters with performance characteristics.
- B. Delegated-Design Submittal: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 2. Support location, type, and weight.
 3. Field measurements.
- B. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Source quality-control reports.
- D. Field quality-control reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each unit.
 - 2. Belts: One spare set.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trane

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Carrier
3. Dunham-Bush
4. McQuay
5. YORK International Corporation.

2.2 AIR HANDLERS

- A. Air handlers must be rigged, lifted, and installed in strict accordance with the Installation, Operation, and Maintenance manual. The units are also to be installed in strict accordance with the specifications.
- B. All units shall be shipped with an integral base frame designed with the necessary number of lift points for safe installation. The lift points shall be designed to accept standard rigging devices and be removable after installation. Units shipped in sections shall have a minimum of four points of lift. Units shall be shipped with a shipping skid designed for forklift transport and the integral base shall be designed with the necessary number of lift points for safe installation. The lift points shall be designed to accept standard rigging devices and removable after installation. Units shipped in sections shall have a minimum of four points of lift.
- C. Per ASHRAE 62.1 recommendation, units shall be shipped stretch-wrapped to protect unit from in-transit rain and debris. Installing contractor is responsible for long-term storage in accordance with the Installation, Operation, and Maintenance manual.
- D. Unit shall be UL and C-UL Listed. Air-handling performance data shall be certified in accordance with AHRI Standard 430. Coil performance shall be certified in accordance with AHRI Standard 410.
- E. Seismic Qualification Testing and structural analysis shall be conducted in accordance with and strict adherence to the standards set forth within ASCE 7 by an independent approval agency with a complete list of certified models, options, and installation methods provided in an approved detailed report. The above referenced equipment shall be approved for seismic applications when properly installed and used as intended. The basis of the certification shall be obtained through a combination of testing of the active and energized components per AC156, and analysis of the main force resisting members of the unit. Additional calculations shall be conducted to ensure components, accessories, and options remained intact and attached to the unit under seismic load conditions. The certification shall be based on a maximum Design Structural Response Acceleration at Short Period (Sds) value of 1.85 g's for IBC 2006 and 2009, and 1.93 for IBC 2000 and 2003. This is obtained from the Maximum Considered Earthquake Short Period Spectral Response Acceleration, Ss, of 2.78 g's or 2.90 g's as determined by the ASCE 7 seismic maps for Soil Site Class B with 5 percent damping. When the site soil properties or final equipment installation location are not known, the soil site coefficient, Fa, defaults to the Soil Site Class D coefficient. Occupancy Category IV and Seismic Design Category C shall be covered under this certification, limited by the Sds value stated above. A seismic importance factor, Ip, of 1.5 shall apply to the certification to include essential facility requirements and life safety applications for post event functionality.
 1. $IBC\ 2006,\ 2009\ FP/WP = 0.4 \times 2/3(Ss=2.78) \times (FA=1) \times (IP=1.5) \times (aP/RP=0.42) \times (1+2(z/h=1.0)) = 1.39\ g's$

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Structural floors, housekeeping pads, supporting curbs, and supporting steel must be seismically designed and approved by the project or building Structural Engineer of Record to withstand the seismic anchor loads. Installation details such as special inspection, attachment to a curb, or attachment to a non-building structure must be outlined and approved by the Engineer of Record for the project or building. The installing contractor shall be responsible for the proper installation of the equipment and must observe the seismic installation requirements set forth by the Engineer of Record.

2.3 UNIT CONSTRUCTION

A. Casing Construction

1. All unit panels shall be 2-inch solid, double-wall construction to facilitate cleaning of unit interior.
2. Unit panels shall be provided with a mid-span, no through metal, internal thermal break. Casing thermal performance shall be such that under 55°F supply air temperature and design conditions on the exterior of the unit of 81°F dry bulb and 73°F wet bulb, condensation shall not form on the casing exterior.
3. All exterior and interior AHU panels shall be made of galvanized steel.
4. Cooling coil sections: interior AHU casing panels shall be made of stainless steel.
5. The casing shall be able to withstand up to 8 inches w.g. positive or negative static pressure. The casing shall not exceed 0.0042 inch deflection per inch of panel span at 1.5 times design static pressure up to a maximum of +8 inches w.g. in all positive pressure sections and -8 inches w.g. in all negative pressure sections.

- B. Unit Flooring: The unit floor shall be of sufficient strength to support a 300-lb. load during maintenance activities and shall deflect no more than 0.0042 inch per inch of panel span.

- C. Casing Leakage: The casing air leakage shall not exceed leak class 9 (CL = 9) per ASHRAE 111 at 1.25 times maximum casing static pressure (P in inches w.g.), up to a maximum of +8 inches w.g. in all positive pressure sections and -8 inches w.g. in all negative pressure sections, where maximum casing leakage (cfm/100 ft² of casing surface area) = CL x P^{0.65}.

- D. Insulation: Panel insulation shall provide a minimum thermal resistance (R) value of 13 ft²•h•°F/Btu throughout the entire unit. Insulation shall completely fill the panel cavities in all directions so that no voids exist and settling of insulation is prevented. Panel insulation shall comply with NFPA 90A.

- E. Drain Pans: All cooling coil sections shall be provided with an insulated, double-wall stainless steel drain pan. To address indoor air quality (IAQ), the drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes promoting positive drainage to eliminate stagnant water conditions. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. All drain pan threaded connections shall be visible external to the unit. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum of 2 1/2 inches beyond the base to ensure adequate room for field piping of condensate drain traps. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

F. Access Doors

1. Access doors shall be 2-inch double-wall construction. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
2. Surface-mounted handles shall be provided to allow quick access to the interior of the functional section and to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance. Handle hardware shall be designed to prevent unintended closure.
3. Access doors shall be hinged and removable for quick, easy access. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.
4. Doors shall be a minimum of 60 inches high when sufficient height is available, or the maximum height allowed by the unit height.
5. Door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit. Optionally, a single-handle door shall be provided for all outward swinging doors linked to multiple latching points necessary to maintain the specified air leakage integrity of the unit.
6. View Windows: A shatterproof window for viewing, capable of withstanding unit operating pressures, shall be provided in the following doors:
 - a. Fan Section
 - b. Humidifier Section
 - c. Cooling coil (with visibility to inspect drain pan)

G. Marine Lights

1. A factory-mounted, weather-resistant (enclosed and gasketed to prevent water and dust intrusion), light emitting diode (LED) fixture shall be provided in sections of the unit as specified for maintenance and service visibility. Fixture shall be complete with aluminum die cast housing, polycarbonate lens designed for maximum light output, and LEDs wired to a single switch within a factory-provided service module. LED lighting shall provide instant-on white light and have a minimum 50,000 hour life. Fixtures shall be designed for flexible positioning during maintenance and service activities for optimal location.
2. All lights within the unit shall be wired to a single switch within the factory provided service module. The service module shall include a GFCI receptacle separate from the load side of the equipment. Electrical contractor shall be required to provide a 120V supply to the factory-mounted service module for the marine light circuit (unless single-point power is provided) and always for the GFCI receptacle circuit per NEC.
3. The service module shall be provided on the fan section, unless a controls section is provided. In which case, the service module shall be provided on the controls section.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 FANS

- A. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- B. Type
 - 1. The fan type shall be provided as required for stable operation and optimum energy efficiency. The fan shall be statically and dynamically balanced at the factory as a complete fan assembly (fan wheel, motor, drive, and belts). The fan shaft shall not exceed 75 percent of its first critical speed at any cataloged speed. Fan wheels shall be keyed to the fan shaft to prevent slipping. The fan shafts shall be solid steel. The fan section shall be provided with an access door on the drive side of the fan.
 - 2. Direct-Drive Plenum Fans: The fan shall be a single-width, single-inlet, 9-blade or 12-blade plenum fan. The fan blades shall be aluminum backward-inclined airfoil. Plenum fan shall be direct-driven. Fan sections containing multiple fans shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.
- C. Fan Isolation
 - 1. Fans shall be mounted on isolation bases and isolated from the unit casing by a flexible connection.
 - 2. The fan and motor assembly shall be internally isolated from the unit casing with 2-inch deflection spring isolators, furnished and installed by the unit manufacturer. The isolation system shall be designed to resist loads produced by external forces, such as earthquakes, and conform to the current IBC seismic requirements.
- D. Fan Drives
 - 1. Variable Pitch. The drives shall be variable pitch, suitable for adjustment within five percent of the specified speed.
 - 2. Fixed Pitch. The drives shall be constant speed with fixed-pitch sheaves.
 - 3. 1.2 Service Factor. The drives shall be selected at a minimum 20 percent larger than the motor horsepower.
 - 4. 1.5 Service Factor. The drives shall be selected at a minimum 50 percent larger than the motor horsepower.
- E. Fan Motors
 - 1. The motor shall be integrally mounted to an isolated fan assembly furnished by the unit manufacturer. The motor shall be mounted inside the unit casing on an adjustable base to permit adjustment of drive-belt tension. The motor shall meet or exceed all NEMA Standards Publication MG1 requirements and comply with NEMA premium efficiency levels. The motor shall have T-frame, squirrel cage with size, type, and electrical characteristics as shown on the equipment schedule.
 - 2. Open Drip-Proof. The motor shall be open and drip-proof.
 - 3. Bearings are selectable with life-time lubrication or with relubrication required. For any bearing requiring relubrication, the grease line shall be extended to the fan-support bracket on the drive side of the fan.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

F. Bearing Protection Ring

1. All motors to be operated with a Variable Frequency Drive shall be equipped with a bearing protection ring (shaft grounding ring).
2. The bearing protection ring shall be manufactured by Aegis, model SGR.
3. Ring shall be factory installed where available, installed per manufacturer's recommendations. Where not available as a factory installed option, the ring shall be field installed in strict accordance with the motor and ring manufacturer's recommendations.
4. For motors up to 100 hp, ring shall be mounted on either the drive end or the non-drive end of the motor. For motors larger than 100 hp, insulate one bearing journal or install a ceramic bearing on the non-drive end of the motor and install the bearing protection ring on the opposite end.
5. All Aegis Rings will be installed as per manufacturer's specifications.
6. All motor shafts will be cleaned and free of foreign material and coated with Colloidal Silver, where Aegis Rings contact the motor shaft.
7. Colloidal Silver is available from Aegis, and shall be installed per manufacturer's specifications.
8. Solid Rings shall be the preferred method of installation, and installed with a two part epoxy, supplied by Aegis.
9. Refer to Section 260526 for Additional Motor Grounding and bonding requirements.

G. Fan Section Options

1. External Motor Junction Box: The fan section shall have motor leads extended to a factory-installed NEMA 4 external junction box to facilitate motor wiring and to maintain air leakage integrity of the casing.
2. Motor wiring conduit: The fan motor wiring shall be factory-wired to the unit-mounted starter/disconnect, variable frequency drive (VFD), or external motor junction box within flexible metal conduit of adequate length so that the fan vibration isolation will not be restricted.
3. Flow Meter: The fan shall have an airflow measurement system to measure fan airflow directly or to measure differential pressure that can be used to calculate fan airflow. The system shall predict airflow within +/-5 percent total accuracy (device and transmitter) when operating within the stable operating region of the fan curve. The submitted fan airflow performance and noise levels shall not be affected by the installation of the device. Any device that provides an obstruction to the fan inlet will not be accepted.
4. Belt Guard: Fan sections with centrifugal housed fans shall be provided with a corrosion-proof, wire mesh belt guard to deter incidental contact with rotating sheaves and belts.
5. Door Guard: Fans sections shall be provided with an expanded-metal guard screen for the access door, mounted on the door opening, to deter unauthorized entry and incidental contact with rotating components.

- H. Fan Modulation: Variable-Frequency Drives (VFDs); airflow shall be modulated by a VFD that controls fan speed. Inverter Test: Inverter test shall be performed to check vibration at unloaded conditions. Fan vibration levels shall be checked from 100 percent to 30 percent of required operating rpm.

