

SECTION 26 05 72

ACCEPTANCE TESTING

PART 1- GENERAL

1.0 It is the intent of these acceptance tests to assure that all Contractor supplied equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with designed specifications.

A. The acceptance tests and inspections shall determine suitability for energization of switchgear and cables.

B. Items that shall be checked, inspected, and tested include, but are not limited to, the following:

1. Relays
3. Power/Lighting panelboards
4. 600V rated cable

1.1 APPLICABLE CODES

A. All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein.

1. California Electrical Code - CEC 2004 Edition.
2. National Electrical Manufacturer's Association - NEMA.
3. American Society for Testing and Materials - ASTM.
4. Institute of Electrical and Electronic Engineers - IEEE.
5. National Electrical Testing Association - NETA.
6. American National Standards Institute - ANSI:
 - a. C2, National Electrical Safety Code
 - b. Z244-1, American National Standard for Personnel Protection
7. State Codes and Ordinances.
8. Insulated Cable Engineers Association - ICEA.
9. Association of Edison Illuminating Companies - AEIC.
10. Occupational Safety and Health Administration:
 - a. Part 1910, Subpart S, 1910.308
 - b. Part 1926, Subpart V, 1926.950 through 1926.960
11. National Fire Protection Association - NFPA:
 - a. ANSI/NFPA 70B, Electrical Equipment Maintenance
 - b. NFPA 70E, Electrical Safety Requirements for Employee Workplaces
 - c. ANSI/NFPA 70, National Electrical Code 2002 Edition

- d. ANSI/NFPA 78, Lightning Protection Code
 - e. ANSI/NFPA 101, Life Safety Code
12. All inspections and tests shall utilize the following references:
- a. Project Design Specification.
 - b. Project Design Drawings.
 - c. Manufacturer's instruction manuals applicable to each particular apparatus.

1.2 QUALIFICATIONS OF TESTING AGENCY

- A. The testing firm shall be an independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm and all the testing personnel shall have been engaged in such practices for a minimum of ten years.
- D. The testing firm shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910, and 1936. Full membership in the National Electrical Testing Association constitutes proof of such criteria.
- E. The lead, on site, technical person shall be currently certified by the National Electrical Testing Associate (NETA) in Electrical Power Distribution System Testing.
- F. Testing firm shall utilize only full-time technicians who are regularly employed by the firm for testing services. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians may assist, but may not perform testing and/or inspection services.
- G. The testing firm shall submit proof of the above qualifications.
- H. The testing firm shall be an independent organization as defined by OSHA Title 29, Part 1936 and the National Electrical Testing Association.
- I. All instruments used by the testing firm to evaluate electrical performance shall meet NETA's Specifications for Test Instruments. (See Section 1.7 of this specification).
- J. The terms used herewith such as Test Agency, Testing Laboratory, or Contractor Test Company, shall be construed to mean testing firm.

1.3 RESPONSIBILITIES

- A. The Contractor shall notify the Owners Representative prior to commencement of any testing.

- B. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported.
- C. The testing firm shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.
- D. A stable source of 60 hertz power shall be provided for testing purposes by the Contractor. Owners Representative shall witness all tests and a minimum of 14 days notice shall be provided.

1.4 TEST EQUIPMENT

A. Test Instrument Calibration

- 1. The testing firm shall have a calibration program that assures that all applicable test instrumentation is maintained within rated accuracy.
- 2. The accuracy shall be directly traceable to the National Bureau of Standards.
- 3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog - 6 months maximum
Digital - 12 months maximum
 - b. Laboratory Instruments – 2 months
 - c. Leased specialty equipment - 12 months (where accuracy is guaranteed by lessor)
- 4. Dated calibration labels shall be visible on all test equipment.
- 5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
- 6. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.
- 7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

1.5 TEST REPORTS

A. The test report shall include the following:

- 1. Summary of project.
- 2. Description of equipment/device tested.
- 3. Description of test, including date, time, and duration of test.
- 4. Test results.
- 5. Conclusions and recommendations.
- 6. Appendix, including appropriate test forms.
- 7. Identification of test equipment used.
- 8. Signature of responsible test organization authority.

9. Signature of the person witnessing the tests.
10. Furnish five copies of the complete report to the Owners Representative no later than thirty (30) days after completion of project unless otherwise directed.

1.6 SAFETY AND PRECAUTIONS

- A. Safety practices shall include, but are not limited to, the following requirements:
 1. Occupational Safety and Health Act of 1970 - OSHA.
 2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4.
 3. Applicable State safety operating procedures.
 4. NETA Safety/Accident Prevention Program.
 5. District's safety practices.
 6. National Fire Protection Association - NFPA 70E.
 7. ANSI Z244.1 American National Standards for Personnel Protection.
- B. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
- C. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

PART 2- PROTECTIVE DEVICE COORDINATION STUDY

- A. A protective coordination study shall be performed using SKM's Dapper or equal software to select or check the selection of power fuse ratings, protective relay characteristics and settings, ratios, and characteristics of associated voltage breaker trip characteristics and settings.
- B. The coordination study shall include all voltage classes of equipment indicated on the single line diagram drawings. The entire electrical system shall be included in the coordination study. Verify characteristics and settings of existing devices in the field and from the manufacturer.
- C. The time-current characteristics of the specified protective devices shall be plotted on the appropriate log-log paper. The plots shall include complete titles, representative one-line diagrams of both buildings and legends, associated relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves, and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, cable damage curves, symmetrical and asymmetrical fault currents. All requirements of the current California Electrical Code shall be adhered to. Reasonable coordination

intervals and separation of characteristic curves shall be maintained. Separate coordination plots for phase and ground protective devices shall be provided on a system basis. Separate curves shall be used to clearly indicate the coordination achieved for feeder breakers with downstream fuses and circuit breakers in switchgear and substations. There shall be a maximum of six protective devices per plot.

- D. The selection and setting of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Discrepancies, problem areas, or inadequacies shall be promptly brought to the project Owners Representative's attention.
- E. Five copies of coordination curves and tabulated data indicating selection and settings of protective devices shall be submitted to the Owners Representative for approval.

PART 3- EQUIPMENT VERIFICATIONS, TESTS AND CALIBRATIONS

3.1 GENERAL

- A. As part of the contract, the Contractor shall perform tests of installed work as herein specified and specified in other Sections of these Specifications.
- B. The Contractor shall provide all materials, equipment, labor and technical supervision to perform such tests and inspections.
- C. All tests shall be performed in compliance with the recommendations and requirements of the National Electrical Testing Association, Inc. (NETA), and applicable codes and standards.
- D. Upon completion of the tests and inspections noted in these Specifications, a label shall be attached to all serviced devices. These labels shall indicate date serviced and the service company responsible.
- C. The test and inspections shall determine suitability for continued reliable operation.
- D. All tests shall be conducted in the presence of the Owners Representative. Provide a minimum of two weeks notice to the Owners Representative.
- E. Furnish the necessary equipment and personnel to perform all required tests of all wiring and connections for continuity, short circuit, and improper grounds. Included, but not limited to, the following systems: substations, air interrupting switches, low voltage main and feeder circuit breakers, interlocking controls, panelboards, distribution transformers, branch circuits.

3.2 SWITCHGEAR, SUBSTATIONS, DISTRIBUTION BOARDS, AND EMERGENCY SYSTEM-GENERAL

A. Visual and mechanical inspection:

1. Inspect for physical damage and code violations.
2. Clean interior and exterior surfaces.
3. Inspect for proper alignment, anchorage, and grounding.
4. Check tightness of accessible bolted bus joints by torque wrench method. Tighten connections in accordance with industry standard torque levels.
5. Make closure attempt on locked open devices. Make opening attempt on locked closed devices.
6. Make exchange with devices operated in off-normal positions.

B. Electrical tests:

1. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground.
2. Inspect all accessible bus joints and cable connections by infrared scanner to detect loose or high-resistance connections and other circuit anomalies.
3. Inspect correctness of control wiring.

3.3 BATTERY SYSTEM

A. Visual and mechanical inspection:

1. Inspect for physical damage, anchorage, electrolyte leakage and level.
2. Check intercell bus link and cable connection integrity for tightness and corrosion.

B. Electrical tests:

1. Measure system charging voltage and each individual cell voltage.
2. Measure electrolyte specific gravity.
3. Perform infrared scan of the intracell links cable connections under current discharge conditions.

3.4 INSTRUMENT TRANSFORMER

A. Visual and mechanical inspection:

1. Inspect for physical damage and connection tightness.
2. Check transformer nameplate with singleline diagram.
3. Check proper operation of grounding or shorting devices.

B. Electrical tests:

1. Measure current transformer ratio by primary current injection.
2. Measure potential transformer ratio.
3. Measure insulation resistance primary-to-ground, secondary-to-ground and primary-to-secondary.
4. Verify secondary wiring connections by secondary current injection.
5. Verify transformer polarity markings.

6. Perform current transformer saturation test. Plot transformer voltage current curve.

3.5 CONTROL POWER TRANSFORMERS - ENCAPSULATED TYPE

A. Visual and mechanical inspection:

1. Inspect for physical damage, proper installation, anchorage, and grounding.
2. Clean interior and all bushing and insulator surfaces.
3. Verify proper auxiliary device operation such as fans and indicators.
4. Check tightness of accessible bolted electrical joints. Tighten connections in accordance with industry standards.

B. Electrical tests:

1. Perform insulation resistance tests winding-to-winding and winding-to-ground. Apply appropriate guard circuit over all bushings.
2. Perform dielectric absorption test winding-to-winding and winding-to-ground for ten (10) minutes. Compute the polarization index.
3. Perform turns ratio test between windings for all top positions.
4. Perform insulation power factor tests on all high and low-voltage windings.
5. Check output voltages.

3.6 PROTECTIVE RELAYS

A. Visual and mechanical inspection:

1. Inspect relays for physical damage, presence of foreign material, moisture, condition of spiral spring, disc clearance and corrosion.
2. Clean cover glass interior and relay components.
3. Check for freedom of movement, proper travel and alignment, and tightness of mounting hardware and top screws.

B. Electrical test:

1. Perform insulation resistance tests on each circuit branch to frame.
 2. Perform the following tests at the settings specified by Owners Representative:
 - a. Pickup parameters on each operating element.
 - b. Timing at three (3) points on time dial curve.
 - c. Pickup target and seal in units.
 - d. Special test as required to check operation of restraint, and other elements per manufacturer's instructions.
 3. Perform phase angle and magnitude contribution tests on all differential type relays after energization to vectorially prove proper polarity and connection.
 4. Check polarity and correctness of control wiring.
- C. Relay calibration and tests:
1. Two relay wiring tests shall be made.
 - a. Primary circuit polarity test shall include a DC test from the current transformer to each terminal block and relay terminal.
 - b. Relay and circuit breaker operation test by application of power from the portable relay test set.
- D. Relay testing shall be accomplished after completion of the switchgear installation, using standard portable test set equipment and the relay manufacturer's testing directions and parameters to determine conformance of the relay to the time-overcurrent information given in the manufacturer's performance curves and the tap settings provided by coordination study. Overcurrent relay testing shall include:
1. Zero set tests.
 2. Pickup tests.
 3. Time-current characteristic (operation at currents 3 and 4 times the directed tap settings), and instantaneous at the directed tap setting.
 4. Target and seal-in operation.
- E. Target differential relays shall be tested similarly, except for the following additional tests:
1. Low voltage "through-currents" of approximately "full load" and "fault" magnitudes shall be circulated in HV busses. Bus differential relays shall not trip.
 2. Low voltage currents shall be circulated within the differential zones of "low-fault" and "high-fault" magnitudes. Bus differential relays shall initiate tripping momentarily.

3.7 LOW VOLTAGE CIRCUIT BREAKERS

A. Visual and mechanical inspection:

1. Inspect for physical condition.
2. Inspect alignment and grounding.
3. Perform mechanical operator and contact alignment tests on the breaker and its operating mechanism in accordance with manufacturer's instructions.
4. Perform insulation resistance test on control wiring.
5. Clean mechanism, insulating surfaces and contacts.

B. Electrical tests:

1. Measure contact resistance.
2. Trip overcurrent protective device by operation of each protective device.
3. Perform an insulation resistance test phase-to-ground, phase-to-phase and across open contacts.
4. Perform insulation resistance test in accordance with Doble procedure.
5. Perform timing test with Travel Analyzer to insure proper contact overtravel and pressure.

3.8 CABLES, LOW VOLTAGE (600 VOLTS AND LESS)

A. Visual and mechanical inspections:

1. Inspect cables for physical damage and proper connection.
2. Torque test cable connection. Tighten connections in accordance with industry standards.
3. Perform infrared scan of all connections under loaded conditions.

