

SECTION 16500

INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Division 0, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 16010, Basic Electrical Requirements.
- C. Section 16050, Basic Electrical Materials and Methods.

1.02 SECTION INCLUDES

- 1. Luminaires and lamp holders
- 2. Lamps
- 3. Ballasts
- 4. Exit signs
- 5. Emergency lighting units
- 6. Photocell controls
- 7. Lighting relay panels

1.03 SUBMITTALS

- A. Submit shop drawings, product data, test data, warranties, and other information as appropriate for the following:
 - 1. Luminaires
 - 2. Lamps
 - 3. Ballasts
 - 4. Emergency lighting units
 - 5. Exit signs
 - 6. Photocell controls
 - 7. Lighting relay panels
- B. Shop Drawings: Indicate construction details for products which are not manufacturer's standard, when product data does not adequately describe fixture physical characteristics, or upon request by Engineer.
- C. Product Data: Provide product data for each luminaire and lighting unit.
- D. Submit written warranty for extended warranty items such as batteries and ballasts.
- E. Submit luminaire shop drawings in booklet form with a separate sheet for each luminaire type. Indicate clearly on each sheet the proposed luminaire "type" designation, manufacturer, luminaire lamp, and ballast designation.
- F. Submittals shall indicate materials, finishes, metal gauges, overall and detail dimensions, sizes of electrical and mechanical connections, fasteners, welds, joints, end conditions, provisions for the work of others and similar information.
- G. A photometric test report showing photometric candlepower distribution, brightness, coefficients of utilization, and paint reflectance shall be included for all fluorescent and HID fixtures. Photometric reports shall be prepared for actual fixture, lamp, lens, and ballast combination. Certify data as that taken under National Bureau of Standards calibrated test conditions according to standards of the Illuminating Engineering Society; upon request, submit photometric test of proposed fixture prepared by an independent testing laboratory such as ETL.

- H. The submittals shall state whether or not the fixture, as an assembly, has been UL tested and approved.
- I. Upon request, submit sample products for inspection. Provide luminaires identical with approved samples; retain approved samples at site for comparison until after all other luminaires have been shipped to site and installed. Transportation charges for samples shall be paid by Contractor. Unapproved samples will be returned at Contractor's expense. Upon notification of disapproval, immediately submit new samples that meet contract requirements.
- J. Upon request by Engineer, provide computerized illumination calculation data for specified interior or exterior areas in digital or isofootcandle format and in such detail as requested.
- K. Operating and Maintenance Instructions: Provide maintenance and operating instructions for battery powered lighting units. Include technical data sheets and parts ordering information for components used in all luminaires.

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed by Underwriters Laboratories, Inc., ETL Testing Laboratories, or other testing firm acceptable to the Owner.
- B. Conform to requirements of ANSI/NFPA 70.
- C. Conform to requirements of NFPA 101.

1.05 QUALITY ASSURANCE

- A. Warrant all lighting and components for one year after acceptance of the work and at no additional cost to the Owner, promptly provide and install replacements for luminaires or components which are defective in materials or workmanship; or repair installed equipment at the job site as necessary to restore first class operating condition. For any time during the warranty period that luminaires are not fully functional due to defects in materials or workmanship, provide, install, and remove suitable temporary lighting. Warrant replacement luminaires in a similar manner for a period of one year following replacement including replacement of defective replacements.
- B. Warrant ballasts, batteries, and occupancy sensors as further specified herein.
- C. Provide products of firms regularly engaged in the manufacture of interior luminaires or components of similar types and ratings to those required. Such products shall have been in satisfactory use in similar applications for not less than two years.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver luminaires and their components to job site, factory assembled and wired to the greatest extent practical, in strict accordance with approved shop drawings, samples, certificates and catalog cuts.
- B. Protect exposed finishes during manufacture, transport, storage and handling; replace damaged materials.
- C. Luminaires shall be stored under cover, above the ground, in clean, dry areas, and be tagged and/or marked as to type and site destination.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide lighting fixtures as listed on the Lighting, Lamping, and Fixture Schedule on the drawings and as specified herein that meet the physical, performance and quality standard exhibited by that fixture. Substitutes shall be equal in all respects including mechanical, electrical, physical, performance,

photometric, and quality characteristics except minor variances in construction details which do not affect overall quality or performance are permitted.