2.5 COILS

- A. Coils shall be manufactured by the supplier of the air handling unit and installed such that headers and return bends are enclosed by unit casing. Coils shall be removable by unbolting the

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

wall panels in the coil section. Coil connections shall be clearly labeled on unit exterior. Fin surfaces shall be cleaned prior to installation in the unit to remove any oil or dirt that may have accumulated on the fin surfaces during manufacturing of the coil.

- B. The coil section shall be provided complete with coil and coil holding frame. Coil section side panels shall be easily removable to allow for removal and replacement of coils without impacting the structural integrity of the unit. The coils shall be installed such that headers and return bends are enclosed by unit casings. If two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. Like the primary drain pan, the intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- C. Inspection Section; the coil section shall include an inspection section complete with a double-wall, removable door downstream of the coil for inspection, cleaning, and maintenance. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.
- D. Water Coils
 - 1. The coils shall have aluminum fins and seamless copper tubes. Copper fins may be applied to coils with 5/8-inch tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes. The coil casing may be galvanized or stainless steel. The coils shall be proof-tested to 300 psig and leak-tested under water to 200 psig. Coil performance data and coils containing water or ethylene glycol shall be certified in accordance with AHRI Standard 410. Propylene glycol or mixtures thereof, are outside the scope of AHRI Standard 410 and, therefore, do not require AHRI 410 rating or certification.
 - 2. Headers are to be constructed of round copper pipe or cast iron. Tubes shall be copper.
 - 3. Hydronic coils may be supplied with factory installed drain and vent piping to unit casing exterior.
- E. Coil Coating: The coil shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from 0.8 - 1.2 mil on all surface areas including fin edges. Superior hardness characteristics of 2H per ASTM D3363-92A and a cross-hatch adhesion of 4B-5B per ASTM B3359-93. Impact resistance shall be up to 160 in/lb. per ASTM D2794-93. Humidity and water immersion resistance shall be up to a minimum 1000 and 260 hours respectively (ASTM D2247-92 and ASTM D870-02). Corrosion durability shall be confirmed through testing to no less than 5,000 hours salt spray per ASTM B117-90 using scribed aluminum test coupons.

2.6 FILTERS

A. Filters and Air Cleaners

1. Filter sections shall have filter racks, at least one access door for filter removal, and filter block-offs to prevent air bypass around filters. The filter sections shall be supplied with 2-inch or 4-inch flat, or 2-inch or 4-inch angled, bag, or cartridge filters.
2. Permanent Filters: The filters shall be 2-inch, all-metal, viscous-imprisonment type, capable of operating up to 625-fpm face velocity without loss of filter efficiency and holding capacity. The filter media shall be layers of cleanable wire mesh. The filter frame shall be constructed of galvanized steel. The filters shall have a MERV 2 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.
3. Throwaway Filters: The filters shall be throwaway-type and shall have 2-inch fiberglass media contained in a rigid frame. Filters shall be capable of operating up to 500-fpm face velocity without loss of filter efficiency and holding capacity. Filters shall have a rigid supporting mesh across the leaving face of the media. The filters shall have a MERV 5 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.
4. Pleated Media Filters: The filters shall be 2-inch or 4 inch, made with 100 percent synthetic fibers that are continuously laminated to a supported steel-wire grid with water repellent adhesive. Filters shall be capable of operating up to 625-fpm face velocity without loss of filter efficiency and holding capacity. The filters shall have a MERV 8 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.
5. Cartridge Filters: The filters shall be constructed with a continuous sheet of fine-fiber media made into closely spaced pleats. The filters shall be capable of operating up to 625-fpm face velocity for 12-inch deep filters without loss of filter efficiency and holding capacity. The filters shall be sealed into a metal frame assembled in a rigid manner. A gasket material shall be installed on the metal header of the filter to prevent filter bypass where the metal headers meet on the side-access racks. All cartridge filters shall be furnished with a 2-inch pleated media MERV 8 prefilter to provide extended cartridge life. The manufacturer shall supply a side-access filter rack capable of holding cartridge filters and prefilters. Cartridge filters shall have a MERV 11 to 15 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.

B. Filter Section Option

1. Differential Pressure Gage: A factory-installed dial type differential pressure gage shall be piped to both sides of the filter to indicate status. Gage shall maintain a +/- 5 percent accuracy within operating temperature limits of -20°F to 120°F. Gage shall be flush mounted with casing outer wall. Filter sections consisting of pre- and post-filters shall have a gage for each.

2.7 DAMPERS

A. Filter/Mixing Section: A functional section shall be provided to support the damper assembly for mixing dampers.

1. Return Air Dampers:
 - a. Shall be arranged in a parallel-blade configuration.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. The dampers shall be of double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on all blades. The blades shall rotate on stainless-steel sleeve bearings. The dampers shall be rated for a maximum leakage rate of 3 cfm/ft² at 1 in. w.g. complying with ASHRAE 90.1 maximum damper leakage. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D.
2. Outside Air Dampers: (TRAQ Dampers):
- a. A factory-mounted airflow measurement station certified in accordance with AMCA Standard 611 and bearing the AMCA Ratings Seal for Airflow Measurement Performance shall be provided in the outdoor and/or return air opening to measure airflow. The damper blades shall be galvanized steel, housed in a galvanized steel frame and mechanically fastened to a rotating axle rod. The dampers shall be rated for a maximum leakage rate of 4 cfm/ft² at 1 in. w.g. complying with ASHRAE 90.1 maximum damper leakage.
 - b. Provide the “low flow” TRAQ option.
 - c. Airflow measurement station shall be capable of measuring from 5 percent to 100 percent of unit nominal airflow. The airflow measurement station shall adjust for temperature variations and provide a 2 to 10 VDC signal that corresponds to actual airflow for controlling and documenting airflow.
 - d. The accuracy of the airflow measurement station shall be ± 5 percent.

2.8 OUTDOOR UNITS

- A. Outdoor Unit Paint: External surface of unit casing shall be prepared and coated with a minimum 1.5 mil enamel finish or equal. Units supplied with casing exterior factory-painted shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Unit casing exterior will be provided with manufacturer’s standard color, or alternative color when required.
- B. Pipe Cabinet: For outdoor units, piping cabinet shall be supplied by the manufacturer (factory-assembled) and shall be of the same construction as the main unit casing. Piping cabinet shall be mounted external to the unit and shipped separate to be field-installed.
- C. Outdoor Unit Roof: Factory engineered inner roofs incorporate mid-span, internal thermal breaks to eliminate thermal conduction paths from the interior of the air handler to the exterior (2-inch R13 foam-insulated). Inner/ Indoor/ roof will be installed in such a manner as to prevent air bypass between internal components. A single layer Outer/Outdoor roof is utilized above the inner roof and will be sloped at a minimum 0.125inches per foot either from one side of unit to other, or from center to sides of the unit. Roof assembly will overhang all walls of units by a 1.5-inch minimum.

2.9 OTHER SECTIONS AND OPTIONS

- A. Access/Inspection Sections: A section shall be provided to allow additional access/inspection of unit components and space for field-installed components as needed. The section length shall be variable to accommodate specific access, spacing, or dimensional requirements. An access door shall be provided for easy access. All access sections shall be complete with a double-wall,

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

removable door downstream for inspection, cleaning, and maintenance. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.

- B. Blender Section: An air blender section shall be provided to mix outside and return air, minimize stratification, and reduce the risk of frozen coils. The blender size, space upstream, and space downstream shall be factory engineered for proper performance.
- C. Diffuser Section: A diffuser section shall be provided immediately downstream of the fan section. The diffuser shall provide equal air distribution to blow-thru components immediately downstream of the diffuser.
- D. Silencers: A rectangular silencer shall be provided to reduce airborne sound transmitted through the air handler. The silencer ratings for dynamic insertion loss and pressure drop shall be in accordance with ASTM E-477 for forward flow (air and noise in the same direction) or reverse flow (air and noise in the opposite direction) per the project's requirements. Acoustical performance within the air handler unit assembly shall be in accordance with AHRI 260.
- E. Turning and Discharge Plenum Sections: Plenums shall be provided to efficiently turn air and provide sound attenuation. Discharge plenum opening types and sizes shall be scaled to meet engineering requirements. The vertical discharge plenum height may be scaled to accommodate the appropriate discharge duct height. The horizontal discharge plenum length may be scaled to accommodate necessary dimensional constraints.
- F. Plenum Attenuation Panels: Discharge plenum panels shall include an acoustical liner. The liner shall be fabricated from stainless steel perforated material to prevent corrosion and designed to completely encapsulate fiberglass insulation. The perforation spacing and hole size shall be such as to prevent insulation breakaway, flake off, or delamination when tested at 9,000 fpm, in accordance with UL Specification 181.

2.10 CONTROLS

- A. Combination VFD and Disconnects
 - 1. A combination VFD/disconnect shall be provided for each fan motor. Each VFD/disconnect shall be properly sized, factory mounted in a full metal enclosure, wired to the fan motor, and commissioned to facilitate temporary heating, cooling, ventilation, and/or timely completion of the project. VFD/disconnects shall include a circuit breaker disconnect with a through-the-door interlocking handle (external-mounted starters - sizes 3-120) or a beside-the-door interlocking handle (internal-mounted starters - sizes 3-120) spring loaded and designed to rest only in the full ON or OFF state and shall be lockable in these states. A concealed defeater mechanism shall allow entry into the enclosure when the handle is in the ON position. The VFD package shall also include:
 - a. Electronic manual speed control
 - b. Hand-Off-Auto (H-O-A) selector switch
 - c. Inlet fuses to provide maximum protection against inlet short circuit
 - d. Current limited stall prevention
 - e. Auto restart after momentary power loss