B. Electrical tests:

1. Perform insulation resistance test of each cable with respect to ground and adjacent cables.

3.9 GROUNDING SYSTEMS

A. Visual and mechanical inspection:

1. Inspect ground system connections for completeness and adequacy.

B. Electrical tests:

1. Perform fall-of-the-potential test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points.

C. INFRARED INSPECTION

1. All doors and cover shall be removed and upon completion of test be reinstalled by testing agency technicians.
2. A load bank shall be furnished to circulate low voltage currents of 400A magnitude through each bus, main breaker and feeder breaker. After two hours infrared scans shall be made of all bus joints. Problem area shall be photographed before and after corrections. After corrections, another current test of two hours duration shall be made. Again an infrared scan shall be made to confirm correct operation.
3. Upon completion, the switchgear shall be energized at 12kV. After 4 hours, infrared scans shall be made to determine areas of excessive corona. Problem area shall be treated the same as under B., above.
4. Upon completion of infrared scans, all covers and doors shall be reinstalled.

END OF SECTION

SECTION 26 05 73

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. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 1. Coordination-study input data, including completed computer program input data sheets.
 2. Study and Equipment Evaluation Reports.
 3. Coordination-Study Report.

1.4 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 not acceptable.

- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on the drawings or a product by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. 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.
 - 1. Optional Features:
 - a. Arcing faults.

- b. Simultaneous faults.
- c. Explicit negative sequence.
- d. Mutual coupling in zero sequence.

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. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. 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. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. 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.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Medium-voltage controller.
 - 3. Motor-control center.
 - 4. Distribution panelboard.
 - 5. Branch circuit panelboard.

- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 or IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141 or IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

C. 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.

- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves 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 temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to 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:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Wall switches.
- B. Receptacles.
- C. Device plates and decorative box covers.
- D. Time switches.

1.2 REFERENCES

- A. NEMA WD 1 - General-Purpose Wiring Devices.
- B. NEMA WD 6 - Wiring Device Configurations.

1.3 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

- A. Single Pole Switch:
 - 1. Hubbell, Model 2121-W.
 - 2. Leviton, Model 5621-2W.
 - 3. Equal by Arrow Hart or Bryant.
- B. Double Pole Switch:
 - 1. Hubbell, Model 2122-W.
 - 2. Leviton, Model 5622-2W.
 - 3. Equal by Arrow Hart or Bryant.
- C. Three-way Switch:
 - 1. Hubbell, Model 2123-W.
 - 2. Leviton, Model 5623-3W.
 - 3. Equal by Arrow Hart or Bryant.
- D. Substitutions: Under provisions of Division 01.

- E. Description: NEMA WD 1, heavy-duty specification grade, AC only general-use quiet type rocker switch, UL approved for tungsten lamp loads or inductive loads without derating.
- F. Device Body: White plastic with rocker handle.
- G. Ratings: 20A., 120-277V A.C. or as required to match with specific branch circuit and load characteristics.
- H. Lock type switches shall be Hubbell #1221L only per District standards.

2.2 RECEPTACLES

A. Duplex Convenience Receptacle:

- 1. Hubbell
- 2. Leviton
- 3. Arrow Hart
- 4. Bryant.

B. GFCI Receptacle:

- 1. Hubbell
- 2. Leviton
- 3. Arrow Hart
- 4. Bryant.

C. Surge Protected Outlets:

- 1. Hubbell
- 2. Leviton
- 3. Arrow Hart
- 4. Bryant.

D. Substitutions: Under provisions of Division 01.

- E. Description: NEMA WD 1; heavy-duty general-use receptacle. 20 Amp, 125V, 2-pole, 3-wire style line series.
- F. Device Body: Plastic.
- G. Configuration: NEMA WD 6; type as specified and indicated.
- H. Convenience Receptacle: Type 5-20R
- I. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

- A. Plates shall be brushed stainless steel and supplied for every local switch, receptacle, telephone and data outlet, wall speaker outlet, etc.
- B. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device cover.
- C. Locking Weatherproof Cover Plate: Pass & Seymour #WP26-L or equal at locations Indicated on drawings.
- D. Plates shall be engraved and filled, when used for:
 - 1. More than two gangs.
 - 2. Equipment that cannot be seen from the locations.
 - 3. All lock type switches.
 - 4. All receptacles other than 120 volts.
 - 5. All pilot switches.
 - 6. Switches in locations from which the equipment or circuits controlled cannot be readily seen.
 - 7. Manual motor starting switches.
 - 8. Where so indicated on the drawings.
 - 9. As required on all control circuit switches, such as heater controls, etc.

2.4 TIME SWITCHES

- A. Manufacturers:
 - 1. Tork.
 - 2. Paragon.
 - 3. Intermatic.
- B. Description: AC electronic time clock, 7 day.
- C. Input voltage: 120V.
- D. Poles: 40A, 120V, number as indicated. (4 pole minimum)
- E. Enclosure: Type as required to meet installation.
- F. Configuration: 365 Day Astronomic, electronic, programmable.
- G. Accessories: Photocell control as indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and will be completely covered by wall plates.

- C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on top
- E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- F. Install decorative plates on switches, receptacles, etc., and blank outlets in finished areas.
- G. Connect wiring devices by wrapping conductor around screw terminal.
- H. Use jumbo size plates for outlets installed in masonry walls.
- I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished area, above accessible ceilings, and on surface mounted outlets.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 260533 to obtain mounting heights specified and indicated on drawings.
- B. Install wall switches as indicated on drawings.
- C. Install convenience receptacles 18 inches above finished floor.
- D. Install convenience receptacle 6 inches above backsplash of counter.

3.5 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires and accessories.
- B. Emergency lighting units.
- C. Exit Signs.
- D. Ballasts.
- E. Fluorescent lamp emergency power supply.
- F. Lamps.
- G. Luminaire accessories.

1.2 REFERENCES

- A. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.
- B. ANSI C82.1 - Ballasts for Fluorescent Lamps -Specifications.
- C. ANSI C82.4 - Ballasts for High-Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).
- D. ANSI/NFPA 70 - National Electrical Code.
- E. ANSI/NFPA 101 - Life Safety Code.
- F. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
- G. Title-24 C.C.R.

1.3 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: Provide dimensions, ratings, and performance data.

- D. **Manufacturer's Instructions:** Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
- E. **Manufacturer's Instructions:** Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 and 260100.
- B. Accurately record actual locations of each luminaire.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01.
- B. **Maintenance Data:** Include replacement parts list.

1.6 QUALIFICATIONS

- A. **Manufacturer:** Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.7 REGULATORY REQUIREMENTS

- A. Conform to California building code and NFPA 101 for installation requirements.

PART 2 - PRODUCTS

2.1 LUMINARIES, EMERGENCY LIGHTING UNITS, AND EXIT SIGNS

- A. Furnish products as specified on Drawings.
- B. Install ballasts, lamps, and specified accessories at factory.

2.2 BALLASTS

- A. **Fluorescent Ballast:**
 - 1. Sylvania Quicktronic ProStart PSX T8
 - 2. Equal by Advance Mark V.
 - 3. Sound Rating: Class A.
 - 4. Description: High power factor type, programmed rapid-start electronic ballast with .74 ballast factor.
 - 5. Provide ballast suitable for lamps specified.
 - 6. Voltage: 120-277
 - 7. Source Quality Control: Certify ballast design and construction by Certified Ballast Manufacturers, Inc. Guarantee ballast replacement for three (3) years.
 - 8. Ballast Protection: Resetting type thermal protector.

B. Fluorescent Dimming Ballast:

1. Sylvania Quicktronic Helios T8.
2. Sound Rating: Class A.
3. Description: High power factor type, programmed rapid start electronic ballast.
4. Provide ballast suitable for lamps specified.
5. Voltage: As noted on drawings.
6. Source Quality Control: California Certified Ballast, U.L. Listed.
7. Protection: ANSIC62.41 CAT. A Transient Protection.

2.3 FLUORESCENT LAMP EMERGENCY POWER SUPPLY

A. Manufacturers:

1. Dual Lite.
2. Siltron.
3. Bodine.

B. Description: Emergency battery power supply suitable for installation in ballast compartment of fluorescent luminaire.

C. Lamp Ratings: One F40CW lamp providing 1200 lumens, minimum.

D. Battery: Sealed type, rated for 10 year life.

E. Include TEST switch and AC ON indicator light, installed to be operable and visible from the outside of an assembled luminaire.

2.4 LAMPS

A. Fluorescent Lamp Manufacturers:

1. Sylvania Octron XPS T8.
2. Equal by Philips or GE

B. Provide lamp type specified for luminaire.

C. Reflector Lamp Beam Patterns: ANSI C78.379.

2.5 ACCESSORIES

- A. Provide all required accessories such as sockets, glassware, boxes, spacers, mounting devices, lamps, etc.
- B. Provide minimum 0.125 inches (3.175 mm) thick, KSH Pattern 12 100% virgin acrylic lenses where applicable.
- C. Provide 50 spare Sylvania Octron XPS T8 lamps.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate and supporting grids for luminaries.
- B. Examine each luminaire to determine suitability for lamps specified.

3.2 INSTALLATION

- A. Install in accordance with manufacturers instructions.
- B. Locate recessed ceiling luminaries as indicated on reflected ceiling plan.
- C. Install surface mounted luminaries and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
- D. Light Fixture Support: Conform to Section 260529.
- E. Install recessed luminaries to permit removal from below.
- F. Install wall mounted luminaries, emergency lighting units and exit signs at height as indicated on Drawings.
- G. Install accessories furnished with each luminaire.
- H. Connect luminaries, emergency lighting units and exit signs to branch circuit outlets provided under Section 260533 as indicated.
- I. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.
- K. Install specified lamps in each luminaire, emergency lighting unit and exit sign.
- L. Verify all ceiling types and provide lighting fixtures with suitable mounting hardware for mounting in or on subject ceiling.

- M. Recessed mounted fixtures shall be approved for the fire rating of the ceiling or shall be enclosed with fire rated material and installed in complete accordance with fire departments requirements.
- N. Surface Mounted Fluorescent Fixtures: Where fixtures are indicated for installation on low-density cellulose fiberboard (see room finish schedule on drawings), provide 1-1/2" insulation, unless UL approved for mounting directly to the ceiling material.
- O. Standard Plaster Frames: Provide plaster frames for all recessed lighting fixtures installed in plaster or drywall ceilings (see room finish schedule on drawings). Provide plaster frame designed and fabricated of such materials to preclude the possibility of staining the plaster.
- P. Properly support and align fixtures and provide all necessary steel shapes for support of the fixtures. Coordinate complete fixture installation with the building construction.
- Q. Square and rectangular fixtures shall be mounted with sides parallel to building lines unless otherwise indicated.
- R. Where special fixtures to be used in special ceiling are scheduled, verify all ceiling systems and coordinate fixture type and accessories prior to ordering fixtures. Coordinate and cooperate with ceiling supplier in the preparation of ceiling system Shop Drawings.
- S. Install fluorescent fixtures as recommended by the manufacturer or as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection on angular jointing of fixtures suspended in continuous rows.
- T. Two-lamp ballasts shall be allowed to feed single lamps in tandem fixtures and shall be properly identified to show which lamps are fed from this ballast by markers on the fixture and the ballast. Provide the quantity and type of ballasts required to achieve switching configuration indicated on the drawings.

3.3 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- B. Each fluorescent fixture when initially energized shall be left on continuously for 100 consecutive hours to properly burn in fluorescent lamps.

3.4 ADJUSTING

- A. Aim and adjust luminaries as directed.
- B. Adjust exit sign directional arrows as indicated.
- C. Relamp luminaries that have failed lamps at Substantial Completion.

3.5 CLEANING

- A. Clean Work under provisions of Division 01.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosure.
- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.

3.6 DEMONSTRATION

- A. Provide systems demonstration under provisions of Division 01.
- B. Provide minimum of two hours demonstration of luminaire operation.

END OF SECTION

SECTION 27 15 00

BASIC COMMUNICATIONS SYSTEMS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies common standards, materials and execution for the work of Division 26, 27 and 28 Sections. Refer to the requirements of such Sections for the functional requirements of systems to be provided using the materials and methods of this section, as well as the additional standards, materials and execution specific to each Section.