- B. Accessories: Provide required accessories for mounting and operation of each luminaire as indicated.
 - 1. Recessed Luminaires: Provide trim type suitable for ceiling system in which luminaire is installed; design fixtures to operate in a 140EF environment.
 - 2. Thermal Protection: Provide thermal protection devices to meet NFPA 70 requirements.
 - 3. Surface Luminaires: Provide spacers and brackets required for mounting; design for a minimum ambient temperature of 92EF.
 - 4. Pendant Luminaires: Provide swivel hangers, pendant rods, tubes, chains, and other hardware as required and/or indicated to install luminaire at appropriate height.

2.02 FLUORESCENT TROFFERS

- A. Provide luminaires with UL or ETL label indicating fixture meets applicable UL 1570 requirements.
- B. Bodies: Form from code gauge steel. After fabrication, treat metal parts with a five stage coating of zinc phosphate and finish coat with white polyester powder paint and bake.
 - 1. Light reflecting surfaces of the fixture shall have a minimum initial reflectance of 88% in the visible range of 400-700 nanometers per ASTM Method E424-71, and shall not yellow or fade with age. Test for fading by covering one half of sample and expose remaining half to a 150 watt sunlamp placed ½" above reflective surface for 72 hours. Comparison of exposed and unexposed sides shall show no visible fading or deterioration in appearance or reflectance. The percentage of Specular Gloss shall be a minimum of 80% as determined by ASTM Method D-523-T, Procedure A.
- C. Design ballast mounting to effectively dissipate heat and allow ballast replacement without the need for special tools. Construct luminaire with a minimum number of joints using only welds, brazing, or screws.
- D. Provide fixture enclosures with an easily operated and reliable latch. Enclosure shall hang from fixture body when unlatched and be readily removable for cleaning. Fixture shall be designed to allow relamping without the use of tools. Construct luminaire to be free from light leaks by the inherent design of body and frame. Where gaskets are necessary, securely bond to body or enclosure frame.
- E. Enclosure Lenses: Extruded or injection molded as indicated, 100% clear virgin acrylic, minimum transmittance of 80%, photometric performance within +/- 5% of the published photometric data given for the referenced fixture, meeting the following:
 - 1. Lenses designated "A12" or "A12.125" shall be nominal 0.125" overall thickness with either 1/8" or 3/16" male or female prisms with non-curved prism faces. Female prism shall have a maximum depth of 0.053" for 1/8" prisms and 0.080" for 3/16" prisms. Male prisms shall have a minimum unpenetrated thickness of 0.090" or thicker. Lens shall be minimum of 7.5 oz. per square foot and show no visible evidence of sagging in the installed position, be strain free, uniform in appearance, and destaticized.
 - 2. Lenses designated "A19" shall comply with the above except provide minimum 0.1875" nominal overall thickness, minimum unpenetrated thickness of .100".
- F. Lamp holders shall be designed to securely hold lamp in place, provide for easy lamp removal and installation, and have low resistance contact to lamp pins suitable for electronic ballasts.
- G. Mark fixture with proper lamp characteristics, i.e. "Use lamps only". Affix lamp marking in a location not visible from normal viewing angles, but readily visible to maintenance personnel.
- H. Provide wiring between fluorescent lamp holders and associated operating and starting equipment in compliance with UL 1570 and NEC.
- I. Provide electronic ballasts and arrange for switching control as indicated on the drawings. Use multiple lamp ballasts wherever possible; use tandem wiring between fixtures such that the use of one lamp ballasts are limited to single odd fixtures in a room or circuit, except where wiring distances over 10 feet or switch groups make it impractical. In tandem configurations, wire inboard lamps to one ballast and

outboard lamps to the other. Ballasts shall be of the same type and manufacturer for ease of stocking replacements.