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- f. Speed search for starting into rotating motor
 - g. Anti-windmill with DC injection before start
 - h. Phase-to-phase short circuit protection
 - i. Ground fault protection
 2. Units with factory-mounted controls shall include a control transformer with sufficient capacity to support both the VFD and controls requirements, binary output on/off wiring, analog output-speed signal wiring, and all interfacing wiring between the VFD and the direct digital controller.
 3. The VFD shall be UL508C listed and CSA certified and conform to applicable NEMA, ICS, NFPA, and IEC standards.
- B. Optional Bypass: Bypass relays and bypass circuitry with a VFD/OFF/Bypass selector switch shall be provided.
- C. Starter/Disconnect or VFD Enclosure Options: Starter or VFD shall be mounted externally on the fan section in a NEMA Type 1 enclosure (unit sizes 3-120) or internally in a NEMA Type 4 equivalent unit casing (unit sizes 3-120) within a dedicated controls section or housed fan section. The internal enclosure shall be an integral part of the unit casing to allow for thermal venting to casing interior, but shall be accessible from unit exterior through access door. Internally mounted starters/VFDs shall have doors with the same construction as other doors on unit. An external disconnect shall be mounted beside the access door to the starter or VFD to disconnect full power from starter/VFD, lights, or control power.
- D. Factory-Mounted DDC System
 1. Factory-mounted direct-digital control (DDC) system shall be engineered, mounted, wired, and tested by the air handler manufacturer to reduce installed costs, improve reliability, and save time at unit startup. Each control system shall be fully functional in a stand-alone mode or may be tied to a building automation system with a single pair of twisted wires. All factory-mounted controls shall be covered by the air handler manufacturer's standard warranty.
 2. Direct Digital Controller: A dedicated, field-programmable, direct digital-controller with the appropriate point capabilities shall be unit-mounted on each air-handling unit. A portable screen and keypad shall be provided to facilitate local monitoring, troubleshooting, and changing of setpoints. The touch pad shall be able to quickly plug into other factory-configured controllers by the same manufacturer.
 3. Factory-Mounted Control Options—Electronic End Devices: All factory-mounted control devices shall be provided to accommodate integration into existing building systems. Devices provided shall be wired to standard point locations of a unit-mounted direct digital controller or terminal block for a remote controller.
 4. Mixing Section Damper Actuators: Spring return actuators shall be mounted with the outdoor air damper linked as normally closed and the return-air damper linked as normally open.
 5. Airflow Measuring Stations (Traq Dampers): Airflow monitoring stations shall provide a 2 to 10 VDC signal, which corresponds to cfm, for controlling and documenting airflow.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. Temperature Sensors: Unit-mounted temperature sensor material shall be selected for ease of integration into existing BAS control systems. Temperature sensor material types include 1k ohm RTD, Platinum 385, 1k ohm RTD, Nickel, 10k ohm, Type II Thermistor, 10k ohm, Type III Thermistor, 20k ohm, Type IV Thermistor, 100k ohm, and Type II Thermistor.
 7. Fan Discharge Temperature Sensors: A button or probe temperature sensor shall be mounted in the fan discharge. The sensor material shall be selected for ease of BAS integration.
 8. Averaging Temperature Sensors: An averaging temperature sensor shall be serpentine across the functional section. Bends of the capillaries shall be curved and fastened with capillary clips to prevent crimping and minimize wear. The sensor material shall be selected for ease of BAS integration.
 9. Low-Limit Switches: A double-pole low limit switch shall be wired to a momentary push-button reset circuit. Capillaries are serpentine across the entering side of the coil. The bends of the capillaries shall be curved and fastened with capillary clips to prevent crimping and minimize wear. A separate low limit shall be provided for each coil in a coil stack.
 10. Airflow Switches: A differential pressure switch piped to the discharge and suction sides of the fan shall indicate fan status.
 11. Dirty Filter Switches: A differential pressure switch piped to both sides of the filter shall indicate filter status.
 12. Condensate Overflow Switches: A float switch conforming to UL 508 shall be factory-installed in the drain pan that will detect a high condensate water level and be used to shut off the air handler in the event that the primary drain is blocked to comply with IMC 2006. The float switch shall be located at a point higher than the primary drain line connection and below the overflow rim of the drain pan.
 13. Customer Interface Relays: Five-amp double-pole, double-throw relays shall be provided as required for each binary output of the controller for customer interface to:
 - a. Motor starters of supply, return, and exhaust fans
 - b. Relief dampers
 - c. Pumps
 - d. Condensing units
- E. Fans shall be plenum type, direct drive as scheduled.
- F. The drain pan shall be non-corrosive and double-sloped to allow condensate drainage. The drain pan construction shall be polymer. Coils shall mount above the drain pan—not in the drain pan—thus allowing the drain pan to be fully inspected and cleaned. The drain pan shall also be removable for cleaning. The polymer drain pan connections shall be unthreaded 3/4” schedule 40 PVC for solvent bonding (transition to insulated copper). The main drain connection shall be at the lowest point of the drain pan. An auxiliary drain connection shall be provided on the same side as the main connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install indoor floor-mounted air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in 230500.
- B. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers.
- C. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7. Secure air handler to upper curb rail, and secure curb base to roof structure with anchor bolts.
 - 1. Verify that the roof structure can adequately support the combined weight of the unit and curb assembly.
 - 2. Ensure that the selected installation location provides sufficient service and operational clearances.
 - 3. Remove any twist within the curb due to roof supports and square the curb.
 - 4. Level the curb.
 - 5. Secure the curb to the roof support members.
 - 6. Install 2-inch thick boards or rigid insulation around the curb.
 - 7. Install cant strips around the curb.
 - 8. Bring field supplied roofing felt up to the top of the curb nailing strips. Nail felt into place.
 - 9. Install field supplied flashing under the lip of the curb flanges and over the felt.
 - 10. Apply sealant to the four corners. Caulk all joints between the curb and the roof. Attach the gasket material to the curb's top flanges (entire perimeter) and to the supply and return air duct opening panel flanges.
- D. Arrange installation of units to provide access space around air-handling units for service and maintenance.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- F. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Support all piping independently of the coils. Provide swing joints or flexible fittings on all connections that are adjacent to heating coils to absorb thermal expansion and contraction strains. Coil piping shall be in accordance with manufacturer's recommendations.
- E. Connect condensate drain pans using piping that matches the drain pan outlet size. Indoor units: Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- F. Install shutoff valve and union or flange at each coil supply connection.
- G. Connect duct to air-handling units with flexible connections.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, fill coils with water, and test coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.
 - 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that dampers open and close smoothly and are in proper positions..
 - 7. Comb coil fins for parallel orientation.
 - 8. Verify that proper thermal-overload protection is installed for electric coils.
 - 9. Install new, clean filters.
- B. Starting procedures for air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust spring isolation.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313

SECTION 237314 - CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY

- A. This Section includes air-handling units with coils for indoor installations.

1.3 DEFINITIONS

- A. Hereinafter, a Class "A" thermal break shall be defined as a thermal break that ensures no member on the exterior of the unit, including fasteners, has through metal contact with any member on the interior of the unit, including fasteners.
- B. Hereinafter, maximum operating pressure for negative sections shall be defined as the maximum negative pressure obtained in the unit during operation. Maximum operating pressure for positive sections shall be defined as the maximum positive pressure obtained in the unit during operation.
- C. Hereinafter, wall assemblies shall include all unit wall panels around the air tunnel perimeter, all channels exposed to both the interior and exterior of the unit, and all removable wall access panels.
- D. Hereinafter, door assemblies shall include interior and exterior unit door panels, door frames, and door channels.
- E. Hereinafter, roof assemblies shall include exterior unit roof panels, interior unit ceiling panels, and all roof channels exposed to both the interior and exterior of the unit.

1.4 SCOPE OF WORK

- A. The RTU Manufacturer's work shall include, but is not necessarily limited to the following:
 - 1. Furnish a complete set of submittals as described hereinafter.
 - 2. Provide RTUs fully factory assembled with the exception of unit splits as required for shipping or installation requirements as indicated on the schedule and drawings. Disassembled RTU components provided to the Mechanical Contractor for field

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

assembly as built-up RTUs shall not be acceptable. As shipped from the RTU Manufacturer, RTUs shall meet the performance requirements shown on the equipment schedule. Units shall be for indoor application and shall have all components and options as indicated on the schedule or drawings. Furthermore, units shall be constructed as detailed hereinafter. Field-provide components and options shall be unacceptable unless otherwise noted. Provide all devices necessary for direct interface with the Johnson Controls BAS which currently exists at the facility.

3. Provide all labor, materials, and equipment necessary for the complete engineering, production, factory assembly, factory testing, packaging, and delivery of the custom RTUs and their related equipment. Provide high voltage components, factory engineered, mounted and wired. Provide control end devices and unit controllers, factory engineered, mounted and wired.
4. Permit the Owner and Engineer to inspect as herein described and to witness performance tests to insure good product quality and compliance with these specifications.
5. Factory test all RTUs as detailed herein and on the schedule.
6. Provide a factory-authorized service representative employed by the RTU Manufacturer to supervise installation and start-up of the units as herein described. Installation shall be performed by the Mechanical Contractor employed by the Owner.
7. Provide Owner's Manual, complete operating instructions.

B. Mechanical Contractor shall provide:

1. Receive and unload the custom RTUs. Inspect the unit sections as they arrive on the job site. Notify the trucking company, RTU Manufacturer, and Owner of any shipping damage immediately.
2. Coordinate work associated with the RTU installation. Schedule with the RTU Manufacturer for a factory-authorized service person employed by the RTU Manufacturer to supervise unit installation. Clear area where unit is to be set of any construction materials or debris. Ensure equipment curbs or support platforms are level prior to setting the units. Hoist and set units in their proper position. Use spreader bars to hoist the unit (sections) to avoid damaging units. If units ship in multiple sections, provide all labor and equipment for placing and field joining sections.
3. Provide chilled water, hot water, steam, and drain piping connections. Fill all inertia bases to the top of the inertia base with concrete per the IOM. Release the fan spring isolator shipping restraints.
4. Remove all foreign objects and thoroughly clean the interior and exterior surfaces of the units with a mild detergent (soap and water). Do not use any abrasives or solvents without first consulting the RTU Manufacturer.
5. Install filter media in filter frames. Operating units without filter media is strictly prohibited.
6. Perform unit start up as detailed herein under the guidance and supervision of a factory-authorized service person employed by the RTU Manufacturer.

1.5 BID REQUIREMENTS

- A. The RTUs shall meet the performance criteria as indicated on the schedule and drawings.
- B. Any RTU Manufacturer not listed above must obtain approval in writing from the Engineer no less than 2 weeks before the bid date. The Mechanical Contractor shall be responsible for all

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

additional costs incurred by the Engineer during the submittal and re-submittal phases for any contract awarded to a manufacturer not on the approved list.

- C. All RTU Manufacturer's that are not basis of design shall deliver selection data to the bid examiner. Selection shall include the following:
 - 1. Fan performance curves, coil performance, and unit discharge, inlet, and radiated sound power levels.
 - 2. Unit casing thermal performance at design supply air temperature graphed on a psychrometric chart.
 - 3. A list of all exceptions and clarifications the RTU Manufacturer is taking to the specifications.

1.6 SUBMITTALS

- A. RTU Manufacturer shall provide the following information with each shop drawing/product data submission:
 - 1. Dimensioned arrangement drawings for each RTU including a plan and elevation view of the assembled unit with overall dimensions, support locations, and weights. Drawings shall also indicate all electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations. Each component of the unit shall be identified and shall include physical dimensions and material of construction.
 - 2. Panel-to-panel joint and corner details and panel-to-roof details, all showing Class "A" thermal breaks.
 - 3. All performance data, including capacities and airside and waterside pressure drops, for components. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, and 4000 Hz.
 - 4. Brand and model of fans, fan motors, coils, air filters, dampers, outside and return air measuring stations, variable frequency drives, being furnished.
- B. The RTU Manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.
- C. The RTU Manufacturer shall list any exceptions to the specification.

1.7 WARRANTY AND SERVICE

- A. RTU Manufacturer shall provide a parts warranty extending 12 months from start-up or 18 months from shipment, whichever comes first.
- B. The RTU Manufacturer shall have a service department located within 50 miles of the job site.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain indoor air-handling units through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of indoor air-handling units and are based on the specific system indicated.
- C. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- D. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- G. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- H. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- I. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- J. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Units may be shipped fully assembled or disassembled to the minimum module size in accordance with shipping or jobsite requirements.
- B. The units must be rigged and lifted in strict accordance with the manufacturer's recommendations.
- C. All unit openings must be sealed to prevent the entrance of construction dust.

1.10 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate size and location of structural-steel support members.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One complete set for each indoor air-handling unit.

PART 2 - PRODUCTS

2.1 CUSTOM AIR HANDLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trane CDQ (Basis of Design)
 - 2. York
- B. Or approved equal subject to owners approval.

2.2 UNIT NAMEPLATES AND LABELS

- A. Metal nameplates shall be provided on the units. All information contained on the nameplate shall be etched or burned into the surface to prevent fading. Information shall include:
 - 1. Job name, sales order number, unit tagging, and service model number.
 - 2. MCA, MOP, and maximum fuse/HACR circuit breaker size.
 - 3. Voltage, frequency, phase, Hp, FLA, and inverter input current for all motors.
- B. RTUs shall be agency listed by UL or ETL. Labels for ARI Standard 410 and the listing agency, either UL or ETL, shall be provided on the units.
- C. Labels shall be provided on the units for unit rigging and coil piping and connection instructions. Labels shall be provided on fans indicating direction of rotation. Warning labels shall be provided on appropriate components indicating hazardous voltage. For each section which must be assembled to another, matching steel identification tags shall be welded at each mating joint to ensure correct assembly order.

2.3 UNIT CONSTRUCTION

- A. Casing Performance
 - 1. Unit air leakage shall not exceed 0.5% of design cfm at 1.5 times maximum operating pressure to a maximum of +12" w.g. in all positive-pressure sections and -12" w.g. in all negative-pressure sections. Leakage shall be calculated by totaling all leakage either in to or out of the unit.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Casing deflection shall not exceed $L/200$ at 0.5 times maximum operating pressure to a maximum of +12" w.g. in all positive-pressure sections and -12" w.g. in all negative-pressure sections, where L is defined as the panel span.
3. Under scheduled supply air temperature and design conditions on the exterior of the unit of 85°F dry bulb and 71°F wet bulb, condensation shall not form on the casing exterior. The RTU Manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, RTU Manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior under the scheduled supply air temperature and design conditions on the exterior of the unit of 85°F dry bulb and 71°F wet bulb. The guarantee shall note that the RTU Manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. Copies of the guarantee shall be provided to the Engineer and the Owner.

