

SECTION 16470 – ISOLATED POWER SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 1, General Requirements, shall be included in, and made part of, this Section.

1.2 DESCRIPTION OF WORK

- A. The Electrical Subcontractor shall furnish and install the isolated power system equipment, including surgical facility panels, isolated power panels, portable laser and x-ray panels including all accessories such as line isolation monitors, remote outlets, power outlets grounding outlets and related circuitry as specified herein and as shown on the contract drawings.
- B. The following isolated power system equipment shall be provided for the new building, as a minimum, but not necessarily limited to the following:
 - 1. Isolated power panels.
 - 2. Three phase laser isolated power panels
 - 3. Line isolation monitors.
 - 4. Associated power and grounding outlets.
 - 5. Hoisting, rigging, setting of all equipment.
 - 6. Testing, cleaning and adjusting.
 - 7. Shop drawings.
 - 8. Phasing of construction and power interruptions.

1.3 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 16010.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.4 REFERENCES

- A. The surgical facility panels, isolated power panels, portable laser and X-Ray panels and all components shall be designed, manufactured and tested in accordance with the latest applicable edition of the following standards:
 - 1. NFPA 99 – Health Care Facilities
 - 2. NFPA 70 – National Electrical Code (NEC)
 - 3. NEC 517
 - 4. UL Standard 1047 – Isolated Power System Distribution Equipment
 - 5. UL Standard 1022 – Line Isolation Monitors

1.5 QUALITY ASSURANCE

- A. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.
- B. To ensure system compatibility, all components within the isolated power system shall be the products of one manufacturer.

1.6 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements, Section 01784 - Warranties and Section 16010 – Electrical Special Conditions regarding guarantees and warranties for the work under this Contract.

1.7 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 ACCEPTABLE MANUFACTURERS

- A. Square D
- B. Post Glover/Halsey

1.9 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with the Shop Drawings, Product Data and Samples Section 01330 in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.
- D. The equipment manufacturer shall submit the following information with each submittal:
 - 1. Master drawing index.
 - 2. Front view elevation.
 - 3. Floor plan.
 - 4. Top view.
 - 5. Single line.
 - 6. Control schematics and wiring diagrams.
 - 7. Nameplate schedule.
 - 8. Component list/bill of material.
 - 9. Conduit entry/exit locations.
 - 10. Assembly ratings including:
 - a. Short circuit rating.
 - b. Information regarding series short circuit ratings.
 - c. Voltage.
 - d. Continuous current.
 - e. Basic Impulse level for equipment over 600 volts.
 - f. KVA.
 - 11. Major component ratings including:
 - a. Voltage.
 - b. Continuous current.
 - c. Interrupting ratings.
 - 12. Cable terminal sizes.
 - 13. Impedance for transformers.
 - 14. Manufacturer's catalog data sheets.
 - 15. Test reports.

16. Certified sound level reports.
17. The following product information shall be submitted:
 - a. Descriptive bulletins.
 - b. Product sheets.

1.10 CLOSEOUT SUBMITTALS AND O & M MANUALS

- A. The following information shall be submitted for record purposes, in a binder, prior to final payment:
 1. Final as-built drawings and information for items listed above.
 2. Operation and maintenance manuals with the following information:
 - a. Instruction books and/or instruction leaflets
 - b. Recommended renewal parts
 3. Wiring diagrams.
 4. Certified production test reports.
 5. Installation information.

PART 2 - PRODUCTS

2.1 ENCLOSURES

- A. The back box housing the isolation transformer and related components shall be a minimum of 14 gauge steel which shall be degreased, phosphatized, primed and finish painted with a coat of baked enamel paint. 14 gauge galvanized steel is acceptable for flush mounted panels. The maximum depth of the panel shall not exceed 12 inches.
- B. The front trim shall be 12 gauge type 304 stainless steel polished to a #4 satin/brushed finish and shall have a 1.5 inch return flange on all sides. Front trim shall have a hinged door with keyed lock to give access to the circuit breakers and LIM and allow for testing. The entire section behind the hinged door shall be a dead front design. All hinges shall be concealed.
- C. The front trim shall not contain any type of grille or louver for the purpose of ventilation. The panel and transformer shall be so designed that the heat generated by the transformer under full load conditions shall not affect the normal operation of the circuit breakers, LIM or ground detector. The maximum front panel temperature shall not exceed 30 degrees C under full load continuous operation. Certification of the temperature test shall be provided to the Engineer upon request.
- D. Back boxes for accessories shall be fabricated of mild steel. When accessories are surface mounted the back box shall have a finished appearance, all seams shall be welded and ground

smooth with the outer surface of the box. The front trim shall be 14 gauge type 304 stainless steel with a #4 satin/brushed finish.