2.03 FLUORESCENT WRAPAROUND FIXTURE

- A. Provide with 15" minimum width heavy duty prismatic acrylic diffuser, which meets, as a minimum, the requirements for "A12" lenses specified above in 2.03 (D). Linear side prisms shall control visual brightness and direct light onto adjacent ceiling.
- B. Housing shall be heavy duty code gauge steel, embossed for maximum rigidity, include embossed mounting projections to allow direct mounting on low density cellulose ceilings.

2.04 FLUORESCENT WET LOCATION FIXTURE

- A. Bodies: High impact and UV resistant reinforced polyester housing, UL listed for horizontal mounting in wet locations, equip with wet location fittings.
- B. Enclosures: High impact acrylic diffuser, secured to fully gasketed housing by six captive cam-action latches per four foot unit.
- C. Finish metal parts with five stage iron phosphate pretreatment and paint with high gloss baked enamel or polyester paint.

2.05 FLUORESCENT STRIP

- A. Bodies: Form from code gauge steel; after fabrication treat metal parts with a five stage coating of zinc phosphate, and finish coat with white polyester powder paint and bake.

2.06 HID LUMINAIRES

- A. Exterior Housing: Diecast aluminum with five stage polyester powder paint finish, electrical components solidly heat-sink mounted to housing, type as described on the drawings.
- B. Ballast: High power factor, energy efficient UL 1029 and ANSI C82.4, constant wattage autotransformer (CWA) or regulator, high power factor type, designed to operate on the voltage system to which they are connected.
 - 1. For outdoor installations, provide single lamp ballasts with a minimum starting temperature of -20°F. Construct so that open circuit operation will not reduce its rated life.
 - 2. High Pressure Sodium (HPS) ballasts shall have a solid state igniter/starter with an average life in the pulsing mode of 10,000 hours at the intended ambient temperature. Igniter case temperature shall not exceed 90°C in any mode. Average life is defined as the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.
- C. Optics: High efficiency, spun or hydroformed aluminum or glass refractor similar to specified fixture, minimum photometric performance in accordance with fixtures listed on Lighting Fixture Schedule.

2.07 EXIT SIGNS

- A. LED Exit Sign Fixture with Battery Backup:
 - 1. Lamps: Manufacturer's standard, light emitting diode (LED) type designed to NFPA 101 and 70 marking of egress requirements. Warrant lamps for 5 years full replacement.
 - 2. Input Voltage: 277 volts for normal power, equip with self-contained battery, solid state charger with brown out protection, and test switch.
 - 3. Battery: Sealed nickel cadmium, warrant for five years full replacement, plus additional 7 years prorata.

- B. Construction:
 - 1. Housing: High strength cast aluminum, equip with low profile canopy mount.
 - 2. Housing and Lens in High Abuse Areas: Injection molded polycarbonate.
 - 3. Face: Aluminum or white painted steel stencil face with green letters, 6" high x 3/4" stroke.
 - 4. Directional Arrows: Universal type for field adjustment.
 - 5. Mounting: Universal, for field selection.
 - 6. Mounting in High Abuse Areas: Ceiling or wall as indicated.

2.08 EMERGENCY LIGHTING UNITS

- A. Self-contained emergency lighting unit.
 - 1. Input Voltage: 277 volts.
 - 2. Battery: Lead calcium maintenance free type, 3 year full, plus 7 year prorated (total 10 year) warranty. Gelled electrolyte batteries are not permitted.
 - 3. Battery Charger: Dual rate type, solid state, with low voltage and brown out protection.
 - 4. Lamps and Lamp holder: LH3-12V halogen, 12 watt.
 - 5. Housing: Steel with manufacturer's standard finish.
- B. Indicators and Controls: AC ON, RECHARGING; TEST switch, battery charge voltmeter.
- C. Electrical Connection: Hardwired.