B. Bases & Floors

1. Base shall be constructed from welded structural aluminum channels around the perimeter and welded structural aluminum cross members. Formed steel channels are not acceptable. The maximum cross-member spacing shall be 24" on center with members located adequately to support fan, coils, and other large components. The height of each base channel shall be no less than the height indicated in the drawings. Each shipping section shall be provided with removable lifting lugs. Structural framework shall fully support the unit casing and all components during installation such that no section deflects more than $L/1000$ during rigging of that section, where L is defined as the distance between lifting lugs.
2. Floor shall be constructed from stainless steel. The floor surface shall be continuously welded with 2" turned up lip around the base perimeter and all floor penetrations. Caulk is not an acceptable sealing method for the floor. Floor drains shall be located in the floor to drain all sections. Floor drains shall be a minimum of 1.5" in diameter and shall be piped to the exterior of the unit base. Floor deflection shall not exceed $L/200$ under a point load of 200 pounds, where L is defined as the floor span. A galvanized steel liner shall be attached to the underside of the unit base and cross members, ensuring that the floor insulation is completely encapsulated.
3. Insulation that meets a minimum R-value of 24 shall be provided underneath the entire unit floor. Insulation shall be closed cell to prevent wicking of moisture. Base assemblies shall comply with NFPA 90 A.

C. Walls

1. Wall assemblies shall be double-wall construction with textured aluminum solid exterior and stainless steel interior. The entire unit shall have a solid wall liner on the interior. All spaces and joints of wall assemblies shall be completely sealed. Wall shall meet the casing deflection limits contained herein.
2. A Class "A" thermal break shall be provided throughout the entire wall assembly.
3. Insulation that meets a minimum R-value of 24 shall be provided throughout all unit wall assemblies. Insulation shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

shall completely fill the panel cavity in all directions so that no voids exist and settling of insulation is prevented. Wall assemblies shall comply with NFPA 90 A.

4. Removable wall access panels shall be provided in coil and fan sections for service removal of components.

D. Access Doors

1. Access doors shall be provided throughout units as indicated on the schedules and drawings. Access doors shall be double wall construction. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively.
2. A Class “A” thermal break shall be provided on all door assemblies downstream of the cooling coil.
3. Insulation that meets a minimum R-value of 24 shall be provided throughout all door assemblies. Insulation shall be closed cell to prevent wicking of moisture. Door assemblies shall comply with NFPA 90 A.
4. All doors shall be a minimum of 60” high if sufficient height is available, or the maximum height allowed by the unit height. All doors shall open against pressure to ensure an airtight seal and to prevent a safety hazard.
5. Door test ports shall be provided by the RTU Manufacturer as indicated on the schedule and drawings. Test ports shall be designed to allow the test and balance contractor to validate pressure losses using a hand held instrument. Test ports shall have a removable cover that completely seals the door penetration when testing and balancing is not being conducted.
6. Door hinges shall be stainless steel type. Door handles shall be Allegis design for minimized leakage and to provide a Class “A” thermal break. All handles shall fasten against the door frame with a roller cam to eliminate wear of the door frame. On indoor units, if Allegis handles are not provided, Ventlok 310 handles shall be provided on all doors to ensure positive seal of the door and to avoid wear of the door frame. All door handles shall be operable from both the unit exterior and interior. Doors that gain access to unprotected fan wheels, belts, or sheaves shall be provided with a key-locking handle.
7. Windows shall be provided in doors as follows: fan sections, humidifier sections, cooling coil – drain pan visual. Windows shall be mounted in a metal frame and shall be a minimum of 12” x 12”, with wire-reinforced safety glass. For any instance where a window cannot fit in a door, a narrower window 12” tall may be provided. Windows in doors with a thermal break shall be thermal, double-pane type.

E. Roofs

1. Roof assemblies shall be double wall construction. Exterior roof panels and interior ceiling panels shall be of the same construction as the exterior and interior wall panels, respectively. In addition to meeting the casing deflection limits contained herein, roof deflection shall not exceed $L/200$ under a point load of 200 pounds, where L is defined as the roof panel span.
2. A Class “A” thermal break shall be provided throughout the entire roof assembly.
3. Insulation that meets a minimum R-value of 12.5 shall be provided throughout all roof assemblies. Insulation shall be closed cell to prevent wicking of moisture. Roof assemblies shall comply with NFPA 90 A.

- F. Shipping Splits: Shipping splits shall be provided as indicated on the schedule and drawings. Heavy-gage gussets shall be provided in the corners of each split on the unit interior to

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

minimize the opportunity for racking of the section during shipping and rigging. Structural members shall be provided at the base of the unit exterior to enable pull together of each shipping split.

- G. Unit Paint: External surfaces of all outdoor unit casings shall be prepared and painted resulting in a minimum 1.5 mil thick coating when dry. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Paint shall be RTU Manufacturer's standard color, unless otherwise indicated in the schedule and drawings. For units requiring a color other than the RTU Manufacturer's standard color, the Architect shall provide a quantity of four 2" x 2" paint samples to the RTU Manufacturer at the time of submittal approval.

2.4 UNIT COMPONENTS

A. Dampers

1. Approved manufacturers: Ruskin.
2. Ultra low-leak modulating dampers shall be provided, sized, and located as indicated on the schedule and drawings. Blade arrangement (parallel or opposed) and orientation (horizontal blades or vertical blades) shall also be provided as indicated on the schedule and drawings. Dampers shall be aluminum double-skin airfoil design for minimal pressure drop. Leakage rate shall not exceed 4 cfm/square foot at 1" w.g. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. All dampers shall be mounted on the RTU interior.
3. The outside and return dampers shall be a Class II (minimum) leakage-rated smoke damper.

B. Outside Airflow Measuring Stations

1. Approved manufacturers: Ruskin, Trane, Ebtron
2. Airflow measurement stations shall be provided, sized, and located in the outside air (SA & RA- see fan spec below) path to drawings to measure airflow. Damper blades shall be galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 3 cfm/square foot at 1" w.g.
3. The airflow measurement station shall measure up to 100% of the total outside and/or return air. The airflow measuring device shall adjust for temperature variations. Output shall be provided from station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/-5%. Airflow measuring stations shall be mounted on the RTU interior.

2.5 AIR FILTERS

- A. All filters shall be 12" x 24", 24" x 24", or 24" x 12" nominal sizes to minimize the number of sizes required to be stocked by the Owner. Filters of other nominal sizes will not be acceptable.
- B. Pre-filters: as scheduled on the drawings.
- C. Final Filters: as scheduled on the drawings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Filters shall be provided with front-loading frames. Filter holding frames shall be constructed of stainless steel and equipped with foam gaskets to seal filters against filter frames. Frame seams shall be sealed to eliminate air bypass. Front-loading frames shall be equipped with filter fasteners of the same material as the filter frame. Filter fasteners shall be capable of being installed without the use of special tools, bolts or nuts. Filter holding frames shall be of a universal type to accommodate standard filters of the same nominal size as well as appropriate fasteners. Filter access shall be as indicated on the schedule and drawings

2.6 COOLING AND HEATING COILS

- A. Approved manufacturers: Aerofin, Heatcraft, and Trane.
- B. Coil performance shall be provided as indicated on the schedule and drawings. Coil capacities, pressure drops and selection procedures shall be certified to ARI Standard 410.
- C. Coils shall have same-end header connections. Water coils shall have non-ferrous headers. Water coils shall have vent and drain taps and flanged connections extended to outside of the unit. Connection locations (handing) shall be as indicated on the drawings. Grommets shall be provided at coil casing penetrations around the coil piping. Grommets shall be designed to seal the opening under positive and negative pressure.
 - 1. Water Coils: Self-draining coil fabricated according to ARI 410.
 - a. Piping Connections: Threaded.
 - b. Tubes: Copper.
 - c. Fins: Aluminum
 - d. Fin and Tube Joint: Mechanical bond.
 - e. Headers: Cast iron with drain and air vent tappings.
 - f. Frames: Stainless-steel channel frame
 - g. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410
 - h. Working-Pressure Ratings: 200 psig, 325 deg F.
 - i. Source Quality Control: Test to 300 psig and to 200 psig underwater.
- D. Coil Racks: For all stacked coils, coil racks shall be provided to allow independent removal of any coil within the stack without the removal of another coil. Coil racks shall be constructed of the same material as the coil casing.
- E. Primary Drain Pans: Primary condensate drain pans shall be provided in coil sections. Cooling coil sections shall be provided with stainless steel primary drain pans. Primary drain pans shall extend under each entire coil bank, including headers and return bends. Primary drain pans shall extend downstream of the coil bank for a minimum distance as indicated in the drawings. Primary drain pans shall be sloped a minimum of 1/8" per foot, shall be a minimum of 2" deep, and shall be double-sloped (sloped in 2 planes) to positively drain. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum of 1-1/2" beyond the base to ensure adequate room for field piping of condensate drain traps. Drain connection locations (handing) shall be as indicated on the schedule and drawings. Any coil support member located inside a primary drain pan shall be of the same material as the drain pan.
- F. Intermediate Drain Pans: For cooling coil sections requiring stacked coils, sloped intermediate drain pans constructed of stainless steel shall be provided under each upper-level coil in the coil

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

bank and shall extend under the entire coil, including headers and return bends. Intermediate drain pans shall extend downstream of the leaving face of the coil bank for a minimum of 4". Non-corrosive pipe with a minimum diameter of 1" shall be connected to each end of all intermediate drain pans, and shall be piped to the primary drain pan of the coil section. Any coil support member located inside an intermediate drain pan shall be of the same material as the drain pan.