1.3 QUALITY ASSURANCE

Comply with the requirements of Division 1 and the following

- A. Company: Work of each Section in this Divisions shall be performed by an Installer who has at least five (5) years direct experience with the devices, equipment and systems of the type and scope specified herein, and who has a fully staffed and equipped maintenance and repair facility, and who is licensed to perform work of this type in the Project jurisdiction. Raceway installation shall be performed by a licensed C-10 contractor. All other work shall be performed by parties licensed to perform such work.
- B. Personnel: Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section. Supervisors shall have at least five (5) years direct experience in similar work. Installation and maintenance personnel shall have at least three (3) years direct experience in similar work.
- C. Designated Supervisor: Provide a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual through the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.
- D. Coordination: Coordinate the Work of this Section with the Work of all other Sections. Comply with Division 01

- E. Verification: Verify dimensions and conditions at the Project Site. Submit any conflicts in timely manner for resolution.
- F. Shop Fabrication and Testing: Assemble and fully wire equipment racks and equipment backboards at a fabrication shop off the Project Site. Burn in for not less than one hundred sixty-eight (168) hours. Perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Request verification of shop test in timely manner. Following verification of shop test and when installation locations are ready as specified herein, deliver such equipment racks and equipment backboards to the Project Site and install.
- G. Project Site Installation and Testing: Install as specified herein. Perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Request verification of Project Site test in timely manner.
- H. Verification of Submitted Test Data: Re-test in presence of designated representatives of the Architect at reasonable mutual convenience. Provide services of the designated supervisor and an additional technician familiar with work of this Section. Provide all test equipment. Provide complete set of latest stamped, actioned submittals of record for reference. Provide complete set of Shop and Project Site Test Reports, as applies. Provide a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
- I. Reference/Project Record Documents: At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies, a complete set of the latest stamped, submittals of record for reference. Also maintain a separate, clean, undamaged set for preparation of Project Record Documents. Also maintain at the workplace a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
- J. Schedule: Comply with the Project schedule. Make all Submittals specified herein in a timely manner. Failure to make timely submittals complete as specified herein is considered to be lack of substantial progress of the Work of this Section.
- K. Deliver all equipment, devices and materials required for the Work of this Section and install, test and ready all work for Acceptance Testing at least fourteen (14) days prior to the completion date for the associated area of the Project, unless specifically instructed otherwise by the Construction Manager.
- L. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the Architect, in lieu of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven (7) days prior to the completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.

1.4 REGULATORY REQUIREMENTS

- A. Codes and Regulations: Perform all work in strict accordance with all applicable Federal, State, County and City Codes, regulations and ordinances.
- B. Unlisted Equipment: Certain equipment specified herein does not bear listing by Underwriters Laboratories (UL) or the City of Los Angeles Electrical Testing Laboratory (herein: LA City Lab). Such equipment is specified herein only where no equipment is known to exist bearing such listing which will perform the function required by the City. In such case, apply for field inspection of such equipment. Pay cost of such inspection.

1.5 APPLICABLE STANDARDS & AGENCIES

- A. In Addition to the requirements of each Division 27 Section, conform to the following:
 - 1. LA City Lab City of Los Angeles Electrical Testing Laboratory.
 - 2. CEC California Electrical Code.
 - 3. NFPA National Fire Protection Association.
 - 4. UBC Uniform Building Code.
 - 5. UL Underwriters Laboratories.

1.6 REFERENCE TO NAMED PRODUCTS

- A. Selected Item: Item so noted was selected based on comparative testing of similar products. Procedure for determination of equivalence is noted in the specification for the item(s).
- B. System Design Basis: Item so noted interacts with other system items to produce total system function. Substitution of this item may require coordinated substitution of other system items.
- C. Design Basis: Item so noted was used as basis for system drawings to establish features, size, etc. Use of specified equivalents may require adjustment of physical layout or wiring, but does not affect system function. No preference is implied.
- D. Industry Standard: Item so noted is unique. It is the de facto standard of the industry. Use of this item is required to cause other items to function as specified. There is no known equal (at time of specification preparation).

1.7 SUBMITTALS

In addition to the requirements of Division 01, submit as applies all materials for review arranged in same order as Specifications, individually referenced-to Specification Section, Paragraph and Contract Drawing number. Conform in every detail as applies to each referencing Section.

- A. Submit number required in Division 01 plus three (3) copies of 8 1/2"x 11 " material and two (2) prints plus one reproducible of drawings. Submit 8 1/2"x 11 " items bound in volumes and drawings in edgebound sets. Submit all drawings on sheets of the same size.
- B. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.
- C. Should the Contractor proceed with the Work of this Section in the absence of submittals for such work submitted and returned with action "No Exception Taken" or "Make Corrections As Noted", the Contractor proceeds at the Contractor's sole risk.
- D. Progress Schedule: Include duration and milestones for at least the following:
 - 1. All submittals specified.
 - 2. Completion of equipment buyout.
 - 3. Completion of equipment receipt at fabrication shop.
 - 4. Shop fabrication.
 - 5. Shop testing.
 - 6. Shipment to site.
 - 7. Installation.
 - 8. Field testing.
 - 9. Owner's first event date.
- E. Manufacturer's Product Data:
 - 1. List of Materials. For each item, include:
 - a. Manufacturer.
 - b. Model number.
 - c. Listing: UL, City Lab or none.
 - d. Quantity.
 - 2. Manufacturer's Product Data Sheets: In sequence of List of Materials, Data sheet for each item, including all accessories, marked for proposed product.
- F. Field and Shop Drawings: With each such submittal, resubmit for coordination reference complete with corrections from previous submittal:
 - 1. List of Materials.
 - 2. Manufacturer's Product Data.
- G. Field (Installation) Drawings: Collate in sequence:
 - 1. Drawing index/symbol sheet.
 - 2. Floor plans. At scale of Contract Documents. Show:

- a. Rough-in.
 - b. Mounting height.
 - c. Conduit size.
 - d. Rough-in.
 - e. Wire type.
 - f. Wire fill.
3. Sections/Elevations: At scale of Contract Documents:
- a. Mounting location reference.
4. Enlarged plans. At scale of Contract Documents or larger as required for trade coordination. Show:
- a. Refer to "floor plans" above.
 - b. Architectural features.
 - c. Rack cabinets.
 - d. Clearances required by applicable Code.
5. System Conduit Riser Drawing, Show:
- a. Terminal cabinets.
 - b. Coordination with floor plans.
 - c. Wire runs not shown on floor plans.
 - d. Wire type.
 - e. Wire fill.
 - f. Fiber loss budgets.
6. Mounting details:
- a. Stamped and signed by an Engineer licensed in the Project jurisdiction for work of this type.
 - b. Show loads, type and strength of connections, sizes, dimensions, materials, etc.
 - c. Show calculations on drawings or in bound volume for review by Authorities having jurisdiction.
 - d. Provide details for:
 - (1) Cable Trays, where indicated and used.
 - (2) Equipment Rack anchorage.
7. Installation details as required:
- a. Terminal cabinets: Terminations.
8. Wire run sheets (if used). Show:
- a. Wire Number.
 - b. Source.

- c. Designation.
- d. Signal Type.
- e. Wire type.
- f. Operating level or voltage (if applies).

H. Shop (Fabrication) Drawings: Collate in sequence:

1. Drawing index/symbol sheet (if separate set from Field Drawings).
2. System functional drawings. Submit separate drawing for each system/subsystem. Show at least:
 - a. Equipment: Function, make, model. Rack number, module frame and slot number.
 - b. Wire number.
 - c. Wire Type.
 - d. Shield condition at both ends (float, ground, location of ground).
 - e. Connector wiring details, each type.
3. Provide drawings for the following wiring systems:
 - a. Coordinated grounding scheme.
 - b. LAN
 - c. Telephone
4. Equipment rack elevations: All racks scaled at 1 1/2" equals 1 foot, or larger. Show Equipment:
 - a. Function.
 - b. Make.
 - c. Model.
5. Rack wiring drawings: For each rack, show:
 - a. Power strip: Receptacles, circuiting.
 - b. Equipment.
 - c. Grounding.
 - d. Wiring, all systems.
 - e. Wiring harness scheme.
6. Fabrication details: Submit for:
 - a. Receptacles.
 - b. Panels.
 - c. Special mounting provisions
7. Legends/engraving details. Half or full size:
 - a. Receptacles.
 - b. Panels.

- c. Equipment.
- 8. Patchbay/Jackfield details, front elevation, full size:
 - a. Layout.
 - b. Text of designations.
- I. Samples: Samples for review by the Architect of all finishes/materials which will be visible to the public, including but not limited to:
 - 1. Receptacles and controls with associated trim plate.
- J. For other items, provide at least 2"x 2" sample.
- K. Shop and Project Site Test Reports:
 - 1. Schedule: Submit test reports in timely manner relative to Project schedule such that the representative of the Architect may conduct Verification of Submitted Test Data without delay of progress.
 - 2. Shop test report: Submit prior to shipping completed equipment racks to Project site.
 - 3. Project Site test report: Submit following system completion and prior to and as condition precedent to Acceptance Review and Testing of the Work of this Section.
 - 4. Content: Include at least:
 - a. Time and date of start of burn-in.
 - b. Time and date of test.
 - c. Personnel conducting test.
 - d. Test equipment, including serial and date of calibration.
 - e. Test object.
 - f. Procedure used.
 - g. Results of test - numerical or graphical presentation.

1.8 OPERATING AND MAINTENANCE DATA

- A. Manuals: In addition to the requirements of Division 01, submit two (2) additional sets. Submit in three (3) post binders (not ring binder) with Tabs.
- B. Include:
 - 1. Index.
 - 2. Systems operating instructions.
 - 3. Reduced set of system Record Drawings.
 - 4. Key schedule.
 - 5. Maintenance and spare parts schedules.
 - 6. Equipment manuals. Collate alphabetically by manufacturer. Provide manufacturer's original operation, instruction and service manuals for

each equipment item. For each set, provide manufacturer's original printed copies only. Photocopies not acceptable.

- C. Framed Operating and Maintenance Instructions: Provide adjacent to each ensemble of equipment racks and -at each equipment backboard. Provide sturdy frame with clear glass or non scratching plastic cover. Provide permanent, nonfading media. Blueprints shall not be acceptable. Include:
1. Sequence for system start-up and shut-down.
 2. System Functional Diagrams.
 3. Signal levels and impedances at accessible system signal and test ports.

1.9 PROJECT RECORD DOCUMENTS

- A. Record Drawings: CAD: Use a computer aided drafting (CAD) system in the preparation of record drawings for this Project. Acceptable CAD systems shall be capable of producing files in AutoCADD compatible DWG or DXF format. Owner's consultant will furnish CAD backgrounds for use by the Contractor except where prohibited by Contract.
- B. At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies, a complete separate, clean, undamaged set of the latest stamped, actioned submittals. As work progresses, maintain records of "as installed" conditions on this set in suitable ink or chemical fluid. Update the set at least weekly. After successful completion of Project Site testing specified herein, and after completion of Punch List corrections, copy all records of "as installed" conditions on to originals.
- C. Quantity:
1. Review sets: As for Shop and Field Drawings.
 2. Record set: Three (3) blueline.
One (1) mylar.
- D. Format: Record Drawings:
1. Pencil, permanent ink or permanent photographic process.
 - a. Front face only of Mylar at least 3.0 mils thick.
 - b. Applique film or lettering prohibited.
 - c. Suitable for microfilming. Lettering 1/8" high minimum.
 2. Diskette copy of Record Drawings - 1 copy of each drawing file in format noted above, 3-1/2 inch IBM PC, High Density format.
- E. Content: All drawings required under "Field and Shop Drawings". Show "as installed" condition. Where room designations according to Project permanent signage differ from construction designations in the Contract Documents, show both designations.

F. Warranty Certificates: Comply with Division 1.

1.10 DELIVERY, STORAGE AND HANDLING

Comply with requirements of Division 1 and the following

- A. Deliver materials in manufacturer's original undamaged packages or in bulk packing which provides equivalent protection.
- B. Store packaged materials off ground or slab in manner to protect them from elements, especially moisture damage.
- C. Deliver completed, wired, tested equipment racks and backboards to associated equipment rooms at the Project site when major work of all other Sections is complete, equipment room ventilation is operating with clean filters in place., the area is clean and free from airborne contaminants, and continuing work of other trades will not produce airborne contaminants or permit transport of such airborne contaminants to the equipment rooms.

1.11 WARRANTY SERVICE

In addition to provisions of Division 1 provide the following:

- A. Warranty: Warrant all of the Work of this Section to be free from defects in materials and workmanship for a period of twelve (12) months from the date of Owner Acceptance of the Work of this Section.
- B. Response Time: Provide a qualified technician familiar with the work at the Project Site within twenty-four (24) hours after receipt of a notice of malfunction. Provide the Owner with telephone number attended eight (8) hours a day, five (5) days a week, to be called in the event of a malfunction.
- C. Off Site Service: Conduct all warranty repairs and services at the Project Site, unless in violation of manufacturer's standard product warranty. Provide substitute systems, equipment, and/or devices acceptable to the Owner for the duration of off-site repairs. Provide transportation for substitute and/or test systems, equipment, devices, materials, parts and personnel to and from the Project Site.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Quality of Products: Material and equipment specified herein have been selected as the basis of acceptable quality and performance and have been coordinated to function as components of the specified systems. Where a particular material, device, piece of equipment or system is specified directly, the current manufacturer's specification for the same shall be considered to be a part of these specifications, as if completely contained herein in every detail. Each material, device or piece of equipment provided hereunder shall comply with all of the manufacturer's published specifications for that item.