2.09 LAMPS

- A. Manufacturers:
 - 1. General Electric
 - 2. Osram/Sylvania
 - 3. Venture
 - 4. Phillips
- B. Provide type and color indicated on the Lighting, Lamping, and Fixture Schedule.
- C. T-8, 1" diameter, nominal 32 watt lamps:
 - 1. Lamps shall only be operated on ballasts designed for T-8 lamps.
 - 2. Initial rated lumen output shall be at least 2,850 lumens.
 - 3. Rated lamp life shall be at least 15,000 hours and 20,000 hours, per IES LM 40-87 operating on an instant start or rapid start mode, respectively.
 - 4. LLD shall be a minimum mean lumen value of at least 90% of the initial lamp lumens at 40% of rated life and 84% at 70% of rated life.
 - 5. Lamp life shall be rated minimum 20,000 hours, color temperature shall be 3500°K, and color rendering index shall be 75 or better.
- D. T-8 U-Tube, 1" diameter, 31 watt, 6" leg spacing Lamps:
 - 1. Lamps shall only be operated on ballasts designed for T-8 lamps.
 - 2. Rated lamp life shall be at least 15,000 hours or 20,000 hours, per IES LM 40-87, operating in an instant start or rapid start mode, respectively.
 - 3. LLD shall be a minimum mean lumen value of at least 90% of the initial lamp lumens at 40% of rated life and 84% at 70% of rated life.
 - 4. Lamp life, color temperature, and color rendering index shall be as specified above for 32 watt lamp.
- E. Compact Fluorescent-General:
 - 1. Lamp shall be rare earth phosphor type with a correlated color temperature (CCT) of 3500 Kelvin, and color rendering index (CRI) of 80 or greater (NEMA designation RE 735).
 - 2. Minimum LLD shall be a mean lumen value of 85% at 40% of rated life.
 - 3. Installation shall conform to application manufacturers' recommendations for enclosed or open operation; of both lamps and ballasts.

- F. Compact Fluorescent (Twin or Quad) Tube Lamps for Use with Preheat Ballasts and Starters:
 1. Lamps shall be designed for operation with ballasts/starters system provided with luminaire.
 2. Lamp wattage and lumen rating shall be as indicated on the drawings.
- G. 400 watt clear metal halide HID.
 1. ANSI Specification Number M59.
 2. Operating position: base-up $\pm 15^\circ$ F.
 3. Nominal bulb diameter: 3.5".
 4. Base type: Mogul screw.
 5. Nominal light center length: 5".
 6. Maximum overall length: 8.3".
 7. Lamp shall only be operated on ballasts designed for this type lamp.
 8. Initial rated lumen output shall be at least 41,000 lumens.
 9. Average rated lamp life shall be at least 20,000 hours when operated at ten (10) hours per start.
 10. Mean lumens at 40% of rated life shall be at least 28,000 lumens.