2.7 DEHUMIDIFICATION CASSETTE

- A. The CDQ dehumidification wheel shall be placed in the air handler as shown in the air handler unit drawings. The dehumidification wheel shall not require an additional regeneration airflow stream or the use of a high heat source. If any preheat is required it shall not exceed the scheduled capacity. The CDQ dehumidification wheel shall not utilize exhaust air. The CDQ wheel shall have no exhaust air transfer.
- B. Cassette casing shall be constructed of heavy duty G90 galvanized steel. Cassettes shall be double face panel with removable side panel for access to belt and drive motor. Small amounts of casing deflection shall have no significant impact on wheel performance or life. Casings shall have a 1"-1 1/2" perimeter flange to facilitate mounting inside RTU cabinet with self-tapping sheet metal screws. Alternatively, cassettes may be mounted using "safe-off" blanking to the side, top, and bottom of the cassette.
- C. The CDQ dehumidification wheels shall be constructed of synthetic matrix with an adsorbent integrally bound into the matrix. The adsorbent shall be selected for its high affinity for water vapor at the CDQ operating conditions. The adsorbent shall be a type III desiccant. Construction of the wheel shall be corrugated, fluted design, which provides distinct air passageways and prevents internal wheel bypass. The desiccant shall be intimately, permanently bound and uniformly dispersed throughout the wheel matrix. Because the desiccant is not applied as a glued on surface coating, it is not susceptible to erosion, abrasion, or delamination of the desiccant. The wheel matrix shall be rigid and glued layer-to-layer, and not susceptible to sagging or separation of the layers. The wheel shall be structurally reinforced with a spoking system to minimize wheel deflection. Because the product is nonmetallic, it offers complete resistance to corrosion. The media shall meet the flammability requirements governing this class of products and be UL recognized components in accordance to UL 1812 and UL1995
- D. Cassettes shall include both a circumferential seal as an air block-off around the perimeter, and an inner diametric seal separating regeneration and supply sides. Seals shall be full contact nylon brush seals to minimize leakage. Seals shall be factory set and field adjustable and make intimate contact with the wheel on all surfaces. CDQ cassette, wheel and seal configuration shall allow for operation at high differential pressures. Seal replacement should not be necessary during the life of the product.
- E. The drive system shall consist of a heavy-duty fractional horsepower A/C gear motor mounted in the cassette and cooled by the RTU air stream. Motor location shall be as required. Motors have permanently lubricated bearings. Minimal amp draw will be required and all motors shall be 115V/1PH/60Hz. Drive belts shall be high performance v-belt multilink belts. The multilink belt shall allow for replacement of individual links (1" each) if a section of belt becomes worn or breaks. Belts shall installed under tension, require no mechanical tensioner, and shall not require adjustment after startup. The rotation speed of the wheel shall not exceed the scheduled value.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Provide a wheel rotation sensor with binary output.
- G. The wheel matrix shall be cleanable by vacuuming or pressurized air blowing, or alternatively with low temperature steam, hot water, light detergent.
- H. Cassettes shall be provided with bearings which support rotation of the wheel around a center shaft driven by a perimeter belt. The bearings shall be internal ball bearings press fitted into the bored wheel hub for all wheels up to and including 72" diameter. Internal bearings shall be permanently lubricated, no maintenance bearings which support fixed shaft operation of the wheel assembly. Flanged or pillow block bearings which support rotating shaft operation of the wheel assembly shall be used for all units larger than 72" diameter. Outboard bearings are provided with grease fittings for periodic lubrication. L10 bearing life shall be greater than 400,000 at design conditions.
- I. The wheel cassette shall be capable of continuous operation over ambient temperatures ranging from -40F to 200F at any relative humidity without adversely affecting wheel performance or life.
- J. Performance shall be as predicted by CDQ selection software as scheduled. The performance shall be based on testing conducted on the wheel cassette installed in the air handler configuration as shown in the RTU drawings. Performance based on stand-alone desiccant wheel cassette or tests with two independent air streams are unacceptable. Performance data shall be from tests of a complete unit per-formed by an ISO 9000 certified laboratory. Temperature measurements shall be taken using instrumentation whose calibration is traceable to NIST standards. Dry bulb and wet bulb temperature measurements shall be accurate to +/- 0.1 Deg F. Performance prediction for the CDQ air handler shall be provided for multiple conditions as required.
- K. Warranty: The dehumidification wheel shall be warranted for a period of five (5) years from date of manufacture (terms and conditions apply). The warranty applies to all parts and components in the cassettes with the exception of the motor, which is warranted for a period of eighteen (18) months.

2.8 FANS

- A. Approved manufacturers: Trane, York, Greenheck, New York Blower, and Twin Cities.
- B. Fans shall be tested, rated and certified in accordance with ANSI/AMCA Standard 210 for air delivery and in accordance with AMCA Standard 300 for sound power levels and shall bear the AMCA seal. The fan balancing process, including vibration limits and documentation, shall be performed in accordance with ANSI/AMCA Standard 204. Fan and motor performance requirements shall be as shown on the schedule and drawings. Maximum rated speed of the fans shall not exceed 75% of the first critical speed.
- C. Unhoused Plenum Fans – Direct Drive: Fans shall be unhoused, SWSI plenum type with high efficient AF blades as indicated on the schedule and drawings. Fans shall be direct driven. Fan wheels shall be aluminum. The HP characteristic of the fans shall be non-overloading. Fans shall be furnished with protective enclosures around the fan wheels. Fans shall be furnished with inlet collars. Fans shall be furnished with inlet screens.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Multiple Fans in Parallel: Multiple fans in parallel of type indicated on the schedule and drawings shall be provided. Fans shall meet the specifications for the fan type contained herein. Each fan shall have its own VFD/disconnect. VFD/Disconnect shall be unit mounted, factory wired for control as specified. Coordinate with Section 230900 for interface with the BAS, provided under separate contract with the owner. Individual VFDs or starter/disconnects running multiple fans shall not be acceptable. Actuator-operated isolation dampers shall be factory mounted to prevent reverse airflow through any fan that fails. Dampers shall be sized and positioned to minimize impact on fan performance. All losses associated with the dampers shall be considered when making fan selections.
- E. Weigh fan and motor assembly at RTU manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions. Balance at design RPM as scheduled on drawings.
- F. Inverter balancing. Fan systems shall be checked with a variable frequency drive for resonant frequencies. Fans, shafts, and drives will meet vibrations tolerance specs from 25% to 100% of selected RPM.
- G. Motors and Drives: Refer to Division 23 Section "Common Work Results for HVAC"
1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
 2. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).
 3. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
 4. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B mounted on adjustable base.
 5. Motors shall be T-frame, squirrel cage, open drip-proof with size, type and electrical characteristics as shown as scheduled.
 6. Overload Protection: Built-in, automatically resetting, thermal-overload protection.
 7. Noise Rating: Quiet.
 8. Efficiency: Energy-efficient motors shall have a minimum efficiency according to IEEE 112, Test Method B. Motors shall be premium efficiency.
 9. Motors shall be inverter-duty.
 10. Motors shall be NEMA Design B, with Class B insulation.
- H. Bearing Protection Ring
1. All motors to be operated with a Variable Frequency Drive shall be equipped with a bearing protection ring (shaft grounding ring).
 2. The bearing protection ring shall be manufactured by Aegis, model SGR.
 3. Ring shall be factory installed where available, installed per manufacturer's recommendations. Where not available as a factory installed option, the ring shall be field installed in strict accordance with the motor and ring manufacturer's recommendations.
 4. For motors up to 100 hp, ring shall be mounted on either the drive end or the non-drive end of the motor. For motors larger than 100 hp, insulate one bearing journal or install a ceramic bearing on the non-drive end of the motor and install the bearing protection ring on the opposite end.
 5. All Aegis Rings will be installed as per manufacturer's specifications.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. All motor shafts will be cleaned and free of foreign material and coated with Colloidal Silver, where Aegis Rings contact the motor shaft.
 7. Colloidal Silver is available from Aegis, and shall be installed per manufacturer's specifications.
 8. Solid Rings shall be the preferred method of installation, and installed with a two part epoxy, supplied by Aegis.
 9. Refer to Section 260526 for Additional Motor Grounding and bonding requirements.
- I. Fan Airflow Measurement Systems: Fan airflow measurement systems shall be provided to measure supply and return fan airflow directly or to measure differential pressure that can be used to calculate fan airflow. The accuracy of the devices shall be no worse than +/-5% when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.

2.9 VIBRATION ISOLATION

- A. The entire fan and motor assembly shall be mounted on vibration isolators which have a 2" deflection to isolate the assembly from the unit housing. Vane axial fan assemblies, the discharge of housed fan assemblies, and the inlet of plenum fan assemblies shall be connected to the pressure-bulkhead panel (wall, floor, or roof) with flexible duct to prevent transmission of vibration to the unit casing. No metal-to-metal contact will be permitted between fixed and floating parts. Thrust restraints shall be provided as required to limit horizontal movement of fan assembly at design conditions. Fan base assemblies shall be rigidly tied to the unit base during shipment to prevent damage from shipping vibrations. Rigid tie shall be field removable with a common tool.
- B. Each fan assembly shall be vibration tested prior to shipment. Measurements shall include both radial and axial displacement at each fan bearing using magnetic accelerometers connected to a vibration analyzer. Vibration shall not exceed limits specified herein.
- C. Fan and motor assembly shall be attached to a concrete inertia base constructed of structural steel members. The depth of concrete shall be equal to 1/12 the largest span between isolators, minimum of 6", maximum of 12", per ASHRAE recommendations. The weight of the inertia base with concrete shall be equal to or greater than the weight of the equipment supported to provide a maximum peak-to-peak displacement of 1/16". The inertia base forms shall be provided by the RTU Manufacturer. Concrete shall be provided and poured in the field by the Mechanical Contractor.
- D. Field Vibration Isolation: In addition to factory vibration isolation specified herein, provide the following:
1. Provide neoprene isolation pads below all support contact points of the RTU.
 2. Provide flex connectors at duct connections.

2.10 UNIT ACOUSTICS

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- A. Acoustical performance shall be estimated per ARI Standard 260 test data. Provide units as with the following maximum sound power levels in dB, re 10^{-12} W. Data provided in Sones or Bels is not acceptable.

2.11 CONTROLS

- A. General: it is the intent that the unit include factory installed wiring and controls for operation as specified. Provide interface with central BAS to allow remote monitoring, setpoint adjustment, scheduling, alarm reporting, and status enable/disable. Refer to Section 230993 for specific sequence of operation requirements.
- B. Combination VFD and Disconnects
 - 1. A combination VFD/disconnect shall be provided for each fan motor. Each VFD/disconnect shall be properly sized, factory mounted in a full metal enclosure, wired to the fan motor, and commissioned to facilitate temporary heating, cooling, ventilation, and/or timely completion of the project. VFD/disconnects shall include a circuit breaker disconnect with a through-the-door interlocking handle (external-mounted starters - sizes 3-120) or a beside-the-door interlocking handle (internal-mounted starters - sizes 3-120) spring loaded and designed to rest only in the full ON or OFF state and shall be lockable in these states. A concealed defeater mechanism shall allow entry into the enclosure when the handle is in the ON position. The VFD package shall also include:
 - a. Electronic manual speed control
 - b. Hand-Off-Auto (H-O-A) selector switch
 - c. Inlet fuses to provide maximum protection against inlet short circuit
 - d. Current limited stall prevention
 - e. Auto restart after momentary power loss
 - f. Speed search for starting into rotating motor
 - g. Anti-windmill with DC injection before start
 - h. Phase-to-phase short circuit protection
 - i. Ground fault protection
 - 2. Units with factory-mounted controls shall include a control transformer with sufficient capacity to support both the VFD and controls requirements, binary output on/off wiring, analog output-speed signal wiring, and all interfacing wiring between the VFD and the direct digital controller.
 - 3. The VFD shall be UL508C listed and CSA certified and conform to applicable NEMA, ICS, NFPA, and IEC standards.
- C. Optional Bypass: Bypass relays and bypass circuitry with a VFD/OFF/Bypass selector switch shall be provided.
- D. Starter/Disconnect or VFD Enclosure Options: Starter or VFD shall be mounted externally on the fan section in a NEMA Type 1 enclosure (unit sizes 3-120) or internally in a NEMA Type 4 equivalent unit casing (unit sizes 3-120) within a dedicated controls section or housed fan section. The internal enclosure shall be an integral part of the unit casing to allow for thermal venting to casing interior, but shall be accessible from unit exterior through access door. Internally mounted starters/VFDs shall have doors with the same construction as other doors on

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

unit. An external disconnect shall be mounted beside the access door to the starter or VFD to disconnect full power from starter/VFD, lights, or control power.