- B. Quantity: Provide quantity as shown on Contract Drawings, or as otherwise defined herein.
- C. Preference: Where more than one manufacturer is listed herein as acceptable or equivalent, no preference is intended or implied by the order of listing.
- D. Substitutions: Comply with provisions of Division 01. Burden of proof of equivalence is on the Contractor.
- E. Provide Complete: Provide all auxiliary and incidental materials and equipment necessary for the operation and protection of the Work of this Section as if specified in full herein.
- F. Provide New': All materials provided under the Work of this Section shall be new, shall be the manufacturer's latest design/model, and shall be permanently labeled with the manufacturer's name, model number and serial number.
- G. Similar: Similar devices shall be of the same manufacturer, unless specifically noted otherwise in these specifications.
- H. Safety Agency Listing: All devices provided under the Work of this Section which are connected to the Project electrical system shall be listed by Underwriters Laboratories (UL) , and shall be so labeled.
- I. Power Rating: All devices provided under the Work of this Section which are connected to the Project electrical system shall provide stable performance fully in accordance with these specifications when operated on mains service which complies with ANSI standard tolerances for voltage, frequency, transients and related parameters.
- J. Circuit Protection: All active devices shall have integral fuse or circuit breaker protection.
 - 1. All circuit breakers shall be fully magnetic.
 - 2. Protection devices shall be located to facilitate examination, resetting and/or, replacement without the need to disassemble or demount the associated device.
 - 3. Contractor-fabricated items shall be provided with either indicating type circuit breakers or fuses of the clear glass cartridge type, mounted in fuse holders which will indicate a blown or defective fuse.
- K. Continuous Use: All active circuitry shall be solid state and shall be rated for continuous use. All circuit components shall be operated in full compliance with the manufacturer's recommendations and shall contain sufficient permanent identification to facilitate replacement.
- L. Construction: All electronic equipment shall be of the "dead-front" type and shall be designed for standard 19" EIA rack mounting, unless noted otherwise.
 - 1. Steel frames and enclosures shall be designed and wired to eliminate all induced currents within both the units and the systems.

2. All bolted connections shall be made with self-locking devices.
- M. Coordinate all consoles and panels so that the general appearance is similar, or as directed by the Architect.
1. All operating panels shall be at least 1/8" thick aluminum.
 2. Provide locking panel covers on all recessed, semi-recessed or surface mounted control panels not located in the equipment rooms, unless specifically noted otherwise. Panel locks shall be flush with no protrusions beyond the panel face when the door is closed. Recessed control panels shall be recessed within the back box to a depth sufficient to permit a locking hinged panel cover to completely close without affecting any device within that enclosed area.
- N. Circuit Boards/Modules: All printed circuit boards or modules shall be mechanically secured by bolt or friction-loading guide, in addition to any electrical connector attachment, and shall include an integral extraction grip.
1. Printed circuit boards shall be connected to associated circuitry via soldered connections or precious metal positively keyed card edge connectors.
 2. All contractor-fabricated printed circuit boards shall be at least 1/16" thick G-10 glass fabric epoxy base, copper plated to a minimum density of 2.0 oz./sq. ft. on one or both sides, and finished with 60/40 tinlead solder either hot rolled or plated over the copper. All holes through the boards shall be plated through and solder filled. All boards shall be permanently identified with a designation that matches that of the mating connector or board position in the assembly.
- O. Identification: Provide permanent intelligible identification on, or adjacent to, all connectors, receptacles, controls, fuses, circuit breakers, patching jacks, and the like. Conform to EIA/TIA 606. This identification shall clearly and distinctly indicate the function of the item and shall be numbered or lettered to correspond with the function, circuit and location consistent with field and shop drawings.
1. Protective Devices: Identification of fuses and circuit breakers shall indicate protected circuitry, rating of protective device and voltage across open circuited protected device.
 2. Panels and Receptacles: Panel surfaces shall be engraved and filled or silk screened with identification, or shall be provided with 1/16" (min.) thick laminated plastic labels with engraved block characters at least 1/8" high fastened to the equipment by stainless steel screws or rivets. Provide white characters on black background unless otherwise noted. Embossed plastic (Dymo) labels shall not be acceptable.
 3. Patching Jacks: Provide designation strip holders with clear plastic covers to retain replaceable designation strips. Provide designation strips with block lettering on permanent background in contrasting color. Use photographic print, plotting ink on mylar, or equivalent non-fading process.

P. Finishes: Any item or component of the Work of this Section which is visible shall comply with the following. Finishes noted or scheduled on the Contract Drawings shall take precedence.

1. Where design location requires that products, materials or equipment are visible to the public, no manufacturer's logos shall be visible. Unless otherwise noted or directed, neatly remove or permanently paint out such logos.
2. Where finishes are not noted or otherwise defined in the Contract Documents, submit manufacturer's standard finish samples for selection by the Architect.
3. Unless otherwise noted, receptacle or device plates subject to connection or operating force shall be stainless steel or hard anodized aluminum. Provide plates which generally match the appearance of Project standard receptacle or device plates in view in the same area. For anodized aluminum, submit samples of standard colors for selection by Architect.
4. Operating panels shall be steel, primed, painted with thermosetting epoxy paint, with legends silk-screened in contrasting color, and coated with clear epoxy thermosetting coating; or aluminum, hard anodized, with legends engraved and filled with contrasting color, all coated with clear epoxy thermosetting coating.
5. All steel surfaces shall be treated with primer equivalent to zinc phosphate and finish painted with baked enamel or painted with a thermosetting epoxy paint.
6. All aluminum surfaces, except those used as operating surfaces, shall be anodized and then painted with a thermosetting epoxy paint.

Q. Keys: Key all boxes, cabinets, enclosures, panels, controls, doors and related provided for similar usage within a system identically. For each unique key type, provide quantity as specified in Division 1 or quantity of ten (10), whichever is greater. Stamp each key with reference designation. Submit schedule of keying. Where so noted, provide Project Standard lock cylinders and keys; coordinate with the work of other sections.

R. Heat Management, General: The drawings show a scheme of heat management based on generic conventionally packaged components to convey design intent. Coordinate fans, blank panels, vent panels and related heat management provisions with products provided hereunder.

2.2 EQUIPMENT ENCLOSURE SYSTEMS

A. Provide enclosure systems including, but not limited to racks, cabinets, cases and related panels and accessories as specified herein, or approved equivalent. Provide size and quantity as shown on drawings. Provide color as shown on drawings. If no color is shown on drawings, submit manufacturer's standard color chips for selection. Unless otherwise noted, completely enclose interior of rack, or ensembles of racks with equipment, blank or vent panels, including

sides and top. Provide rear access door except at racks flush with wall behind or portable.

- B. Equipment Racks: Provide each bay with basic frame and pairs of adjustable mounting angles located at front and rear of each bay, angles tapped 10-32, EIA Universal Spaced. At each bay, provide pontoon base, solid top panel and louvered locking rear door. Except where otherwise indicated, at each ensemble of bays, provide end (side) panels to provide complete enclosure.

1. Vertical floor cabinet:

- a. Sectional frame, heavy duty, nominal 24" or 30" deep as indicated.
- b. Provide equivalent to:

- (1) AMBO 'Semi Custom' Series.
- (2) Atlas/Soundolier Select Series.
- (3) Atlas/Soundolier Select Series V.
- (4) Bud Industries Series 2000, Series 30-2000.
- (5) California Chassis System 90.
- (6) Emcor (equivalent).
- (7) Equito Electronics "Challenger" Series.
- (8) Gerrard (equivalent).
- (9) GKM Manufacturing "FR" Series.
- (10) Hammond Manufacturing (equivalent).
- (11) Morton Hi-Tek Furnishings, Series 1 00 (24") and Series 1 00 Special (30").
- (12) Premiere Metal "TVA" Series.
- (13) Stantron (equivalent).
- (14) Zero Saber Series 1 0.

2. Rack cabinet, single bay, wall and floor supported with swing out interior frame for rear access of equipment from front of rack.

a. Features:

- (1) Sectional exterior frame, heavy duty, nominal 24" or 30" deep as indicated.
- (2) Solid top and sides.
- (3) Center insert swing-away section.
- (4) At least 40 RU interior height.

b. Acceptable:

- (1) Hoffman APX Modular Enclosure System with solid rear cover, swing-out rack frame assembly and make-up trim metal as required.
- (2) equal by Rittal.

- (3) Wyle Laboratories/Electronic Enclosures. Drawing No. 28845 Series with standard solid top, with height as indicated, with swing opposite hand where indicated.
225 S. Aviation Boulevard
El Segundo, CA 90245
(310) 643-8181
 - (4) Knurr USA Inc., Miracel NS 19.8
1890 North Voyager Avenue
Simi Valley, CA 93063
(805) 526-7733
 - (5) Schroff "Eurorack" series with swing frame.
170 Commerce Drive
Warwick, RI 02886
(800) 451-8755
3. Wall cabinet, wall mounted, sectional, w/ center swing section and locking front door:
- a. Acceptable:
 - (1) Atlas/Soundolier AWR 320 Series.
 - (2) Lowell
 - (3) Equal by House of Metal Enclosures (HOME).
 - (4) Hammond WMAC Series.
4. Wall cabinet, with locking front door:
- a. Acceptable:
 - (1) Atlas/Soundolier 600-12.
5. Wall cabinet, tilt out:
- a. Acceptable:
 - (1) Atlas/Soundolier AWR Series.
 - (2) Equal by House of Metal Enclosures (HOME).
 - (3) Equal by Hammond Manufacturing.
6. Computer/Server Rack, Floor Mount Closed.
- a. Functions/Features:
 - (1) 19" EIA rack, 30" Deep, 70" High min.
 - (2) Integral Plexi-Front Doors
 - (3) Rear Access Door
 - (4) Sides at each rack or ensemble of racks

- (5) Integral Top Fans
- (6) Type R9b - Includes standard options to accommodate:
 - (a) 2 tower PC's/Servers in 1 sliding tower case drawer.
 - (b) 1 monitor
 - (c) 1 keyboard tray
 - (d) Full locking door with plexiglass insert.
 - (e) 2 Monitor, Keyboard, Mouse cable assembly

b. Acceptable:

- (1) Apex PC Solutions (206) 861-5858, DensePack Cabinet Assembly - omit casters, bolt to floor:
 - (a) Type R9a - Basic Unit
 - (b) Type R9b - Configured for Tower PC Equipment, arrange as directed by Owner.
- (2) Wrightline LAN Locker Series equivalent (41 5) 467-1200.

7. Computer/Server Rack, Floor Mount Open.

a. Construction:

- (1) Open frame component system.
- (2) Shelving for monitor, keyboard and tower PC.
- (3) Integral cable routing channel.
- (4) Steel floor attachment brackets

b. Acceptable:

- (1) Ergo Systems Assembly including:
 - (a) (1) 2OLNS-30-78-APG H Frame.
 - (b) (1) 30" W Server Shelf for monitor.
 - (c) (1) 34TS-30-22-APG 30" tower shelf.
 - (d) (1) 21-FSB-APG Security bracket to secure to floor, pair.
 - (e) (1) 55-WD-23-60-APG Cable routing channel.
 - (f) (1) 21L-26L-APG Legs, set of two.
 - (g) (1) 74-APG-K30SP Keyboard Holder, Style K30.
 - (h) (1) Lot Mounting Brackets.
- (2) Equivalent by Wrightline.

8. Relay Rack, Open Side and Back:

a. Construction:

- (1) Floor mounted front and rear aluminum or steel angle floor plates bolted to floor - 3 1/2 " x 6' x 3/8" thick minimum.
- (2) Complete perimeter side and top channel frame, side channels tapped with EIA mounting holes. Upright channel construction at least 3" x 1.265" Channel, 1/4" thick 6061TX aluminum minimum.
- (3) Integral Wire Management Rings built onto extended wings to either side of frame.
- (4) Acceptable:
 - (a) Hubbell MCC84CMRR19 Relay Rack and Cable Channels.
 - (b) Equal by Ortronics, OR-60400149 Mighty Moe Series with Wire Management Rings and Mounting Hardware.
 - (c) Approved equal by Chatsworth Products from Universal Self Support Rack System and custom accessories.
 - (d) Approved Equal.