2.2 ISOLATION TRANSFORMER

- A. Transformer sizes, breaker quantities and sizes and primary and secondary voltage ratings for isolated power panels, duplex isolated power panels, three phase isolated power panels and portable x-ray isolated power panels shall be as scheduled on the drawings.
- B. Single Phase Transformers
 - 1. The transformer shall be wound with an electrostatic shield between the primary and secondary windings which shall be grounded to the enclosure. The electrostatic shield shall be designed such that it will prevent direct shorting of the primary winding to the secondary winding and reduce the coupling of harmonic distortions between the primary circuits and secondary circuits.
 - 2. Regulation shall not exceed 2.6% at 0.8 power factor at 20 degrees C above the full load continuous operating temperature in accordance with NEMA-ANSI Standards.
 - 3. The transformer shall have a Class H insulation system with a temperature rise of 55 degrees C above ambient under full load conditions when tested in accordance with NEMA-ANSI Standards. Transformer shall have a 220 degrees C UL recognized insulation system.
 - 4. The transformer shall be of the stacked core design and shall be securely clamped and bolted. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration dampening system. The core and coils shall be varnish impregnated and shall have a final wrap of insulating material to prevent exposure of bare conductors.
- C. Three Phase Transformers
 - 1. The transformer shall be wound with an electrostatic shield between the primary and secondary windings. The shield shall be connected to the reference ground point within the isolation panel. The electrostatic shield shall be designed such that it will prevent direct shorting of the primary winding to the secondary winding and reduce the coupling of harmonic distortions between the primary circuits and secondary circuits.
 - 2. Regulation shall not exceed 3.0% at unity power factor with the transformer current at full rated capacity in accordance with UL 1047. The manufacturer shall supply certified test data indicating compliance with this operating characteristic to ensure adequate voltage for critical equipment during high power demand conditions in the operating room.
 - 3. The transformer shall have a Class H insulation system with a temperature rise of 80 degrees C above ambient under full load conditions when tested in accordance with NEMA-ANSI Standards. Transformer shall have a 180 degrees C UL recognized insulation system.
 - 4. The transformer shall be of the stacked core design utilizing "E" or "I" shaped laminations. The laminations shall be securely clamped and bolted. Core laminations of the "wound" type, split "C" or "I" shaped will not be acceptable. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration dampening

system. The transformer assemblies shall be varnish impregnated and shall have a final layer of insulating material to protect the coils from damage during transport and installation.

- D. The total leakage current to ground from the transformer shall not exceed the values shown in UL 1047, Standard for Hospital Isolating Panels, Table 29.2
- E. Noise levels shall not exceed the values in the following table:

Transformer Rating (kVA)	Noise Level (db)
3	27
5	27
7.5	35
10	35
15	35
25	35

2.3 CIRCUIT BREAKERS

- A. Provide a primary and secondary main circuit breaker for each isolated power panel transformer. Refer to the drawings for voltage and ampere ratings and number of poles.
- B. Single Phase Isolated Power Panels
 - 1. All circuit breakers for single phase isolated power panels shall be 2 pole with a minimum interrupting rating of 10,000 amperes. Panel shall have a minimum capacity of 16 secondary circuit breakers,
- C. Three Phase Isolated Power Panels
 - 1. All circuit breakers for three phase isolated power panels shall be three pole with a minimum interrupting rating of 10,000 amperes. Panels shall have a minimum capacity of 8 secondary circuit breakers
- D. All circuit breakers shall be of the thermal-magnetic type.
- E. Refer to drawings for sizes and quantities of circuit breakers.

2.4 LINE ISOLATION MONITOR

- A. Each isolated power panel, duplex isolated power panel, three phase laser isolated power panel and portable x-ray isolated power panels shall be equipped with a line isolation monitor (LIM).
- B. The LIM shall be microprocessor based and shall use circuitry to continuously monitor the impedance from all secondary conductors of the isolated power system to ground. The LIM

shall be capable of detecting all combinations of resistive and capacitive faults whether they are balanced, unbalanced or hybrid. LIM's that internally switch between either line to ground will not be acceptable. The LIM shall not contribute more than 25 microamperes to the total hazard current of the system.