E. Factory-Mounted DDC System

1. Factory-mounted direct-digital control (DDC) system shall be engineered, mounted, wired, and tested by the air handler manufacturer to reduce installed costs, improve reliability, and save time at unit startup. Each control system shall be fully functional in a stand-alone mode or may be tied to a building automation system with a single pair of twisted wires. All factory-mounted controls shall be covered by the air handler manufacturer's standard warranty.
2. Direct Digital Controller: A dedicated, field-programmable, direct digital-controller with the appropriate point capabilities shall be unit-mounted on each air-handling unit. A portable screen and keypad shall be provided to facilitate local monitoring, troubleshooting, and changing of setpoints. The touch pad shall be able to quickly plug into other factory-configured controllers by the same manufacturer.
3. Factory-Mounted Control Options—Electronic End Devices: All factory-mounted control devices shall be provided to accommodate integration into existing building systems. Devices provided shall be wired to standard point locations of a unit-mounted direct digital controller or terminal block for a remote controller.
4. Mixing Section Damper Actuators: Spring return actuators shall be mounted with the outdoor air damper linked as normally closed and the return-air damper linked as normally open.
5. Airflow Measuring Stations (Traq Dampers): Airflow monitoring stations shall provide a 2 to 10 VDC signal, which corresponds to cfm, for controlling and documenting airflow.
6. Temperature Sensors: Unit-mounted temperature sensor material shall be selected for ease of integration into existing BAS control systems. Temperature sensor material types include 1k ohm RTD, Platinum 385, 1k ohm RTD, Nickel, 10k ohm, Type II Thermistor, 10k ohm, Type III Thermistor, 20k ohm, Type IV Thermistor, 100k ohm, and Type II Thermistor.
7. Fan Discharge Temperature Sensors: A button or probe temperature sensor shall be mounted in the fan discharge. The sensor material shall be selected for ease of BAS integration.
8. Averaging Temperature Sensors: An averaging temperature sensor shall be serpentine across the functional section. Bends of the capillaries shall be curved and fastened with capillary clips to prevent crimping and minimize wear. The sensor material shall be selected for ease of BAS integration.
9. Low-Limit Switches: A double-pole low limit switch shall be wired to a momentary push-button reset circuit. Capillaries are serpentine across the entering side of the coil. The bends of the capillaries shall be curved and fastened with capillary clips to prevent crimping and minimize wear. A separate low limit shall be provided for each coil in a coil stack.
10. Airflow Switches: A differential pressure switch piped to the discharge and suction sides of the fan shall indicate fan status.
11. Dirty Filter Switches: A differential pressure switch piped to both sides of the filter shall indicate filter status.
12. Condensate Overflow Switches: A float switch conforming to UL 508 shall be factory-installed in the drain pan that will detect a high condensate water level and be used to shut off the air handler in the event that the primary drain is blocked to comply with IMC 2006. The float switch shall be located at a point higher than the primary drain line connection and below the overflow rim of the drain pan.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

13. Customer Interface Relays: Five-amp double-pole, double-throw relays shall be provided as required for each binary output of the controller for customer interface to:
 - a. Motor starters of supply, return, and exhaust fans
 - b. Relief dampers
 - c. Pumps
 - d. Condensing units

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. Factory testing shall be conducted at the RTU Manufacturer's facility prior to shipment of the units being tested. The RTU Manufacturer shall provide all equipment and trained personnel to conduct each test. Results shall be recorded and provided to the Owner and Engineer.
- B. Air Leakage Tests: The RTU Manufacturer shall conduct factory air leakage tests on units as indicated in the schedule and drawings. Positive-pressure sections of units shall be tested under positive pressure and negative-pressure sections of units shall be tested under negative pressure. Unit air leakage shall not exceed 1.0% of design cfm at 1.5 times maximum operating pressure to a maximum of +12" w.g. in all positive-pressure sections and -12" w.g. in all negative-pressure sections. Leakage shall be calculated by totaling all leakage either in to or out of the unit.
- C. Panel Deflection Test: The RTU Manufacturer shall conduct factory panel deflection tests on units as indicated in the schedule and drawings. Positive-pressure sections of units shall be tested under positive pressure and negative-pressure sections of units shall be tested under negative pressure. Casing deflection shall not exceed $L/200$ at 1.5 times maximum operating pressure to a maximum of +12" w.g. in all positive-pressure sections and -12" w.g. in all negative-pressure sections, where L is defined as the panel span.
- D. The RTU Manufacturer shall repair/replace at his own expense any items that fail or are damaged during testing. For any unit that fails testing, the RTU Manufacturer shall retest the unit until all items are in compliance with limits specified herein.
- E. After factory assembly, inspection and testing of units, the RTU Manufacturer shall disassemble each unit (where required) only to the extent necessary for shipment, unless otherwise detailed herein.
- F. The RTU Manufacturer shall legibly mark the parts of work to be erected or field-assembled to enable the Mechanical Contractor to identify the various parts and erect the work without delay.

3.2 SHIPPING

- A. Paper copies of the IOM shall also be shipped with each RTU.
- B. The RTU Manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

of units when they are received. For parts too small to mark individually, the RTU Manufacturer shall place them in containers.

- C. To protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.
- D. After loading the equipment for shipment, the RTU Manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.
- E. On Site Storage: If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.3 EXAMINATION

- A. Field Examination: The Mechanical Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
- B. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.
- C. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- D. Examine roughing-in of piping systems and electrical services to verify actual locations of connections before installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 INSTALLATION

- A. Arrange installation of units to provide access space around indoor air-handling units for service and maintenance.
- B. The Mechanical Contractor shall be responsible to coordinate installation requirements with the Owner and the Owner's selected Mechanical Contractor to insure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or -welded joints, and all other installation and assembly requirements.
- C. The RTU Manufacturer shall provide all screws and gaskets for joining of sections in the field.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. The RTU Manufacturer shall provide a factory-authorized service representative employed by the RTU Manufacturer to supervise the RTU installation work provided by the Mechanical Contractor.
- E. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the RTU Manufacturer's final inspection and start-up:
 - 1. Spring-isolated components have had their shipping restraints removed and the components have been leveled.
 - 2. On field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
 - 3. Water and steam piping connections have been completed and hydrostatically tested and all waterflow rates have been set in accordance with the capacities scheduled on the Drawings.
 - 4. Ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
 - 5. Power wiring, including motor starters and disconnects, serving the unit has been completed.
 - 6. Automatic temperature and safety controls have been completed.
 - 7. Dampers are fully operational.
 - 8. Shipping materials have been removed.
 - 9. Clean filter media has been installed in the units.

3.5 LEVELING

- A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

3.6 FINAL INSPECTION AND START-UP SERVICE

- A. After the Mechanical Contractor has provided all water and steam piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the factory-authorized service representative employed by the RTU Manufacturer shall inspect the installation. The Mechanical Contractor shall then perform startup of the equipment.
- B. The Automatic Temperature Control (BAS) Contractor shall be scheduled to be at the job site at the time of the equipment start-up.
- C. Under the guidance and supervision of the factory-authorized service representative employed by the RTU Manufacturer the Mechanical Contractor, shall perform the following tests and services and submit a report outlining the results:
 - 1. Record date, time, and person(s) performing service.
 - 2. Lubricate all moving parts.
 - 3. Check all motor and starter power lugs and tighten as required.
 - 4. Verify all electrical power connections.
 - 5. Conduct a start-up inspection per the RTU Manufacturer's recommendations.
 - 6. Record fan motor voltage and amperage readings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
8. Check fan for excessive vibration.
9. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
10. Disengage all shipping fasteners on vibration isolation equipment.
11. Check safety guards to insure they are properly secured.
12. Secure all access doors to the fan, the unit and the ductwork.
13. Switch electrical supply "on" and allow fan to reach full speed.
14. Physically check each fan at start-up and shut-down to insure no abnormal or problem conditions exist.
15. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.
16. Check all control sequences.

3.7 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to indoor air-handling units as shown on the plans.
- D. Connect condensate drain pans with full-size piping. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan per manufacturer's recommendations, and install cleanouts at changes in direction.
- E. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.
- F. Connect to ductwork using flexible duct connections.
- G. Electrical: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.8 CLEANING

- A. Clean indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- B. After completing system installation and testing, adjusting, and balancing indoor air handling and air-distribution systems, clean filter housings and install new filters.

3.9 DEMONSTRATION

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain indoor air-handling units.

END OF SECTION 237314

SECTION 238413 - HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following humidifiers:
 - 1. Self-contained.

1.3 DEFINITION

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which humidifiers will be attached.
 - 2. Size and location of initial access modules for acoustical tile.
- B. Field quality-control test reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.9 COORDINATION

- A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 SELF-CONTAINED HUMIDIFIERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Dristeam Model VLC 6-1 or a comparable product by one of the following:
 - 1. Armstrong International, Inc.
 - 2. Carel USA, LLC.
 - 3. Carnes Co., Inc.
 - 4. Herrmidifier.
 - 5. Hygromatik; Spirax Sarco, Inc.
 - 6. Nortec Industries Inc.
- B. Electric-Resistance Heater Container: Cleanable, ASTM A 666, Type 316 stainless steel. Comply with UL 499.
- C. Manifold: Stainless-steel tube with integral fan to discharge vapor directly into occupied space.
- D. Manifold: ASTM A 666, Type 316 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.
- F. Control Panel:
 - 1. Factory-wired disconnect switch.
 - 2. Liquid-crystal display.
 - 3. Programmable keyboard.
 - 4. Set-point adjustment.
 - 5. Warning signal indicating end of replaceable cylinder or ionic bed insert life.
 - 6. Low-voltage, control circuit.
 - 7. Diagnostic, maintenance, alarm, and status features.
 - 8. High-water sensor to prevent overfilling.
- G. Controls:
 - 1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
 - 2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
 - 3. Field-adjustable timer to control drain cycle for flush duration and interval.
 - 4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
 - 5. Conductivity-type level controls.
 - 6. Provide interface with facility BAS to allow remote alarm notification, setpoint adjustment, and scheduling.
- H. Accessories:
 - 1. Humidistat: Return-duct-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
 - 2. Duct-mounting, high-limit humidistat.
 - 3. Airflow switch for preventing humidifier operation without airflow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.2 INSTALLATION

- A. Install humidifiers with required clearance for service and maintenance.
- B. Seal humidifier manifold duct or plenum penetrations with flange.
- C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- D. Install stainless-steel drain pan under each manifold mounted in duct.
 - 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
 - 2. Connect to condensate trap and drainage piping.
 - 3. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.
- E. Install manifold supply piping pitched to drain condensate back to humidifier.
- F. Install drip leg upstream from steam trap a minimum of [**12 inches (300 mm)**] tall for proper operation of trap.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to humidifiers to allow service and maintenance.
 - 2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
- B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
- C. Install piping from safety relief valves to nearest floor drain.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 238413

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. RS-485 cabling.
 - 2. Low-voltage control cabling.
 - 3. Control-circuit conductors.
 - 4. Identification products.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

- A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches (1520 mm) or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CMR.
 - 1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1685.

2.4 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMR.
 - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1685.

2.5 CONTROL-CIRCUIT CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Encore Wire Corporation.
 2. General Cable Technologies Corporation.
 3. Southwire Company.
- B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.
- C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway complying with UL 83.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
1. Smoke control signaling and control circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
- B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1 and NFPA 70.
- B. General Requirements for Cabling:
1. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 2. Cables may not be spliced.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems".
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
7. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems". Monitor cable pull tensions.
8. Support: Do not allow cables to lay on removable ceiling tiles.
9. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
- a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.5 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

- A. Comply with requirements in Division 07.

3.7 GROUNDING

- A. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 2. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Section 260548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. ERICO International Corporation.
 - c. Thomas & Betts Corporation.
 - d. Unistrut; Tyco International, Ltd.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 5. Toggle Bolts: All-steel springhead type.
 6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260573.16 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and equipment evaluation reports.
 - 3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Specialist.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01, include the following:
 - a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - b. Power system data.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:
1. ESA Inc.
 2. Operation Technology, Inc.
 3. Power Analytics, Corporation.
 4. SKM Systems Analysis, Inc.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study:
1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- F. Protective Device Coordination Study:
1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - c. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - d. Cables and conductors damage curves.
 - e. Ground-fault protective devices.
 - f. Motor-starting characteristics and motor damage points.
 - g. Generator short-circuit decrement curve and generator damage point.
 - h. The largest feeder circuit breaker in each motor-control center and panelboard.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

5. Provide adequate time margins between device characteristics such that selective operation is achieved.
6. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- E. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- F. Motor Protection:
 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- H. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- I. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- J. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Low-voltage switchgear.
 - 3. Motor-control centers.
 - 4. Standby generators and automatic transfer switches.
 - 5. Branch circuit panelboards.
- K. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
 - 1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 241 and IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative.
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Electrical power utility impedance at the service.
3. Short-circuit current at each system bus, three phase and line-to-ground.
4. Voltage level at each bus.
5. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
9. Maximum demands from service meters.
10. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
11. Motor horsepower and NEMA MG 1 code letter designation.
12. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
13. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Time-current-characteristic curves of devices indicated to be coordinated.
 - g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - h. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

3.4 FIELD ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
2. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Lighting contactors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Mfg. Company Inc.
4. NSi Industries LLC; TORK Products.
5. Tyco Electronics; ALR Brand.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: SPST.
3. Contact Rating: 20-A ballast load, 120-/240-V ac.
4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
5. Automatic daylight savings time changeover.
6. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. Sensor Switch, Inc.
9. Square D; a brand of Schneider Electric.