9. LAN Terminal Node/Intermediate Distribution Enclosure

a. Construction:

- (1) Wall mounted.
- (2) Sectional construction as for R3 above, with either a 4' deep door or adjustable mounting depth rack rails to permit racks to permit patch cords to enter patch panels and hubs with extreme bending.
 - (a) Fixed Mounted Rear Section - Suitable for Mounting of IDF and/or FDP
 - (b) Swing Away Center Front Section
 - (c) Locking front steel door
 - (d) Combined depth of swing-away center section and fixed rear section to be not less than 14".
- (3) Acceptable:
 - (a) Everest Electronic Enclosures Wall Mount Telecom Equipment Cabinets. 714-634-2866.
 - (b) Vero Electronics IMRAK 2 Section Cabinet with Metal Door. 203-288-8001
 - (c) Rittal Wall Mounted Distribution Enclosure System with solid steel door.
 - (d) Schroff Tecnopac Electronic Case solid steel door

- (e) Any meeting R3 above modified for either specified door depth or adjustable rails.

C. Rack Panels and Accessories:

1. Rack Mounting Screws: Screws 10-32; length as required for at least 1/4" excess when fully seated; oval head with black plastic non marring cup washer or equivalent ornamental head; nickel, cadmium or black plated; Phillips, Allen Hex, Square-Tip or Torx drive. Slotted screws are not acceptable.
2. Blank Panels:
 - a. Atlas/Soundolier S19 Series.
 - b. House of Metal Enclosures (HOME) Series PM.
 - c. Middle Atlantic Products Bi, SB or HBL Series.
 - d. Zero ZPI 12000 Series.
3. Vent Panels:
 - a. Atlas/Soundolier SVP Series.
 - b. House of Metal Enclosures (HOME) Series PRP.
 - c. Middle Atlantic Products VT Series.
 - d. Equal by Zero.
4. Shelf:
 - a. Atlas/Soundolier SH 1 9 Series.
 - b. Middle Atlantic Products U Series.
 - c. Zero A52 Series.
5. Shelf, Sliding:
 - a. Middle Atlantic Products SS Series.
 - b. Atlas/Soundolier VTD3-16 (2 RU only)
6. Drawer:
 - a. Atlas/Soundolier SD Series.
 - b. House of Metal Enclosures (HOME) SD Series.
 - c. Middle Atlantic Products D Series.
 - d. Zero A43/A36 Series.
7. Equipment Custom Rackmount Shelf:
 - a. Middle Atlantic Products Model RSH-4A Series.

- D. Equipment Enclosure Ventilation: Provide UL Recognized devices. Connect to enclosure power, comply with applicable Codes.
1. Fan panel, 5 1/4" high painted steel rack panel with 4" diameter fans, each fan with chrome plated finger guard, low speed air flow, two fans per panel, total 120 CFM:
 - a. Atlas/Soundolier ES/IS Series.
 - b. BGW Systems.
- E. Equipment Enclosure Power and Signal Grounding: Comply with applicable Codes and applicable portions of Division 26. Provide UL Listed devices, Specification or Hospital Grade. Provide all junction boxes, raceway, fittings, wire, supports and fastenings as required for complete installation. Unless otherwise noted, provide receptacles of NEMA 5-20R configuration.
1. Full height receptacle strip, one (1) or two (2) circuits, Isolated Ground:
 - a. Wiremold 2000 Plugmold IG Series.
 - b. Walkermold.
 2. Full height receptacle strip, three (3) or more circuits, Isolated Ground:
 - a. Wiremold 3000 Series with Specification Grade IG 5262 Series receptacles.
 - b. Walkermold 1700 Series with Specification Grade IG 5262 Series receptacles.
 3. Wireway, lay in, NEMA 1:
 - a. Any meeting NEMA 1 and UL870. Size as required.
 4. Signal Grounding bus bar, insulated from enclosure frame:
 - a. Atlas/Soundolier BBG Series mounted on standoff insulators.
 - b. Zero A32 Series.
 - c. Panelboard Isolated Ground bus kit by manufacturer of Project Panelboards specified in Division 16.
 5. Multi-Outlet Assembly,. Surge Suppressing, UL Listed.
 - a. Comply with ANSI/IEEE C62.41-1980.
 - b. Provide at least six (6) receptacles.
 - c. Provide equivalent to:
 - (1) EFI Electronics Corporation Model 153.
 - (2) MCG Electronics, Inc. Model 296 (subject to UL Listing).
 - (3) American Power Conversion Professional Surge Arrest.
 - (4) Approved equal.

6. Transient Over-Voltage (TOV) Surge Suppressor, Branch Circuit, UL Listed.
- a. Comply with ANSI/IEEE C62.41-1980, Category A.
 - b. Provide Sine Wave Tracking type clamping action.
 - c. Provide in branch circuits feeding one or more circuits at full height receptacle strips provided herein. Provide in circuits feeding equipment so indicated.
 - d. Coordinate related branch circuit protection with work of Division 16.
 - e. Acceptable - Provide equivalent to:
 - (1) Control Concepts Corporation "Isolatron" BC-1 15, BC-130.
 - (2) EFI Electronics Corporation Model MBPL 20EFI-YI.
7. Computer Grade Uninterruptable Power System, UL Listed.
- a. Drawing Reference: UPS *** where *** denotes VA rating.
 - b. Features/Functions/Performance:
 - (1) Provide continuous, no-break power with sine wave output.
 - (2) Size to carry connected load at least 10 minutes following loss of power, after at least two hours of charge time.
 - (3) Provide Transient Over-Voltage (TOV) Surge Suppression; comply with ANSI/IEEE C62.41-1980, Category A and Category B.
 - (4) Provide complete isolation from Line.
 - (5) Provide output voltage regulation to ANSI C84.1 for computing equipment.
 - (6) Provide output KVA, switch-mode power supply rated, not less than 150% of connected load indicated.
 - c. Acceptable - Provide equivalent to:
 - (1) SmartUPS by American Power Conversion (APC) with Power Chute Novell utility
 - (2) Approved equal by Best Power Technology, Inc. "MicroFerrups" Series.
8. Computer Grade Uninterruptable Power System, UL Listed, Rack Mount.
- a. Drawing Reference: UPS**/TVSS, where ** indicates required load carry period in minutes.
 - b. Features/Functions:
 - (1) Front panel battery status indicator.
 - (2) Provide complete isolation from line.

- (3) Sealed, maintenance free batteries, minimum 3 year guaranteed life.
- (4) Software programmable configuration.

c. Performance:

- (1) Provide continuous, no-break power with sine wave output, including under brownout - 120Vac ($\pm 5\%$)
- (2) Size to carry connected load at least indicated period in minutes following loss of power, after at least six hours of charge time.
- (3) Provide Transient Over-Voltage (TOV) Surge Suppression; comply with ANSI/IEEE C62.41-1980, Category A and Category B:
 - (a) Clamping Response Time: < 5 ns, normal mode.
 - (b) Normal mode IEEE Surge: <0.3% of peak, Cat A, 6kV surge.
- (4) < 5 ms transfer time.
- (5) Provide output KVA, switch-mode power supply rated, not less than 150% of connected load indicated.
- (6) Provide output voltage regulation to ANSI C84.1 for computing equipment.

d. Software Monitor:

- (1) Provide SNMP based monitor module.

e. Acceptable - Provide equivalent to:

- (1) American Power Conversion (APC) Smart-UPS RM Series
- (2) Approved equal by Best Power Technology, Inc.
- (3) Approved equal by Liebert.

2.3 MISCELLANEOUS PRODUCTS

The following connection devices or approved equals shall be acceptable as required herein:

A. Custom Assemblies and Related:

1. Receptacle Plates

- a. Pro Co Sound "Plateworks" Series.
- b. RCI
- c. Custom by Contractor using- plates and connectors specified elsewhere herein.

B. Circuit Components and Related:

1. Impedance Correction Resistors: 1 % precision power resistor; non-inductive:
 - a. Allen-Bradley.
 - b. Ohmite.

C. Power Panel:

1. Drawing Reference: POWER.
2. Functions/Features: Front face of panel shall provide two electrical power outlets and a switch. An indicator lamp shall show the presence of AC power when on. The front face of panel shall have a black finish. The rear face shall provide a minimum of at least four receptacles. The panel shall be racked mounted in a maximum of two rack units. The panel shall be Code approved and UL rated for this application.
3. Acceptable, subject to above:
 - a. Perma Power J24AOB or J24BOB.
 - b. Wiremold R4.

D. Power Supplies and Related:

1. Drawing Reference: PS24.
2. Relay and Lamp Power Supply: 24 VDC, regulated within 5%. Ripple not greater than 1.5%. Output current rating at least 150% of maximum possible load. Circuit breaker or intrinsic over current protection. UL Recognized or UL Listed.

E. Relays and Related:

1. Power Control Circuit Relays:
 - a. Latching, momentary pulse control, 24 V AC or DC coil, 120 V contacts, 20A. UL Listed.
 - (1) General Electric RR Series.
 - (2) Pass & Seymour/Legrand 1070-B.
 - (3) Sierra.
 - (4) Touchplate.

F. Switches, Indicators and Related:

1. Illuminated Pushbutton Switches:
 - a. Switchcraft PL Series.
 - b. Clare-Pendar (submit).
 - c. Dialite (submit).

- d. Unimax THE 31 Series.
- 2. Non-illuminated Pushbutton Switches:
 - a. Switchcraft PL Series.
 - b. Clare-Pendar (submit).
 - c. Schadow F and G Series.
- 3. Panel Mounting Indicators, Light Emitting Diode:
 - a. Switchcraft PL Series.
 - b. Clare-Pendar (submit).
 - c. Dialite (submit).
- 4. Heavy-Duty Non-illuminated Pushbutton Switches:
 - a. General Electric.
 - b. Oak.
 - c. Smith.
- 5. Illuminated Three-Position Lever Switches:
 - a. Switchcraft Lever-Lite III Series 84000.
- 6. Panel Mounting Indicators, Light Emitting Diode:
 - a. Switchcraft PL Series.
 - b. Clare-Pendar (submit).
 - c. Dialite (submit).
- 7. Rotary switch, sealed, audio grade, fixed stop, 300 or greater indexing:
 - a. ITW Series CO.
 - b. Grayhill.
 - c. Shalco.
- 8. Panel Mounting Miniature Toggle Switches. Toggle height: 1/4".
 - a. Gold contacts:
 - b. C&K T Series:

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform the Work of this Section in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Furnish and install (herein, "provide") all materials, devices, components, and equipment required for complete, operational systems.

3.2 TEST EQUIPMENT

- A. Furnish, store and maintain test equipment at the fabrication shop and the job site for both routine and Acceptance Testing of the Work of this Section. Maintain all test equipment at the job site from installation of equipment racks until Owner Acceptance of this Work; thereafter remove all of this test equipment from the job site. Provide all required test cables, jigs and adapters. Provide at least one (1) each of the following items or approved functional equivalents:
1. Communications and Related:
 - a. Communications equipment.
 2. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.

3.3 FINISHES

- A. Finishes and materials for contractor fabricated assemblies such as racks, custom control panels, brackets, blank panels, equipment mounting in furniture or casework, and in general any item or component herein which is visible shall adhere to the following:
1. Finish shall be as directed by the Owner.
 2. In the event that the Owner provides no direction as to finish, finish shall match exactly the surrounding and adjacent surfaces.
 3. Wooden speaker back boxes and baffles shall be painted flat black if not otherwise finished or stained.

3.4 EQUIPMENT ENCLOSURE (RACK) AND EQUIPMENT BACKBOARD FABRICATION

- A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.
- B. Within each equipment enclosure, provide a full-height multi-circuit ISOLATED GROUND outlet strip with branch circuit count as shown on drawings; locate on the left side of the equipment enclosure, as viewed from the rear. In each enclosure provide number of receptacles required by present and future equipment indicated on drawings, plus at least two spare receptacles. Provide flexible steel raceway and junction box for connection of power service. Bond internal raceway to rack frame.
- C. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.
- D. Maintain separation of wiring classifications as specified herein. Separately dress, route and land microphone and line level cables and related on the right side of the equipment enclosure, as viewed from the rear; dress, route, and land loudspeaker level and control cables on the left side of the equipment enclosure, as viewed from the rear.

- E. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.
- F. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.
- G. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels-which will remain in place when active equipment is removed for possible service.
- H. At jackfields, provide service loop to permit removal of jackfields from rack sufficient to conveniently access all jack contacts for routine cleaning and maintenance. Organize the service loop and harness such that reasonable reconnection of jacks and jack normals is possible -without cutting apart the harness.
- I. Coordinate the design and execution of wire harnessing of multi-bay rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.
- J. At each equipment backboard, provide UL Listed surge suppressing multioutlet assembly with at least six (6) receptacles.

3.5 EQUIPMENT RACK AND EQUIPMENT BACKBOARD TESTING AND ADJUSTING PROCEDURES

- A. Conduct procedures in fabrication shop. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Request and coordinate verification of submitted test data by the representative of the Architect. Correct all non-conforming conditions prior to shipment to Project Site. Perform at least the following procedures:
 - B. Preliminary : Verify:
 - 1. Grounding of devices and equipment. Integrity of signal and electrical system ground connections.
 - 2. Proper provision of power to devices and equipment.
 - 3. Integrity of all insulation, shield terminations and connections.
 - 4. Integrity of soldered connections. Absence of solder splatter, solder bridges.