2.10 FLUORESCENT ENERGY SAVER BALLASTS

- A. Use only where electronic ballasts are not available, or as indicated.
- B. Provide energy efficient fluorescent ballasts conforming where relevant to UL 935, "Fluorescent Lamp Ballasts"; ANSI C82.1, "Ballasts for Fluorescent Lamps - Specification"; ANSI C82.2, "Methods of Measurement of Fluorescent Lamp Ballasts"; ANSI NFPA/70; and Public Law 100-357 National Appliance Energy Conservation Amendment of 1988, as applicable.
- C. Provide fluorescent rapid start ballast suitable for use under installation conditions listed for each luminaire and lamp holder.
 1. Voltage: Dual voltage 120/277 volts.
 2. Ballasts for nominal 430 mA lamps.
 3. Power factor corrected to at least 95% lagging, maximum Total Line Current Harmonic Distortion 20%.
 4. Minimum rating of Premium, CBM certified, UL labeled.
- D. Provide sound rating of "A". Ballasts shall not exhibit excessive noise during start-up. Any ballast or group of ballasts in a space which contribute more than 1 db to the background room noise level when measured with a sound meter calibrated to the "A" scale may also be considered defective.
- E. Ballast shall start lamps at a minimum starting temperature of 50EF for 40W T-12, T-8, and T-5 lamps and 60E F for 34W T-12 lamps. Provide low temperature fluorescent ballasts having a minimum starting temperature of -20EF in luminaires located where ambient temperature may fall below 32E F.
- F. Ballasts shall withstand line transients as defined in ANSI/C62.41.
- G. Ballast shall not contain polychlorinated biphenyls (PCBs) and shall be labeled "NO PCBs."
- H. Ballast shall have a warranty of three (3) years and a replacement labor allowance of \$20.
- I. Lamp/ballast efficacy shall meet or exceed the minimum Lamp/Ballast Efficacy values shown in the table below.

Minimum 2-Lamp Ballast (120 and 277 V)	Lamp	(BEF) (Lumens)		Lamp/Ballast Efficacy
Electronic	F32T8 32W	1.52	2850	86.4
Electronic	T-5 22.5" 38-40W	1.30	3150	81.6

2.11 FLUORESCENT ELECTRONIC BALLASTS

- A. Electronic ballasts shall comply with the applicable requirements specified above for energy saver ballasts
- B. Ballasts shall operate the lamps at a frequency between 20 and 40 KHz from an input frequency of 60 Hz.
- C. Size the ballast case to be physically interchangeable with standard core and core ballasts and suitable for standard mounting in new or existing lighting fixtures.
- D. Mark the ballast to indicate the required supply voltage, frequency, RMS current, current surge during starting, input watts, power factor at the design center voltage, open circuit voltage, crest factor and efficacy.
- E. Performance:
 - 1. At the design voltage, the light output for the specified lamps shall be at least 15 percent greater than that obtained by a standard core-and-coil ballasted system meeting ANSI and CBM standards. The comparison test shall be measured in the same fixture at 25EC (plus or minus one degree) ambient room temperature.
 - 2. Tests shall be made in fixtures designed only for the number of lamps being tested.
 - 3. For other applications (higher ambients, etc.) the tests should be operated with equivalent lamp wall temperatures plus or minus 4EC.
 - 4. The ballast shall be capable of starting the specified lamps at an ambient temperature of 50EF or more for an input voltage of plus or minus 10 percent about the center design voltage.
 - 5. The ballast shall safely and reliably operate in a room ambient temperature from 50EF to 105EF.
 - 6. The light output shall not vary by more than plus or minus 15 percent for a plus or minus 10 percent variation of the input voltage about the center design voltage.
 - 7. The ballast shall operate the lamps in a manner that will not adversely curtail the normal life of the lamp.
 - 8. The ballast shall be able to withstand a single input surge of 6,000 volts from a 50 ohm 50 KHz damped sinewave source.
 - 9. Flicker shall be less than 5 percent.
 - 10. Audible noise levels shall be equivalent to the Class A rating of CBM certified ballasts.
 - 11. Ballasts shall meet the requirements of the Federal Communications Commission Rules and Regulations, Chapter 18, Part C (RF Lighting Devices), regarding radio frequency interference (RFI) and electromagnetic interference (EMI).
 - 12. Ballasts shall safely operate the specified lamps for two, three, or four lamp combinations in accordance with its rating. Failed lamps shall not affect ballast life.
 - 13. Power factor shall be not less than 90 percent, crest factor not more than 1.6, and total harmonic content not more than 10 percent of input current.
 - 14. Lamp/ballast efficacy shall meet or exceed the minimum Lamp/Ballast Efficacy values shown in the table above.
- F. Warranty: The ballast shall have a rated life of 10 years or 30,000 hours (based on a 10 hour day). Ballasts shall be warranted by the manufacturer unconditionally for 5 years; failed units within warranty period to be replaced at no charge to the Owner, plus pay \$20.00 per unit to Owner for replacement labor allowance. Deliver ballast manufacturer's written warranty under submittals to Engineer.
- G. Certifications: Ballasts shall be labeled or listed by UL, CBM or ETL. Submit a test report from an independent testing laboratory certified by a qualified registered professional engineer upon request showing that the electronic ballasts meet or exceed all the performance requirements in this specification.