B. General Requirements for Sensors: Ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell H-MOSS or comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Leviton Mfg. Company Inc.
 3. Lightolier Controls.
 4. Sensor Switch, Inc.
 5. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[,
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag OS:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 1000 sq. ft. (84 sq. m).
 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Voltage: Match the circuit voltage type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

D. Wall-Switch Sensor Tag WS2:

1. Standard Range: 180-degree field of view, with a minimum coverage area of 1000 sq. ft. (84 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, dual circuit, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Match the circuit voltage; type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation.
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
5. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and mechanically held, combination-type lighting contactors complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
5. Where two-wire maintained switch control is indicated, provide solid-state control modules as required for indicated switching arrangement.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes manually operated lighting controls with relays, time clock, photocell control, external source relays and control module.
- B. Related Sections:
 - 1. Section 260923 "Lighting Control Devices" for time clocks, photoelectric sensors, occupancy sensors, and multipole contactors.

1.3 DEFINITIONS

- A. BACnet: A networking communication protocol that complies with ASHRAE 135.
- B. BAS: Building automation system.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- F. PC: Personal computer; sometimes plural as "PCs."
- G. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
- H. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.
- I. UTP: Unshielded twisted pair.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- B. Field quality-control reports.
- C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 1. Match components and interconnections for optimum performance of lighting control functions.
- B. Coordinate lighting control components specified in this Section with components specified in Section 262416 "Panelboards."

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 2. Warranty Period: Two years from date of Substantial Completion.
 3. Extended Warranty Period Failure Due to Transient Voltage Surges: five years.
 4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.10 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell LX series or comparable product by one of the following:
 - 1. Acuity Brands Lighting, Inc.; Lithonia Lighting brand.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lighting Control & Design, Inc.
 - 4. Lightolier Controls; a division of Genlyte Group, LLC.
 - 5. Lutron Electronics Co., Inc.

2.2 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

2.3 CONTROL MODULE

- A. Control Module Description: Comply with UL 508 (CAN/CSA C22.2, No. 14); microprocessor-based, networked, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.

2.4 POWER DISTRIBUTION COMPONENTS

- A. Modular Relay Panel: Comply with UL 508 (CAN/CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
1. Cabinet: Steel with hinged, locking door.
 - a. Barriers separate low-voltage and line-voltage components.
 - b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
 - c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
 2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
 - a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
 - b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
 - c. Endurance: 50,000 cycles at rated capacity.
 - d. Mounting: Provision for easy removal and installation in relay cabinet.
- B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels or field-mounting surge suppressors that comply with Section 264313 "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for Category A locations.

2.5 MANUAL ANALOG SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
1. Match color specified in Section 262726 "Wiring Devices."
 2. Integral green LED pilot light to indicate when circuit is on.
- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 262726 "Wiring Devices."
- C. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."
- D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

- A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.
- B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
 - 1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Section 262726 "Wiring Devices."
 - 2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Section 271500 "Communications Horizontal Cabling."
- E. RS-485 Cables:
 - 1. Standard Cable: NFPA 70, Type CMR.
 - a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1581.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Minimum conduit size shall be 1/2 inch (13 mm).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. For power wiring comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- G. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Test for circuit continuity.
 2. Verify that the control module features are operational.
 3. Check operation of local override controls.
 4. Test system diagnostics by simulating improper operation of several components selected by Architect.
- C. Lighting controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.3 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. See Division 01 for further information.

END OF SECTION 260943

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Source quality-control test reports.
- C. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. ACME Electric Corporation; Power Distribution Products Division.
 2. Eaton Electrical Inc.; Cutler-Hammer Products.
 3. General Electric Company.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Siemens Energy & Automation, Inc.
5. Sola/Hevi-Duty.
6. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Aluminum.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2 unless otherwise noted.
 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
 1. Finish Color: Gray
- F. Taps for Transformers Smaller Than 3 kVA: None
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding the shield.
 - 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- M. Wall Brackets: Manufacturer's standard brackets.
- N. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
 - 1. 9 kVA and Less: 37dBA.
 - 2. 30 to 50 kVA: 42dBA.
 - 3. 51 to 150 kVA: 47dBA.
 - 4. 151 to 300 kVA: 52dBA.

2.4 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Finish Color: Gray

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
 - 3. Comply with NFPA 70E.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.11 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets as indicated on the drawings.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel or Same finish as panels and trim.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder
- C. Incoming Mains Location: Top or bottom to match feeder locations.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

D. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only as scheduled.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only as scheduled.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Panelboards will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Hospital-grade receptacles.
4. Weather-resistant receptacles.
5. Snap switches and wall-box dimmers.
6. Wall-switch occupancy sensors.
7. Cord and plug sets.
8. Floor service outlets, poke-through assemblies, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
 - 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).
- B. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 8310 (single), 8300 (duplex).
 - b. Hubbell; HBL8310 (single), HBL8300 (duplex).
 - c. Leviton; 8310 (single), 8300 (duplex).
 - d. Pass & Seymour; 8301 (single), 8300H (duplex).
 2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.

2.4 GFCI RECEPTACLES

- A. General Description:
 1. Straight blade, feed -through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGFH20.
 - b. Hubbell; HFR8300HL.
 - c. Leviton; 7899-HG.
 - d. Pass & Seymour; 2095HG.

2.5 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A unless otherwise indicated: Comply with NEMA WD 1, NEMA WD 6 Configuration, and UL 498.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.6 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
1. Matching, locking-type plug and receptacle body connector.
 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
 4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

- A. Description:
1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
 3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.8 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Single Pole:
 - 2) Cooper; AH1221.
 - 3) Hubbell; HBL1221.
 - 4) Leviton; 1221-2.
 - 5) Pass & Seymour; CSB20AC1.
 - 6) Two Pole:
 - 7) Cooper; AH1222.
 - 8) Hubbell; HBL1222.
 - 9) Leviton; 1222-2.
 - 10) Pass & Seymour; CSB20AC2.
 - 11) Three Way:
 - 12) Cooper; AH1223.
 - 13) Hubbell; HBL1223.
 - 14) Leviton; 1223-2.
 - 15) Pass & Seymour; CSB20AC3.
 - 16) Four Way:
 - 17) Cooper; AH1224.
 - 18) Hubbell; HBL1224.
 - 19) Leviton; 1224-2.
 - 20) Pass & Seymour; CSB20AC4.
- C. Pilot-Light Switches, 20 A:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221PL for 120 and 277 V.
 - b. Hubbell; HBL1201PL for 120 and 277 V.
 - c. Leviton; 1221-LH1.
 - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
 - 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

2.9 DECORATOR-STYLE DEVICES

- A. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).
 - c. Leviton; 5621-2 (single pole), 5623-2 (three way).
 - d. Pass & Seymour; 2621 (single pole), 2623 (three way).
- B. Lighted Toggle Switches, Square Face, 120/277V, 15 A: Comply with NEMA WD 1 and UL 20.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 7631 (single pole), 7633 (three way).
 - b. Hubbell; DS120IL (single pole), DS320 (three way).
 - c. Leviton; 5631-2 (single pole), 5633-2 (three way).
 - d. Pass & Seymour; 2625 (single pole), 2626 (three way).
 2. Description: With neon-lighted handle, illuminated when switch is "off."
- C. Pilot-Light Switches, Square Face, 20 A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell; SNAP212PL for 120 and 277 V.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON".

2.10 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.11 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Material for Finished Spaces: , satin-finished, Type 302 stainless steel 0.04-inch- (1-mm) thick.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.12 FLOOR SERVICE FITTINGS

- A. Type: Modular, flap-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular or Round, with finish as selected by Architect.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 271500 "Communications Horizontal Cabling."

2.13 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Pass & Seymour/Legrand.
 3. Square D/Schneider Electric.
 4. Thomas & Betts Corporation.
 5. Wiremold/Legrand.
- B. Description:
1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
 2. Comply with UL 514 scrub water exclusion requirements.
 3. Service-Outlet Assembly Flush type with four simplex receptacles and space for four RJ-45 jacks complying with requirements in Section 271500 "Communications Horizontal Cabling."
 4. Size: Selected to fit nominal 4-inch (100-mm) cored holes in floor and matched to floor thickness.
 5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 6. Closure Plug: Arranged to close unused 4-inch (100-mm) cored openings and reestablish fire rating of floor.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 271500 "Communications Horizontal Cabling."

2.14 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 - 2. Test Instruments: Use instruments that comply with UL 1436.
 - 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Test straight-blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

- 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
- 3. Current-limitation curves for fuses with current-limiting characteristics.
- 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
- 5. Coordination charts and tables and related data.
- 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified Division 01, include the following:

- 1. Ambient temperature adjustment information.
- 2. Current-limitation curves for fuses with current-limiting characteristics.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. Littelfuse, Inc.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders: Class RK1, time delay or Class RK5, time delay.
 - 2. Motor Branch Circuits: Class RK5, time delay.
 - 3. Other Branch Circuits: Class RK1, time delay or Class RK5, time delay.
 - 4. Control Circuits: Class CC, time delay.
- B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac as appropriate for circuit voltage, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw,-240 or 600-V ac as appropriate for circuit voltage, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 4.
 - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- D. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- F. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- G. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 8. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.4 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device Coordination Study."

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Nameplate legends.
 - d. Short-circuit current rating of integrated unit.
 - e. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.
- C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electrical systems.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with interruption of electrical systems without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 - 2. Configuration: Nonreversing.
 - 3. Surface mounting.
 - 4. Red pilot light.
- C. Magnetic Controllers: Full voltage, across the line, electrically held.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 - 2. Configuration: Nonreversing
 - 3. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 120-V ac maximum; obtained from integral CPT, with primary and secondary fuses, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. Melting Alloy Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 7. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
 8. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 9. N.O., isolated overload alarm contact.
 10. External overload reset push button.
- D. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 2. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 3. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

4. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.O. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

5. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. N.O. alarm contact that operates only when MCCB has tripped.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 1. Dry and Clean Indoor Locations: Type 1.
 2. Outdoor Locations: Type 3R
 3. Other Wet or Damp Indoor Locations: Type 4X.

2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, type.
 - a. Push Buttons: Recessed types; momentary.
 - b. Pilot Lights: LED types; colors as indicated; push to test.
 - c. Selector Switches: Rotary type Hand-off-automatic for units with remote automatic control; on-off for units with only local control.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Reversible N.C./N.O. auxiliary contact(s).
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- D. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

- D. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers

END OF SECTION 262913

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
- B. Related Requirements:
 - 1. Division 21 for automatic transfer switches for fire pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. Retain one of first two subparagraphs below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

is critical to valid certification. Second definition is used for essential facilities where equipment must operate immediately after an earthquake.

- b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
 1. Features and operating sequences, both automatic and manual.
 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.
- G. Comply with NFPA 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Notify Owner no fewer than five days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 COORDINATION

- A. For floor mounted equipment, coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Contactor Transfer Switches:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide products manufactured by Emerson; ASCO Power Technologies, LP or comparable product by one of the following:
 - a. Kohler Power Systems; Generator Division.
 - b. Onan/Cummins Power Generation; Industrial Business Group.
 - c. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 260553 "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- I. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

G. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Interior lighting fixtures, lamps, and ballasts.
- 2. Exit signs.
- 3. Lighting fixture supports.

B. Related Sections:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- 2. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Ballast, including BF.
 3. Energy-efficiency data.
 4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples: As requested by Architect. Each Sample shall include the following:
1. Lamps and ballasts, installed.
 2. Cords and plugs.
 3. Pendant support system.
- D. Installation instructions.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Lighting fixtures.
 2. Suspended ceiling components.
 3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
 4. Ceiling-mounted projectors.
 5. Structural members to which suspension systems for lighting fixtures will be attached.
 6. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Access panels.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of fixtures for mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.9 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
- G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.
- H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher unless otherwise noted.
10. Power Factor: 0.95 or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electronic Programmed-Start Ballasts: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.