5. Absence of debris of any kind, tools, etc.
 6. Routing and dressing of wire and cable.
 7. All wiring, including polarity and continuity, including conformance with wire designations on running sheets, field and shop drawings.
 8. Mechanical integrity of all support provisions.
- C. Rig temporary power and grounding. Comply with all applicable Codes, regulations and ordinances.
- D. Determine the proper sequence of energizing systems to minimize the risk of damage. Energize. Burn in for at least one hundred sixty-eight (168) hours.

3.6 SYSTEMS PERFORMANCE TESTING AND ADJUSTING PROCEDURES

- A. Upon completion of the installation of all equipment in an area, perform the following tests and record results. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Correct all non-conforming conditions prior to requesting Acceptance Review and Testing. Perform at least the following procedures:
1. Mechanical: Verify:
 - a. Integrity of all support provisions.
 - b. Absence of debris of any kind, tools, etc.
 2. Power and Isolated Ground: Verify:
 - a. Isolation of Isolated Ground system from raceway and related ground.
 - b. Grounding of devices and equipment. Integrity of signal and technical power system ground connections.
 - c. Proper provision of power to devices and equipment.
 3. Signal Wiring: Verify:
 - a. Integrity of all insulation, shield terminations and connections.
 - b. Integrity of soldered connections. Absence of solder splatter, solder bridges.
 - c. Routing and dressing of wire and cable.
 - d. Continuity, including conformance with wire designations on running sheets, field and shop drawings.
 - e. Absence of ground faults.
 - f. Polarity.
 4. Use the proper sequence of energizing systems to minimize the risk of damage. Energize.

3.7 ACCEPTANCE REVIEW AND TESTING PROCEDURES

Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the Construction Manager in writing that the Work of this Section is complete and fully complies with the Contract Documents. Request Acceptance Review and Testing. The representative of the Architect will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These Procedures may be performed at any hour of the day or night as required by the representative of the Architect to comply with the Project Schedule and avoid conflict with these procedures from possible ongoing work of other sections. Provide all specified personnel and equipment at any time without claim for additional cost or time.

- A. Personnel: Provide services of the designated supervisor and additional technicians familiar with work of this, Section. Provide quantity of technicians as required to comply with Project Schedule.
- B. In Addition, Provide:
 - 1. Set of hand and power tools appropriate for performance of adjustment of and corrections to this Work. Include spare wire and connectors and specified tooling for application.
 - 2. Ladders, scaffolding and/or lifts as required to access high devices.
 - 3. All test equipment.
 - 4. Complete set of latest stamped, actioned submittals of record for reference.
 - 5. Complete set of Shop and Project Site Test Reports.
 - 6. Complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
- C. Demonstrate: Complete operation of all systems and equipment, including Portable Equipment.
- D. Adjust: As directed by the representative of the Architect.
- E. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the representative of the Architect.

3.8 CLOSEOUT

- A. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify Construction Manager of completion of Punch List.
- B. Portable Equipment: Furnish all portable equipment and spares to the designated representative of the Owner, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.
- C. Operating and Maintenance Data: instructions. Submit Manuals.

- D. Project Record Documents: Submit.
- E. Keys: If applicable, replace construction locks with permanent locks. Transmit keys to Owner.
- F. Training: Conduct specified training.
- G. Warranty: Submit Warranty dated to run from date of Acceptance of the Work of this Section.

3.9 OWNER'S RIGHT TO USE EQUIPMENT

Acceptance of the Work of this Section will be after completion of corrections and adjustments required by the "Punch List" which results from Acceptance Review and Testing of the completed installation. The Owner reserves the right to use equipment, material and services provided as part of the Work of this Section prior to Acceptance without incurring any obligation to Accept any equipment or completed systems until all Punch List work is complete and all systems comply with the Contract Documents; or accept any claim for additional cost or time.

END OF SECTION

SECTION 27 15 01

STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Provisions and Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies standards of materials and execution in the provision of wiring, cable and related terminations to be provided under the work of Division 26 Sections. Refer to the requirements of such Sections for the functional requirements of systems to be provided using the materials and methods of this section, as well as the additional standards, material, and execution specific to each Section.

1.3 QUALITY ASSURANCE

Comply with the requirements of Division 01 and the following

- A. Company: Work of each Section in this Divisions shall be performed by an Installer who has at least eight (8) years direct experience with the devices, equipment and systems of the type and scope specified herein, and who has fully staffed and equipped maintenance and repair facility, and who is licensed to perform work of this type in the Project jurisdiction. Raceway installation shall be performed by a licensed C-10 contractor. All other work shall be performed by parties licensed to perform such work.
- B. Personnel: Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section. Supervisors shall have at least eight (8) years direct experience in similar work. Installation and maintenance personnel shall have at least five (5) years direct experience in similar work.
- C. Designated supervisor: Provide a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual through the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.

- D. Coordination: Coordinate the Work of this Section with the Work of all other Sections. Comply with Division 01.
- E. Verification: Verify dimensions and conditions at the Project site. Submit any conflicts in timely manner for resolution.
- F. Project Site Installation and Testing: Install as specified herein. Perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Request verification of Project Site test in timely manner.
- G. Verification of Submitted Test Data: Re-test in presence of designated representatives of the Architect at reasonable mutual convenience. Provide services of the designated supervisor and an additional technician familiar with work of this Section. Provide all test equipment. Provide complete set of latest stamped, actioned submittals of record for reference. Provide complete set of Shop and Project Site Test Reports, as applies. Provide a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
- H. Reference/Project Record Documents: At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies, a complete set of the latest stamped, actioned submittals of record for reference. Also maintain a separate, clean undamaged set for preparation of Project Record Documents. Also maintain at the workplace a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
- I. Schedule: Comply with the Project schedule. Make all Submittals specified herein in a timely manner. Failure to make timely submittals complete as specified herein is considered to be lack of substantial progress of the Work of this Section.
- J. Deliver all equipment, devices and material required for the Work of this Section and install, test and ready all work for Acceptance Testing at least fourteen (14) days prior to the completion date for the associated area of the Project.

1.4 REGULATORY REQUIREMENTS

- A. Codes and Regulations: Perform all work in strict accordance with all applicable Federal, State, County and City codes, regulations and ordinances.

1.5 APPLICABLE STANDARDS & AGENCIES

- A. Conform to the following:
 - 1. LA City Lab City of Los Angeles Electrical Testing Laboratory.
 - 2. CEC California Electrical Code.
 - 3. NFPA National Fire Protection Association.

4. UBC Uniform Building Code.
5. UL Underwriters Laboratories.
6. American National Standards Institute (ANSI)
 - a. ANSI C2 (1990) National Electric Safety Code
7. American Society For Testing and Materials (ASTM)
 - a. ASTM A228 (1983) Steel wire, Music Spring Quality
 - b. ASTM C338 (1973; R 1983) Softening Point of Glass
8. Electronic Industries Association (EIA)
 - a. EIA-455-3A (May 1989) Procedures to Measure Temperature Cycling Effects on Optical Fibers, Optical Cables, and Other Passive Fiber Optic Components
 - b. EIA-455-5A (June 1990) Humidity Test Procedure for Fiber Optic, Connecting Devices
 - c. EIA-455-41 (Feb. 1985) FOTP-41 Compressive Loading Resistance of Fiber Optic Cables
 - d. EIA-455-46 (Mar. 1983) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
 - e. EIA-455-47A (Sep. 1983) FOTP-47 Output Far-Field Radiation Pattern Measurement
 - f. EIA-455-51 (Sep. 1983) FOTP-51 Pulse Distortion Measurement of Multimode Glass Optical Fiber Information Transmission Capacity
 - g. EIA-455-53 (Apr. 1986) FOTP-53 Attenuation by Substitution Measurement – for Multimode Graded-index Optical Fiber or Fiber Assemblies Used in Long-Length Communications Systems
 - h. EIA-455-81 (Mar. 1985) FOTP-81 Compound Flow (Drip) Test for Fiber Optic Cable
 - i. EIA-455-103 (Jul 1984) FOTP-103 Buffered Fiber Bend Test
 - j. EIA/TIA 568 (July 1991) Commercial Building Telecommunications Cabling Standard
 - k. EIA/TIA TSB36
 - l. EIA/TIA TSB40 (August 1992) Additional Transmission Specifications for Unshielded Twisted Pair Connecting

- m. EIA/TIA 569 Hardware
(Oct. 1990) Commercial Building
Standard for Telecommunications
Pathways and Spaces
 - n. EIA/TIA 606 Administrative Standard for the
Telecommunications Infrastructure of
Commercial Buildings
9. Insulated Cable Engineers Association (ICEA):
- a. ICEA S-56-434 (1983, 5th Ed.) Polyolefin Insulated
Communication Cables for Outdoor
Use.
10. Underwriters Laboratories, Inc. (UL):
- a. UL 497 (Dec. 15, 1978, 4th Ed.; Rev. thru
Oct. 9, 1990) Protectors for
Communications Circuits.

1.6 PERFORMANCE STANDARDS

A. Data Category 5E: To EIA/TIA Category 5E.

B. Fiber Optic Cabling:

- 1. Optical Budget: For specified cabling, not more than 2 dB over the cabling manufacturer's specified loss for that same length plus .4dB for each connector and .3 dB for each splice measured at 1300 nm.
- 2. Bandwidth: 500MHz/km or per cable specification, whichever is more restrictive.

1.7 DELIVERY, STORAGE AND HANDLING

Comply with requirements of Division 01, Section 27 and the following:

A. Shipping Conditions:

- 1. All cable shall be shipped on reels.
- 2. The diameter of the drum shall be at least 13 times the diameter of the cable.
- 3. The reels shall be substantial and so constructed as to prevent damage during shipment and handling.
- 4. Secure the outer end of the cable to the reel head so as to prevent the cable from becoming loose in transit.
- 5. Project the inner end of the cable into a slot in the side of the reel, or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.

6. The inner end shall be fastened so as to prevent the cable from becoming loose during installation. End seals shall be applied to each of the cables to prevent moisture from entering the cable.

B. Storage:

1. Retain factory cable protection until installation. Supplement with heavy gauge plastic sheeting if factory protective membrane is pierced prior to installation. Tape ends and seams water and dust tight.
2. The reels with cable shall be suitable for outside storage conditions when the temperature ranges from minus 40 degrees C' to plus 65 degrees C', with relative humidity from 0 to 100 percent.
3. Protect cable reels from physical damage from site construction vehicles or from settling into the soil.
4. Equipment, other than cable, to be delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.8 DEFINITIONS

- A. Definitions of Terms: The following definitions and conditions apply to each of the respective parameters and the measurements of those parameters, unless specifically stated otherwise:

1. Frequency Response: The minimum acceptable frequency band over which the amplitude response is within 3 dB (or any specified range), or the specified limits of the response relative to the reference frequency under design load conditions, at any operating level up to and including the specified maximum output while fully in compliance with all other performance specifications.
2. Maximum Output Level: The minimum acceptable maximum signal output level (voltage, current or power) attained under design load conditions attained while fully in compliance with all other performance specifications.
3. Signal to Noise Ratio: The minimum acceptable ratio of signal to noise levels derived from broadband measurements under design load at maximum output over the entire range of the specified frequency response.
4. Design Load: The load (in ohms) specified by usage of the particular device input or output.
5. Loss: Attenuation in dB referenced to a path length and frequency.

1.9 REFERENCE TO NAMED PRODUCTS

- A. Select Item: Item so noted was selected based on comparative testing of similar products. Procedure for determination of equivalence is noted in the specification for the item (s).

- B. System Design Basis: Item so noted interacts with other system items to produce total system function. Substitution of this item may require coordinated substitution of other system items.
- C. Design Basis: Item so noted was used as basis for system drawings to establish features, size, etc. Use of specified equivalents may require adjustment of physical layout or wiring, but does not affect system function. No preference is implied.
- D. Industry Standard: Item so noted is unique. It is the de facto standard of the industry. Use of this item is required to cause other items to function as specified. There is no known equal (at time of specification preparation).

1.10 SUBMITTALS

In addition to the requirements of Division 1, submit as applies all materials for review arranged in same order as Specifications, individually reference-to Specification section, Paragraph and Contract Drawing number. Conform in every detail as applies to each referencing Section.

- A. Coordination Drawings: Prepare coordination drawings in accordance with the provisions in Section 01330.
- B. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.
- C. Should the Contractor proceed with the Work of this Section in the absence of submittals for such work submitted and returned with action "No Exception taken" or "Make Corrections As Noted", the Contractor proceeds at the Contractor's sole risk.
- D. Progress Schedule: Include duration and milestones for at least the following:
 - 1. All submittals specified.
 - 2. Shipment to site.
 - 3. Installation.
 - 4. Field testing.
- E. Manufacturer's Product Data:
 - 1. List of Material. For each item, include:
 - a. Manufacturer.
 - b. Model number.
 - c. Listing: UL, City Lab or none.
 - d. Quantity.