2.12 COMPACT FLUORESCENT BALLASTS

- A. Ballasts and related hardware shall be designed to operate on the voltage system to which they are connected and be UL listed for operating the specified lamps in accordance with ANSI C82.1 and C78, as applicable, or in accordance with the specified lamp manufacturer's recommendations where no ANSI standards exist.

- B. Ballasts for indoor use shall start lamps at a starting temperature of 50EF. For outdoors applications or where ambient temperatures may fall below 50EF, manufacturers' minimum starting temperatures for lamps and ballasts shall be -20EF.
- C. Design ballasts to withstand line transients as defined in IEEE Publication 587, Category A, provide Class P thermal protection and sound rating of "A" for interior applications.
- D. Ballasts shall not contain polychlorinated biphenyls (PCBs).
- E. Lamp current crest factor shall not exceed 1.7 when tested with the lamps specified.
- F. Warranty for two years, follow applicable manufacturers' recommendations for enclosed or open operation of both lamps and ballasts.
- G. Electronic rapid or instant start ballasts for use with Compact Fluorescent Lamps without Integral Starters shall comply with the following:
 - 1. Ballasts shall comply with 2.11.A-F, above.
 - 2. Ballasts shall be designed expressly to operate the lamps specified.
 - 3. Ballasts shall meet the requirements of the Federal Communications Commission Rules and Regulations, Chapter 18, Part C (RF Lighting Devices), regarding radio frequency interference (RFI) and electromagnetic interference (EMI).
 - 4. Ballasts shall have a frequency of operation of 20 KHz or greater and incorporate adequate 60 Hz filtering in order to operate with less than 5% flicker (maximum 0.20 Flicker index) with any rare earth phosphor lamp suitable for the ballasts.
 - 5. Ballasts shall be high power factor type with a power factor of 0.9 or greater.
 - 6. Ballast total harmonic distortion shall not exceed 10%.
 - 7. Light output (ballast factor) shall be no less than 0.85 when tested with a compatible lamp.

2.13 LIGHTING RELAY CONTROL PANELS

- A. Acceptable Manufacturers:
 - 1. General Electric
 - 2. Lighting Control and Design.
- B. The lighting relay control panel shall be comprised of a panelboard style assembly including low voltage relays, microprocessor control system, operator interface, and related items, like GE TLC panels, or LCD GR panels. Provide panels with control capabilities indicated and specified.
- C. Mounting Panel: Flush mounted modular design with hinged lockable (all panels keyed alike) cover similar to circuit breaker panelboards. Design panels so that power wiring is contained in a separate compartment and external low voltage control wiring enters panel in the control compartment. Provide wiring/relay schedule card mounted inside door for circuit identification.
- D. Relays: Rated 20 amperes, 277 volts, low voltage electrically operated, mechanically latched, like GE RR9P series, or electrically held which carry a 10-year warranty and do not exhibit any noticeable hum or chatter when energized.
- E. Low Voltage Switches: Specification grade momentary pushbutton type with cover plates to match those specified for switches and outlets in Section 16050.
- F. Automatic Control Panel: Provide microprocessor control modules to allow time of day, day of week, control functions for each lighting circuit.
 - 1. Control shall allow a different schedule for each relay or group of relays.
 - 2. Provide each circuit with the means to incorporate external override control by manual switches and/or photocell control as indicated on the drawings.
 - 3. Provide 40 character x 8 line backlit LCD display and function specific keypad; programming functions shall be easily accomplished by nontechnical personnel.
 - 4. The system shall include a reliable backup power source capable of maintaining system time for a minimum of 48 hours after loss of power. Operating program and stored time schedules shall be

nonvolatile such that upon restoration of prime power, the system shall resume normal functions without operator intervention.