C. The LIM shall have the following specifications:

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|-------------------------------|------------------------|
| 1. Operating voltage: | 85 to 265 VAC |
| 2. Accuracy: | 5% or better |
| 3. Alarm level: | 2 or 5 mA (selectable) |
| 4. Alarm bandwidth: | Zero (0) |
| 5. Alarm hysteresis (on/off): | 50 micro amperes |
| 6. Mode: | Single- or three-phase |
| 7. Monitor hazard current: | 50 micro amperes |
| 8. Operating frequency: | 50 or 60 Hz |

D. The LIM shall alarm when the total hazard current reaches a value of 5 milliamperes. When the total hazard current is less than 5 milliamperes, a green light shall be illuminated indicating normal conditions. Should the total hazard current reach 5 milliamperes, a red light shall illuminate and a buzzer shall sound indicating alarm. A silence switch shall be provided to quiet the buzzer, which, when operated shall cause an amber warning light to illuminate, indicating that the audible signal has been silenced. The LIM shall automatically reset to normal status when the fault condition is corrected. The LIM shall also detect and signal an alarm if the ground connection to the LIM is broken. All lamps shall be long life LED type.

E. A momentary test switch shall be provided for periodic testing of the LIM circuitry. When pressed, the test switch shall check and recalibrate the unit. The test switch shall also perform a complete test of all indicating lamps and meters on the face of the LIM and at any remote indicating stations. Test switches that require manual reset will not be acceptable.

F. In addition to the test switch recalibration, the LIM shall be capable of automatically checking its calibration and recalibrating itself to original performance specifications every 90 minutes. If internal components are more than 30% out of original specifications because of aging or failure, the LIM shall notify the user by displaying an error message.

G. The LIM shall contain both analog and digital indication of the isolated power system's hazard current. Digital indication shall be provided by a digital meter and the analog indication shall be graph type calibrated from 0 – 160% of the alarm setting of the LIM.

H. Provide an external set of normally open and normally closed dry contacts, rated 3 amperes at 120 volt for use with external alarm systems. The LIM shall also provide an output signal of sufficient capacity to power remote indicator alarm units. This output signal shall not increase the hazard current of the system being monitored.

I. The LIM shall incorporate a loss-of-ground feature which will activate the audible and visual alarms when connection is lost with the reference ground of the isolated power system being monitored. The unit shall also display an error code in the digital display.

- J. The LIM shall be flush mounted on the front of the panel so that the LIM signals are clearly visible at all times. The LIM signals must not be obscured when the circuit breaker door is open.

2.5 MASTER REMOTE ANNUNCIATOR PANEL

- A. The LIM in each isolated power panel, duplex isolated power panel, three phase laser isolated power panel and portable x-ray isolated power panels shall report to a Master Remote Annunciator panel.
- B. Provide a master remote annunciator panel to provide centralized monitoring of all isolated power systems. The master remote annunciator panel shall be located at the nurse's station, as indicated on the drawings.
- C. The annunciator panel shall have one set of red, green and amber lights and a silence switch for each isolated power system. A buzzer shall provide audible annunciation of an alarm. The master remote annunciator shall be flush mounted. The lights shall mimic the lights on the associated line isolation monitor. The lights in the remote annunciator shall also mimic the lights on the LIM when the test switch on the LIM is depressed.

2.6 POWER AND GROUND OUTLETS

- A. Provide a Power and Ground Outlets with 8300-R, duplex straight blade power receptacles. Devices shall be flush mounted and located as indicated on the drawings. All receptacles shall be firmly attached with concealed fasteners that do not appear on the surface of the trim.
- B. Provide one Ground Module/Ground Jack panel located in OTS. Module shall contain one ground jack flush mounted. A #14 AWG to #1/0 AWG main lug shall be included.

2.7 LASER OUTLETS

- A. Provide Laser Outlets to match the laser plug in locations as shown on the drawings with a 50 ampere, NEMA type receptacle mounted in an angular recessed compartment. The laser outlet shall include a plug control interface switch. A door over the recessed compartment shall conceal the receptacle when not in use. The laser outlet shall be flush mounted. The remote line isolation monitor signals, consisting of red and green indication lights, warning buzzer and silence switch, shall be incorporated into the front trim.
- B. Provide a Plug in Control system for selective activation of each branch circuit so only those circuits with a laser machine plugged in will be energized. All other circuits will remain OFF, but not locked out. The system shall interface with the outlet module. A series of branch circuit contactors and relays shall be provided to control both the power and the line isolation monitor signals for each circuit.