2. Manufacturer's Product Data Sheets: In sequence of List of Materials, Data sheet for each item, including all accessories, marked for proposed product.
- F. Field and Shop Drawings: With each such submittal, resubmit for coordination references complete with corrections from previous submittal:
1. List of Materials.
 2. Manufacturer's Product Data.
- G. Field (Installation) Drawings: Collate in sequence:
1. Drawing index/symbol sheet.
 2. Floor plans. At scale of Contract Documents. Show:
 - a. Rough-in.
 - b. Mounting height.
 - c. Conduit size.
 - d. Rough-in
 - e. Wire type.
 - f. Wire fill.
 3. Sections/Elevations: At scale of Contract Documents: Mounting location reference.
 4. Enlarged plans. At $\frac{1}{2}'' = 1' - 0''$ scale. Show:
 - a. Refer to "floor plans" above.
 - b. Architectural features.
 - c. Rack cabinets.
 - d. Clearances required by applicable Code.
 5. Wire run sheets (if used). Show:
 - a. Wire Number.
 - b. Source.
 - c. Designation.
 - d. Signal Type.
 - e. Wire Type.
 6. Patchbay / Jackfield details, front elevation, full size:
 - a. Layout.
 - b. Text of designations.
- H. Samples: Samples for review by the Architect of all finishes/materials which will be visible to the public, including but not limited to:
1. Receptacles and controls with associated trim plate.

- I. For other items, provide at least 2" x 2" sample.
- J. Shop and Project Site Test Reports:
 - 1. Schedule: Submit test reports in timely manner relative to Project schedule such that the representative of the Architect may conduct Verification of Submitted Test Data without delay of progress.
 - 2. Shop test report: Submit prior to shipping completed equipment racks to Project site.
 - 3. Project Site test report: Submit following system completion and prior to and as condition precedent to Acceptance Review and Testing of the Work of this Section.
 - 4. Content: Include at least:
 - a. Time and date of test.
 - b. Personnel conducting test.
 - c. Test equipment, including serial and date of calibration.
 - d. Test object.
 - e. Procedure used.
 - f. Results of test – numerical or graphical presentation.

1.11 OPERATING AND MAINTENANCE DATA

- A. Manuals: In addition to the requirements of Division 1, submit two (2) additional sets. Submit in three (3) post binders (not ring binder) with Tabs.
- B. Include:
 - 1. Index.
 - 2. Reduced set of system Record Drawings.
 - 3. Maintenance and spare parts schedule.
 - 4. Equipment manuals. Collate alphabetically by manufacturer. Provide manufacturer's original operation, instruction and service manuals for each item. For each set, provide manufacturer's original printed copies only. Photocopies not acceptable.
- C. Quantity:
 - 1. Review sets: As for Shop and Field Drawings.
 - 2. Record set: Three (3) blueline.
One (1) mylar.
- D. Format: Record Drawings:
 - 1. Pencil, permanent ink or permanent photographic process.
 - a. Front faces only of Mylar at least 3.0 mils thick.
 - b. Applique film or lettering prohibited.
 - c. Suitable for microfilming. Lettering 1/8" high minimum.

2. Diskette copy of Record Drawings – 1 copy of each drawing file in format noted above, 3-1/2 inch IBM PC, High Density format.
- E. Content: All drawings required under "Field and Shop Drawings". Show "as installed" condition. Where room designations according to Project permanent signage differ from construction designations in the Contract Documents, show both designations.
- F. Warranty Certificates: Comply with Division 01.

1.12 WARRANTY SERVICE

In addition to provisions of Division 01 provide the following:

- A. Warranty: Warrant all of the Work of this Section to be free from defects in materials and workmanship for a period of twelve (12) months from the date of Owner Acceptance of the Work of this Section.
- B. Response Time: Provide a qualified technician familiar with the work at the Project Site within twenty-four (24) hours after receipt of a notice of malfunction. Provide the Owner with telephone number attended eight (8) hours a day, five (5) days a week, to be called in the event of a malfunction.
- C. Off Site Service: Conduct all warranty repairs and services at the Project Site, unless in violation of manufacturer's standard product warranty. Provide substitute systems, equipment, and/or devices acceptable to the Owner for the duration of off-site repairs. Provide transportation for substitute and/or test systems, equipment, devices, materials, parts and personnel to and from Project Site.

PART 2 - PRODUCTS

2.1 COPPER COMMUNICATIONS CABLES AND RELATED

- A. General: Comply with applicable Code for insulation, jacket, marking and listing for applicable use. Data cable shall have a blue color jacket. Voice cable shall have a grey color jacket.
- B. Category 3 Cabling (N.I.C.)
 1. Construction (Plenum Rated):
 - a. 24 gauge bare solid copper conductors.
 - b. Dual insulated with polyethylene and fire retardant overall jacket.
 - c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
 - d. No shield in the sheath.
 - e. Each sheath shall contain 4 unshielded copper pairs.
 - f. Each pair shall have a minimum of two (2) twists per foot.

- g. UL Listed, NEC compliant for plenum installation.
2. Construction (Non-Plenum Rated):
 - a. 24 gauge bare solid copper conductors.
 - b. Dual insulated with polyethylene and fire retardant overall jacket.
 - c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
 - d. No shield in the sheath.
 - e. Each sheath shall contain 4 unshielded copper pairs.
 - f. Each pair shall have a minimum of two (2) twists per foot.
 3. Construction (Outdoor Rated):
 - a. 24 gauge bare solid copper conductors.
 - b. Dual insulated with polyethylene and fire retardant overall jacket.
 - c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
 - d. No shield in the sheath.
 - e. Each sheath shall contain 4 unshielded copper pairs.
 - f. Each pair shall have a minimum of two (2) twists per foot.
 4. Performance:
 - a. ANSI/TIA/EIA 568A (Category 3).
 - b. ANSI/ICEA S-90-661 Category 3.
 - c. NEMA WC63.1 (Category 3).
 - d. Electrical Characteristics: Worst Case Pair.

(1)	DC Resistance (max) Ohms/100m @ 20°C		9.38
(2)	Mutual Capacitance (nom) pF/ft @ 1 kHz		18
(3)	Characteristic Impedance		Ohms (min-max)
	Frequency (f):	772 kHz	87-117
		1.0-16.0 MHz	85-115
(4)	Structural Return Loss (SRL)		dB (min)
	Frequency (f):	1.0-10.0 MHz	12
		10.0-16.0 MHz	12-10 log (f/10)
(5)	Frequency	Attenuation dB/100m (max)	Near-End Crosstalk dB (min)
	772 kHz	2.2	43
	1 MHz	2.6	41
	4 MHz	5.6	32
	8 MHz	8.5	27

10 MHz	9.7	26
16 MHz	13.1	23

5. Acceptable, subject to the above:
 Plenum Non-Plenum Outdoor

- a. Comscope
- b. Belden
- c. BICC General
- d. Substitution

C. Category 5 Cabling (where indicated on plans)

1. Construction (Plenum Rated):

- a. 24 gauge bare solid copper conductors
- b. Dual insulated with polyethylene and fire retardant overall jacket.
- c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
- d. No shield in the sheath.
- e. Each sheath shall contain 4 unshielded copper pairs.
- f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.
- g. UL Listed, NEC compliant for plenum installation.

2. Construction (Non-Plenum Rated):

- a. 24 gauge bare solid copper conductors
- b. Dual insulated with polyethylene and fire retardant overall jacket.
- c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
- d. No shield in the sheath.
- e. Each sheath shall contain 4 unshielded copper pairs.
- f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

3. Construction (Outdoor Rated):

- a. 24 gauge bare solid copper conductors
- b. Dual insulated with polyethylene and fire retardant overall Jacket.
- c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
- d. No Shield in the sheath.
- e. Each sheath shall contain 4 unshielded copper pairs.
- f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

4. Performance:

- a. ANSI/TIA/EIA (Category 5).
- b. ANSI/ICEA S-90-661 Category 5.
- c. NEMA WC63.1 (Category 5).
- d. Electrical Characteristics:

(1)	DC Resistance (max) Ohm/100m (328ft) @ 20° C	8.9
(2)	Mutual Capacitance (nom) pF/ft @ 1 kHz	14
(3)	Characteristic Impedance Frequency (f):	Ohms (min-max) 87-117 85-115
	772 kHz 1.0-100 MHz	
(4)	Delay Skew (max) ns/100m	45
(5)	Nominal Velocity of Propagation (NVP) % Speed of Light	70
(6)	Propagation Delay (max) ns @ 10 MHz	518

(7)	Max Atten. dB/100m Frequency	Near End Cross-Talk (328ft)	Power Sum Near End Cross-Talk dB (min)	dB (min)	Structural Return loss dB (min)
	772 kHz	1.8	64.3	64.3	23
	1 MHz	2.0	62.3	62.3	23
	4 MHz	4.1	53.3	53.3	23
	8 MHz	5.8	48.3	48.3	23
	10 MHz	6.5	47.3	47.3	23
	16 MHz	8.2	44.3	44.3	23
	20 MHz	9.3	42.3	42.3	23
	25 MHz	10.4	41.3	41.3	22
	31.25 MHz	11.7	39.3	39.3	21
	62.5 MHz	17.0	35.3	35.3	18
	100 MHz	22.0	32.3	32.3	16

5. Acceptable, subject to the above:
Plenum Non-Plenum Outdoor

- a. BICC General
- b. Comscope
- c. Belden
- d. Substitution

D. Category 5E Cabling (Data)

1. Construction (Plenum Rated)
 - a. 24 gauge bare solid copper conductors
 - b. Dual insulated with polyethylene and fire retardant overall jacket.
 - c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
 - d. No shield in the sheath.
 - e. Each sheath shall contain 4 unshielded copper pairs.
 - f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.
 - g. UL Listed, NEC compliant for plenum installation.

2. Construction (Non-Plenum Rated)
 - a. 24 gauge bare solid copper conductors
 - b. Dual insulated with polyethylene and fire retardant overall jacket.
 - c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
 - d. No shield in the sheath.
 - e. Each sheath shall contain 4 unshielded copper pairs.
 - f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

3. Construction (Outdoor Rated):
 - a. 24 gauge bare solid copper conductors
 - b. Dual insulated with polyethylene and fire retardant overall jacket.
 - c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
 - d. No shield in the sheath.
 - e. Each sheath shall contain 4 unshielded copper pairs.
 - f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

4. Performance:
 - a. ANSI/TIA/EIA 568A (Category 5E, Draft II).
 - b. ANSI/ICEA S-90-661 Category 5x-100.
 - c. NEMA WC63.5 (Category 5).
 - d. Electrical Characteristics:

(1)	DC Resistance (max) Ohm/100m (328ft) @ 20° C	8.9
(2)	DC Resistance Unbalance (max) Individual Pair %	3.0

(3)	Input Impedance		
	Frequency (f):	1. 0-100 MHz	100 ± 15
		100-350 MHz	100 ± 22
(4)	Characteristic Impedance		
	Frequency (f):	1-350 MHz	100 ± 15
(5)	ACR @ 100 MHz		DB (min)
			21
(6)	PS-ACR @ 100 MHz		DB (min)
			19
(7)	Delay Skew (max) ns/100m		25
(8)	Nominal Velocity of Propagation (NVP) % Speed of Light		70

(9)	Max Attenuation dB/100m	ELFEXT dB (min)	PS-ELFEXT dB (min)	PS-NEXT dB (min)	(min)	NEXT dB (min)	SRL	Return Loss dB
772 kHz		1.8	66	63	70	72	-	-
1 MHz	2.0	64	61	68	70	24.5	20.0	
4 MHz	4.1	52	49	59	61	24.5	23.0	
8 MHz	5.8	46	43	54	56	24.5	24.5	
10 MHz	6.5	44	41	53	55	24.5	25.0	
16 MHz	8.2	40	37		50	52	24.5	25.0
20 MHz	9.3	38	35		48	50	24.5	25.0
25 MHz	10.4	36	33		47	49	24.0	24.3
31.25 MHz	11.7	34	31		45	47	23.5	23.6
62.5 MHz	17.0	28	25		41	43	22.0	21.5
100 MHz	22.0	24	21		38	40	21.0	20.1
155 MHz	28.1	20	17		35	37	20.1	18.8
200 MHz	32.4	18	15		33	35	19.5	18.0
300 MHz	41.0	14	11		31	33	18.6	16.8
350 MHz	44.9	13	10		30	32	18.3	16.3

5. Acceptable, subject to the above:
- | | | | |
|----|--------------|------------|---------|
| | Plenum | Non-Plenum | Outdoor |
| a. | BICC General | | |
| b. | Comscope | | |

- c. Belden
- d. Substitution

E. Category 6 (N.I.C.)

1. Construction (Plenum Rated)

- a. 24 gauge bare solid copper conductors
- b. Dual insulated with polyethylene and fire retardant overall jacket.
- c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
- d. No shield in the sheath.
- e. Each sheath shall contain 4 unshielded copper pairs.
- f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.
- g. UL Listed, NEC compliant for plenum installation.