D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

E. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.
- G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
 - 4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
- H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
 - 1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 50 percent of rated lamp lumens.
 - 2. Ballast shall provide equal current to each lamp in each operating mode.
 - 3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
 - 1. Lamp end-of-life detection and shutdown circuit.
 - 2. Automatic lamp starting after lamp replacement.
 - 3. Sound Rating: Class A.
 - 4. Total Harmonic Distortion Rating: Less than 20 percent.
 - 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 6. Operating Frequency: 20 kHz or higher.
 - 7. Lamp Current Crest Factor: 1.7 or less.
 - 8. BF: 0.95 or higher unless otherwise indicated.
 - 9. Power Factor: 0.95 or higher.
 - 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.6 FLUORESCENT LAMPS

- A. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature as scheduled, and average rated life of 20,000 hours unless otherwise indicated.
- B. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature as scheduled, and average rated life of 20,000 hours unless otherwise indicated.
- C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature as scheduled, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.
1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 2. Install lamps in each luminaire.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Lighting Fixtures Supports:
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to generator and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
 - 1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding rods.
 - 5. Grounding labeling.

1.3 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. EMT: Electrical metallic tubing.
- C. TGB: Telecommunications grounding busbar.
- D. TMGB: Telecommunications main grounding busbar.

1.4 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. Ground rods.
 - 2. Ground and roof rings.
 - 3. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B. Qualification Data: For installation supervisor, and field inspector.
- C. Field quality-control reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01, include the following:
 - a. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

- A. Comply with J-STD-607-A.

2.2 CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Panduit Corp.
 - 2. Tyco Electronics Corp.
 - 3. Hubbell
 - 4. Commscope
- B. Comply with UL 486A-486B.
- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: **No. 6 AWG.**

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG **26 kcmils (13.3 sq. mm)** and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
2. Not smaller than No. 10 AWG **26 kcmils (13.3 sq. mm)]**and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Manufacturers: Subject to compliance with requirements, or comparable product by one of the following:
 1. Burndy; Part of Hubbell Electrical Systems.
 2. Chatsworth Products, Inc.
 3. Panduit Corp.
 4. Tyco Electronics Corp.
 5. Commscope
- C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 1. Electroplated tinned copper, C and H shaped.
- D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Busbar Connectors: Cast silicon bronze, solderless compression type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.
- F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, **1/4 by 4 inches (6.3 by 100 mm)** in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a **4-inch (100-mm)** clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- B. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 - 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm long, with)stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet (19 mm **by 3 m**) in diameter.

2.6 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with J-STD-607-A.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm.)

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.
4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding bus bars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 1. Use crimping tool and the die specific to the connector.
 2. Pretwist the conductor.
 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
 - 1. Install the conductors in grid pattern on 4-foot (1200-mm) centers, allowing bonding of one pedestal from each access floor tile.
 - 2. Bond the TGB of the equipment room to the reference grid at two or more locations.
 - 3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

3.7 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB. Maximum acceptable ac current level is 1 A.
- D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Surface pathways.
7. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
3. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Alpha Wire Company.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney; a brand of EGS Electrical Group.
 - 6. Southwire Company.
 - 7. Thomas & Betts Corporation.
 - 8. Western Tube and Conduit Corporation.
 - 9. Wheatland Tube Company; a division of John Maneely Company.
- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- C. GRC: Comply with ANSI C80.1 and UL 6.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Arnco Corporation.
 - 5. CANTEX Inc.
 - 6. CertainTeed Corp.
 - 7. Condux International, Inc.
 - 8. Electri-Flex Company.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Niedax-Kleinhuis USA, Inc.
 - 11. RACO; a Hubbell company.
 - 12. Thomas & Betts Corporation.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Rigid HDPE: Comply with UL 651A.
- E. Continuous HDPE: Comply with UL 651B.
- F. RTRC: Comply with UL 1684A and NEMA TC 14.
- G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Alpha Wire Company.
 - 2. Arnco Corporation.
 - 3. Endot Industries Inc.
 - 4. IPEX.
 - 5. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Comply with UL 2024; flexible-type pathway, approved for riser installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Hoffman; a Pentair company.
 3. Mono-Systems, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with TIA-569-B.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with TIA-569-B.
- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mono-Systems, Inc.
 - b. Niedax-Kleinhuis USA, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Adalet.
 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. Hoffman; a Pentair company.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

6. Hubbell Incorporated; Killark Division.
7. Lamson & Sessions; Carlon Electrical Products.
8. Milbank Manufacturing Co.
9. Molex; Woodhead Brand.
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:

1. Material: Cast metal
2. Type: Fully adjustable
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, **cast** aluminum with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

K. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts.
 - c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: general purpose communications cabling may be run without conduit. Fiber optic cabling shall be run in EMT.
5. Damp or Wet Locations: IMC
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway
8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

B. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface pathways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange pathways to keep a minimum of **1 inch (25 mm)** of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to RNC, Type EPC-40-PVC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- R. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings. All pathways shall be recessed in walls or above ceilings in finished spaces unless noted otherwise.
 - 2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
 - 2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- W. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F (70 deg C)** temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F (86 deg C)** temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: **125 deg F (70 deg C)** temperature change.
 - d. Attics: **135 deg F (75 deg C)** temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- CC. Set metal floor boxes level and flush with finished floor surface.
- DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07.

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Coaxial cable.
3. Multiuser telecommunications outlet assemblies.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.
- G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- I. RCDD: Registered Communications Distribution Designer.
- J. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For coaxial cable, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration drawings and printouts.
 - 4. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - 5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Patch-Panel Units: one of each type.
 - 2. Connecting Blocks: one of each type.
 - 3. Device Plates: one of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: An NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cables to determine the continuity of the strand end to end.
 - 2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
 - 3. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 - 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 - 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.3 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 UTP CABLE

- A. Manufacturers: Siemon.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or CMG
 - b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
 - c. Communications, Riser Rated: Type CMR, complying with UL 1666.
 - d. Communications, Limited Purpose: Type CMX.
 - e. Multipurpose: Type MP or MPG.
 - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.5 UTP CABLE HARDWARE

- A. Manufacturers: Siemon.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: one for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 1. Number of Jacks per Field: one for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, four-pair cables in 36-inch (900 mm) lengths; terminated with eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.6 COAXIAL CABLE

- A. Manufacturers: Siemon
- B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- C. RG-11/U: NFPA 70, Type CATV.
 - 1. No. 14 AWG, solid, copper-covered steel conductor.
 - 2. Gas-injected, foam-PE insulation.
 - 3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
 - 4. Jacketed with sunlight-resistant, black PVC or PE.
 - 5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
- D. RG-6/U: NFPA 70, Type CATV or CM.
 - 1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - 2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 - 3. Jacketed with black PVC or PE.
 - 4. Suitable for indoor installations.
- E. RG59/U: NFPA 70, Type CATV.
 - 1. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - 2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
 - 3. PVC jacket.
- F. RG59/U (Plenum Rated): NFPA 70, Type CMP.
 - 1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 - 2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
 - 3. Copolymer jacket.
- G. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
 - 1. CATV Cable: Type CATV.
 - 2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
 - 3. CATV Riser Rated: Type CATVR, complying with UL 1666.
 - 4. CATV Limited Rating: Type CATVX.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.7 COAXIAL CABLE HARDWARE

- A. Manufacturers: Siemon
- B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.8 CONSOLIDATION POINTS

- A. Manufacturers: Siemon.
- B. Description: Consolidation points shall comply with requirements for cable connecting hardware.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
 - 2. Number of Connectors per Field:
 - a. One for each four-pair UTP cable indicated.
 - b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
 - 3. Mounting: recessed in ceiling
 - 4. NRTL listed as complying with UL 50 and UL 1863.
 - 5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.9 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Provide port-connector assemblies mounted in single faceplate.
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
 - 3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.10 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.11 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.12 SOURCE QUALITY CONTROL

- A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- B. Factory test UTP cables according to TIA/EIA-568-B.2.
- C. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.
- D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- E. Cable will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
 - 3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
6. Terminate conductors; no cable shall contain non terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than **60 inches (1524 mm)** apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

- A. Comply with requirements in Division 07.
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Administration Class: 1.
 - 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- C. Comply with requirements in Division 09 for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.
- E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- G. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 - 2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
 - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 5. UTP Performance Tests:
 - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
 - 6. Coaxial Cable Tests: Conduct tests according to Section 274133 "Master Antenna Television System."
 - 7. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within 2 years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

END OF SECTION 271500

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire alarm wire and cable.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Pathways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Seismic Qualification Certificates: For pathways, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Source quality-control reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 PROJECT CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
 - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Comtran Corporation.
 - 2. Draka Cableteq USA.
 - 3. Genesis Cable Products; Honeywell International, Inc.
 - 4. Rockbestos-Suprenant Cable Corp.
 - 5. West Penn Wire; a brand of Belden Inc.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
1. Low-Voltage Circuits: No. 16 AWG, minimum.
 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
- B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
 1. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 2. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 3. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.4 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method:
 - 1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 - 2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Type CI, is permitted.
 - 3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

3.5 CONNECTIONS

- A. Comply with requirements in Division 28 Section "Digital Addressable Fire-Alarm System " for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

- A. Comply with requirements in Division 07.

3.7 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- C. Prepare test and inspection reports.

END OF SECTION 260520

SECTION 283111 - FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders.

B. Related Requirements:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Show field wiring required for HVAC unit shutdown on alarm.
12. Locate detectors according to manufacturer's written recommendations.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For fire-alarm control unit accessories and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1.6 Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01, include the following and deliver copies to authorities having jurisdiction:

- a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
- c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
- d. Riser diagram.
- e. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
- f. Manufacturer's required maintenance related to system warranty requirements.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

1.9 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
- C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. All components provided shall be listed for use with the existing system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Combustible gas detectors.
 6. Automatic sprinkler system water flow.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

7. Preaction system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Release fire and smoke doors held open by magnetic door holders.
5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
6. Close smoke dampers in air ducts of designated air-conditioning duct systems.
7. Activate preaction system.
8. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. User disabling of zones or individual devices.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in internal circuits of fire-alarm control unit.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

2.4 FIRE-ALARM CONTROL UNIT

- A. Manufacturer: The existing fire alarm control unit was manufactured by Notifier.
- B. Provide common components, control panel modifications, power supplies relays, batteries, programming, etc. as required to support full operation of components added to the system under the work of this section.

2.5 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. Where surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type.
 - 2. Station Reset: Key- or wrench-operated switch per local fire department requirements.

2.6 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Detectors shall be two-wire type.
 - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- B. Photoelectric Smoke Detectors
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 - 2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 3. Relay Fan Shutdown: rated to interrupt fan motor-control circuit.

2.7 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, red.

2.9 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Expand, modify, and supplement existing control equipment as necessary to extend existing functions to the new devices. New components shall be capable of merging with existing configuration without degrading the performance of the system.
- C. Install wall-mounted equipment, with tops of cabinets not more than **78 inches (1980 mm)** above the finished floor.
- D. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within **60 inches (1520 mm)** of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between **42 inches (1060 mm)** and **48 inches (1220 mm)** above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- E. Smoke- or Heat-Detector Spacing:

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed **30 feet (9 m)**.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
 5. HVAC: Locate detectors not closer than **36 inches (910 mm)** from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than **12 inches (300 mm)** from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than **36 inches (9100 mm)** long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- H. Audible Alarm-Indicating Devices: Install not less than **6 inches (150 mm)** below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least **6 inches (150 mm)** below the ceiling. Install all devices at the same height unless otherwise indicated.

3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08. Connect hardware and devices to fire-alarm system.
1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 GROUNDING

- A. Ground fire-alarm associated circuits; comply with IEEE 1100.

EYECARE MEDICAL GROUP
PHASE 2 – ADDITION & RENOVATION

- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111