2.8 WIRING

- A. All components within the isolation panel shall be prewired using low leakage type XHHW wire. A barriered compartment shall be provided for the incoming primary feeder and separation shall be maintained between grounded and ungrounded conductors. Terminal blocks shall be provided for connection of branch circuits and remote signal conductors.
- B. All branch circuit conductors of the isolated power system shall be stranded copper having cross linked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Type XHHW is suitable for this purpose. Each branch circuit conductor shall be color coded in accordance with the National Electrical Code. Wire pulling compound produces an adverse effect upon the dielectric constant of conductor insulation and shall not be used when pulling the wire of the isolated power system.
- C. All wiring within isolation panels, remote accessories and field wiring installed by the Electrical Subcontractor shall be color-coded in compliance with the NEC and NFPA No. 99.

PART 3 - EXECUTION

3.1 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor, shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.
- I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.
- J. The Electrical Subcontractor shall not allow any equipment or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment are located, such as electric rooms, electric closets, telephone or data closets. The Electrical Subcontractor shall notify the Contractor of such violations and request immediate removal.

3.2 INSTALLATION

A. General

- 1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular

installation methods and requirements peculiar to certain items and classes or material and equipment.

2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
6. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co. Where reference to channel supports is made under "Lighting Fixtures" paragraph of this Section, the maximum length of span shall be 10'-0". If longer spans are required, the size and wall thickness of the steel channel support shall be as specifically approved by the Engineer.

B. Isolated Power Panels

1. The Electrical Subcontractor shall install the isolated power panels and portable laser and x-ray panels per the manufacturer's recommendations and the Contract Drawings.
2. The installation of all equipment, including working space requirements, shall conform to all NEC and local codes.
3. All necessary hardware to secure the assembly in place shall be provided by the Electrical Subcontractor.
4. The Electrical Subcontractor shall ensure that no piping, ductwork or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to that of the electrical distribution equipment plus 6" on either side of panel.
5. All electrical equipment shall be installed such that the handle of the highest circuit breaker does not exceed 6'-6" above finished floor.
6. Electrical distribution equipment that is part of the emergency distribution system shall be located in spaces fully protected by an approved automatic fire suppression system or in spaces with a one (1) hour fire resistance rating.
7. The equipment shall be installed and checked in accordance with the manufacturer's recommendations prior to first energization. This shall include but not limited to:
 - a. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
 - b. Assemble all shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.

- c. Measure and record megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
 - d. Inspect and install all circuit breakers, components, etc. in their proper compartments.
8. Identification shall be provided for all surgical facility panels, isolated power panels and portable laser and x-ray panels. The electrical system identification shall clearly describe the equipment connected. Method of identification shall not be effected by the use of hospital type cleaning materials. Engraved letters at least 1/4" high and securely attached to the equipment with galvanized screws. Adhesives or cements shall not be used. A list of nameplates shall be submitted to the Architect for approval prior to fabrication.
9. Recessed and surface mounted equipment shall be mounted on walls with studs and cross-bracing, as required to assure sufficient strength so as to restrict any movement of the equipment.

3.3 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.4 FIELD TESTING AND CERTIFICATION

- A. The Electrical Subcontractor shall include the cost of, and make all arrangements, for testing all ungrounded isolated power systems by a qualified factory technician from the manufacturer providing the isolated power systems. The testing shall include a complete inspection of all connections and material used. The Electrical Subcontractor shall be prepared to demonstrate

the factory technician that proper polarity was observed and installation practiced were in accordance with the drawings and specifications for these systems.

- B. The factory technician shall check and record system leakage currents and shall simulate faults, on each system panel, of a magnitude high enough to bring the total system leakage, which the line isolation monitor detects, above the calibrated point, thus verifying correct operation of the LIM. The faults simulated shall be combinations of resistive and capacitive faults.
- C. The factory technician shall check the resistance between the ground point of each receptacle and the reference point and ensure it is less than 0.1 ohms. The voltage potential difference between any exposed conductive surfaces in the patient vicinity shall be checked and shall be no more than 40 millivolts. Tests shall be per requirements in NFPA 99.
- D. The factory technician shall instruct the Owners' personnel in the proper use and maintenance of the equipment, including, but not limited to:
 - 1. Operation of the equipment.
 - 2. Procedure for periodic testing and logging test results.
 - 3. The panel and LIM as a leakage measuring device.
 - 4. How instrument leakage areas can be measured and labeled.
 - 5. How to perform leakage tests.
- E. The technician shall furnish log books to the Owners maintenance department, enter the first readings of all panels in these books and clearly instruct the maintenance staff on how to enter future readings.
- F. The technician shall also test the system impedance of the entire isolated power system to ensure compliance with the applicable sections of NFPA 99, chapter 3. The measured system impedance shall become part of the permanent logged records of each panel.
- G. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's representative's test reports and certification before final payment is made.

END OF SECTION