5. Each panel may contain its own control modules and operate independently, or a single control may be used to control all panels. If a single control is used, provide appropriate cabling for this purpose.

2.14 PHOTOCCELL SWITCH

- A. UL 773 or UL 773A, hermetically sealed cadmiumsulphide cell rated 240 volts ac, 60 hertz with single-throw contacts rated 1000 watts, and 600 volts.
- B. Mount switch in a cast weatherproof aluminum housing, with swivel arm mount, in a high impact resistant, noncorroding and nonconductive molded plastic housing, with an EEI-NEMA locking-type receptacle.
- C. The switch shall turn on below 3 footcandles and off at 3 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Mount a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Aim switch according to manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Examine adjacent surfaces to determine that surfaces are ready to receive work.
- B. Install wiring in accordance with Section 16010.
- C. Install luminaires and accessories in accordance with manufacturer's instructions, as indicated, with equipment, materials, parts, attachments, devices, hardware, hangers, cables, supports, channels, frames and brackets necessary to make a safe, complete, and fully operative installation.
- D. Install luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires, and secure in accordance with manufacturers' directions and approved shop drawings. Conform to the requirements of National Electrical Code ANSI/NFPA 70.
 1. Specified or indicated mounting heights are to be to the bottom of each luminaire for suspended and ceiling mounted luminaires, and to the center of each luminaire for wall mounted luminaires. Obtain approval of exact mounting for luminaires on the job before installation is commenced and, where applicable, after coordinating with type, style, and pattern of ceiling being installed.
 2. Provide pendant accessory to mount suspended luminaires and exit signs at height indicated. Use swivel hanger on sloped ceilings.
 3. Support surface mounted luminaires from ceiling grid tee structure; provide auxiliary support laid across top of ceiling tees and fasten to prohibit movement.
 4. Install recessed luminaires to permit removal from below and install earthquake clips.
 5. For lighting fixtures mounted in or on suspended ceilings, provide two support hangers per fixture so that each is independently supported from the building structure.
 6. Provide two support hangers for the minimum security fixtures so that each is independently supported from the building structure.
 7. Install lamps in luminaires and lamp holders.
 8. Ground non current carrying parts of electrical equipment in accordance with UL and NEC provisions.
- E. Install lighting fixtures where indicated on the plans; plans may be scaled for approximate locations; minor adjustments are permitted to avoid conflicts. Fixture placement that does not conform to the layout indicated shall be corrected; consult Engineer if in doubt about correct placement. Install all lighting so that it is securely fastened, rows are uniformly spaced and in alignment, and fixture rests flat on mounting surface.

- F. Install ballasts and fixtures to avoid amplifying hum. Any ballast or fixture which develops an excessive hum within one year shall be replaced.
- G. Where multilevel switching is indicated, all outer lamps shall be switched together and all inner lamps together.
- H. Install 2 x 2 fixtures for consistent lamp orientation within each room.
- I. Perform insulation resistance and ground continuity test.

3.02 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of work.
- B. Aim adjustable luminaires and lamp holders as indicated or as directed.
- C. Adjust directional arrows on exit signs to meet approval of authority having jurisdiction.
- D. Clean paint splatters, dirt, and debris from installed luminaires.
- E. Touch up luminaire and pole finish at completion of work.
- F. Relamp luminaires which have failed lamps at completion of work.

3.03 OWNER INSTRUCTION

- A. Provide on-site training of Owner's personnel in operation of controls systems by a factory trained manufacturer's representative. Include instruction in programming time controls to obtain required control functions. Provide one follow-up visit if necessary.

END OF SECTION