2. Construction (Non-Plenum Rated):

- a. 24 gauge bare solid copper conductors
- b. Dual insulated with polyethylene and fire retardant overall jacket.
- c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
- d. No shield in the sheath.
- e. Each sheath shall contain 4 unshielded copper pairs.
- f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

3. Construction (Outdoor Rated):

- a. 24 gauge bare solid copper conductors
- b. Dual insulated with polyethylene and fire retardant overall jacket.
- c. Conductors are tightly twisted into pairs and jacketed with polyethylene.
- d. No shield in the sheath.
- e. Each sheath shall contain 4 unshielded copper pairs.
- f. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

4. Performance:

- a. ANSI/TIA/EIA 568A (Proposed Category 6).
- b. ANSI/ICEA S-90-661 Category 5x-160.
- c. ISO/IEC/180
- d. Electrical Characteristics:

- (1) DC Resistance (max) 8.9
Ohm/100m (328ft) @ 20° C

(2)	DC Resistance Unbalance (max) Individual Pair %		3.0
(3)	Delay Skew (max) ns/100m		25
(4)	Nominal Velocity of Propagation (NVP) % Speed of Light		70
(5)	Characteristic Impedance		Ohms
	Frequency (f):	1-500 MHz	100 ± 15
(6)	Input Impedance		
	Frequency (f):	1. 0-100 MHz	100 ± 15
		100-350 MHz	100 ± 22
		350-500 MHz	100 ± 32

The Input Impedance values specified are based on swept frequency cable measurements per ISO/IEC 11801. No curve fitting or smoothing functions are used.

Frequency	ACR dB@100 m (min)	PS-ACR dB@100 m (min)	PS- ELFEXT dB (min)	PS- ELFEXT dB (min)	NEXT dB (min)	PS- NEXT dB (min)	ATTEN. dB@100 max	RETURN SRL dB (min)	Loss dB (min)
772KHz	74	72	77	74	76.0	74.0	1.8	-	-
1 MHz	72	70	75	72	74.3	72.3	2.0	25.5	20.0
4 MHz	61	59	63	60	65.3	63.3	3.8	25.5	23.0
10 MHz	53	51	55	52	59.3	57.3	6.0	25.5	25.0
16 MHz	48	46	51	48	56.3	54.3	7.6	25.5	25.0
20 MHz	46	44	49	46	54.8	52.8	8.5	25.5	25.0
31.25 MHz	40	38	45	42	51.9	49.9	10.7	24.5	23.6
62.5 MHz	32	30	39	36	47.4	45.4	15.5	23.0	21.5
100 MHz	25	22	35	32	44.3	42.3	19.9	22.0	20.1
200 MHz	11	9	29	26	39.8	37.8	29.2	20.5	18.0
350 MHz	-	-	24	21	36.2	34.2	40.0	19.3	16.3
400 MHz	-	-	23	20	35.3	33.3	43.2	19.0	15.8
500 MHz	-	-	21	18	33.8	31.8	49.2	18.5	15.2

5. Acceptable, subject to the above:
Plenum Non-Plenum Outdoor

- a. BICC General
- b. Comscope
- c. Belden
- d. Essex

2.2 COPPER CABLING, TELEPHONE INSIDE AND OUTSIDE PLANT

A. Cables: Voice cables which interconnect IDF's with the MDF interior distribution centers shall conform to ICEA S-80-576 shall be contractor furnished and installed. Cable shall be UL classified low smoke and low flame for use in air plenums in accordance with NFPA 70. Each cable shall be copper 24 AWG, 25 to 900 pair.

1. Features/Functions:

- a. Solid round copper wire, individually bound per REA PE-39 color coded.
- b. Polyethylene Overall Jacket.
- c. Suitable for direct burial.

2. Acceptable:

- a. AT&T PIC Alpeth Sheath-filled Solid Cable
- b. AT&T PIC Alpeth Sheath-filled Foam/Skin (DEPIC) Cable.

B. Telephone, Inside Distribution Wire:

1. Construction:

- a. 25 to 900 pair count Category 1 (Pots) voice pair cabling in overall jacket where specifically noted on plans.
- b. Plenum application.
- c. USCO color code.
- d. NEC Type CM, Type CMR in riser applications.

2. Acceptable:

- a. CommScope
- b. General Cable
- c. Northern Telecom
- d. Approved equal.

C. Telephone, Indoor Distribution Wire:

1. Construction:

- a. 25 to 900 pair count Category 3 voice pair cabling in overall jacket where specifically noted on plans.
- b. Plenum application.
- c. USCO color code.
- d. NEC Type CM, Type CMR in riser applications.

2. Acceptable:

- a. CommScope
- b. General Cable
- c. Northern Telecom
- d. Approved equal.

D. Telephone, Outside Distribution Wire:

1. Construction:

- a. 25 to 900 pair count Category 1 (Pots) voice pair cabling in overall jacket where specifically noted on plans.
- b. Plenum application.
- c. USOC color code.
- d. NEC Type CM, Type CMR in riser applications.

2. Acceptable:

- a. CommScope
3. General Cable
4. Northern Cable
5. Substitution.

E. Telephone, Outside Distribution Wire:

1. Construction:

- a. 25 to 900 pair count Category 3 voice pair cabling in overall jacket.
- b. Plenum application.
- c. USOC color code.
- d. NEC Type CM, Type CMR in riser applications.

2. Acceptable:

- a. CommScope
- b. General Cable
- c. Northern Cable
- d. Approved equal.

2.3 FIBER OPTIC COMMUNICATIONS CABLING AND RELATED

Fiber count per cable to comply with minimum counts indicated on the plans. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.

A. Fiber, Multimode – General:

1. Meeting EIA/TIA 568
2. Construction:

- a. Multi-mode
- b. Core Diameter: 62.5 ± 3.0 , μm
- c. Cladding Diameter: 125 ± 2.0 μm
- d. Numerical Aperture: 0.275 ± 0.015
- e. Core and Cladding Non-Circularity:

- (1) Core: $<6.0\%$
- (2) Cladding: $<2.0\%$

- f. OVD Process

3. Performance:

- a. Bandwidth:
- b. 850 nm: > 160 MHz/km
- c. 1300 nm: 500 MHz/km
- b. Chromatic Dispersion:

- (1) Minimum Zero Dispersion Wavelength: 1332nm
- (2) Maximum Zero Dispersion Wavelength: 1354 nm
- (3) Maximum Zero Dispersion Slope: 0.097 ps/nm'okm

c. Attenuation:

- (1) Max attenuation point'discontinuity:
 >0.1 dB at 1300 nm and 1500 nm
- (2) @ 1383 ± 3 nm: < -2.1 dB/km
- (3) Bending Attenuation: induced @ 1550 nm, with 1 00 turns on 75mm dia mandrel: <0.10 dB

- d. Attenuation Difference: at 1380 nm: $<$ attenuation at 1300 nm. + 1 dB/km

- e. Temperature Stability: induced attenuation, -60 C to 85° C, 1300 and 1550 nm, < 0.05 dB/km
- f.

- g. Water Immersion: Induced attenuation, 23° C
water immersion: <0.05 dB/km

3. Acceptable:

- a. Corning LNF
- b. equal by AT&T

B. Fiber Optic Cable, Inside Distribution:

- 1. Fiber: Refer to FIBER, MULTIMODE, GENERAL.
- 2. Application: In-building Distribution.
- 3. Approvals: Where used outside conduit, OFN, OFNP, OFNR per NEC 770-51, as applies.
- 4. Construction:

- a. All Dielectric.
- b. Suitable and approved for indoor use.
- c. Tight buffer,
- d. Breakout style construction, with individual jacket per fiber with overall outside jacket.
- e. FGE/Kevlar strength member
- f. Maximum Cable Diameter:

- (1) 6 Fibers: .363"
- (2) 8 Fibers: .437"
- (3) 10 Fibers: .473"
- (4) 12 Fibers: .506"

5. Performance:

a. Maximum attenuation:

- (1) 850 nm: < 3.5 dB/km
- (2) 1300 nm: < 1.0 dB/km

b. Maximum required bend radius:

- (1) At installation: 15x's diameter
- (2) Long term application: 10 x's diameter

c. Minimum Safe Longitudinal Load:

- (1) At installation,
 - (a) 6 Fibers: 380 lbs
 - (b) 8 Fibers: 480 lbs
 - (c) 10-1/2 Fibers: 575 lbs

(2) Long term application:

- (a) 6 Fibers: 115lbs
- (b) 8 Fibers: 145 lbs
- (c) 10-12 Fibers: 75 lbs

- d. Crush resistance: 250 lb/inch
- e. Impact Resistance: 3.6 ft-lbs, 10 impacts
- f. Flex, Twist/Bend 1000 cycles, 22 lbs, 10 x O.D. radius

6. Acceptable, subject to above:

- a. BICC General
- b. Belden 225XXX Series
- c. Berk-Tek
- d. Brand-Rex
- e. Chromatic Technologies, Inc.
- f. Mohawk
- g. Siecor
- h. West Penn

C. Fiber Optic Cable, Outside Plant:

- 1. Fiber: Refer to FIBER, MULTIMODE, GENERAL.
- 2. Application: Inter-building site distribution in manholes and site conduit.
- 3. Construction:
 - a. All dielectric, unless otherwise noted.
 - b. Multiple fibers per tube, as applies.
 - c. Suitable and approved for wet location/direct burial.
 - d. Loose tube, Tight Buffer, military grade tactical field cable meeting Mil Spec DOD-C-85045C.
 - e. Jacket: Polyethylene, polyurethane or PVC.
 - f. Heavy duty construction, Fiberglass Epoxy Rod/Kevlar strength member (s)
 - g. Maximum Cable Diameter:
 - (1) 4 - 6 Fibers: .465"
 - (2) 8 - 36 Fibers: .525"
- 4. Performance:
 - a. Maximum attenuation:
 - (1) 850 nm: < 3.5 dB/km
 - (2) 1300 nm: < 1.0 dB/km
 - b. Maximum required bend radius:

- (1) At installation: 20 x's diameter
 - (2) Long term application: 10 x's diameter
- c. Minimum Safe Longitudinal Load:
- (1) At installation,
 - (a) 2 or more Fibers: 600 lbs.
 - (2) Long term application:
 - (a) 4 or more Fibers: 180 lbs.
 - (b) Crush resistance: 250lb/inch.
 - (c) Impact Resistance: 3.3 ft-lbs, 25 impacts.
 - (d) Flex, Twist/Bend: 25 cycles, 12 lbs, 10 x O.D. radius.
5. Acceptable, subject to above:
- a. BICC General
 - b. Belden 2254XX Series
 - c. Berk-Tek
 - d. Brand-Rex
 - e. Chromatic technologies, Inc.
 - f. General

2.4 DATA STATION JACKS & RECEPTACLES

A. Category 5 Data Jacks Requirements (where indicated), General:

- 1. Construction:
 - a. High impact, flame retardant UL-rated 94V-0 thermoplastic.
 - b. The jack shall be designed with an integral locking mechanism which, upon insertion of a modular plug, provide maximum pullout strength at the plug/jack interface.
 - c. Integral ID label holders and color keyed jack identifier inserts.
- 2. Performance – The jack shall meet or exceed the following standards.
 - a. EIA/TIA 568 "Commercial Building Wiring Standard:, Telecommunications Outlet Connector Specification
 - b. TIA/EIA TSB40 "Telecommunications Systems Bulletin-Additional Transmission Specifications for Unshielded Twisted pair Connecting Hardware", Category 5.
 - c. CSA Certified

- d. UL listed
- e. FCC Part 68, Subpart F
- f. Electrical – The modular jacks shall meet the following electrical performance and certification requirements.
 - (1) Insulation resistance – 500 MO maximum
 - (2) Dielectric withstand voltage
 - (a) 1000 VAC RMS, 60 Hz minimum, contact to contact
 - (b) 1000 VAC RMS, 60 Hz minimum to exposed conductive surface
 - (3) Contact Resistance – 20 mD maximum
 - (4) Current Rating – 1.5 amps at 68 degrees F (20 degrees C) per IEC Publication 51 2-3, Test 5b.
 - (5) Attenuation *:

Attenuation (in dB) for Frequency (in MHz)

Jack Wire No.'s	1.0	4.0	8.0	10.0	16.0	20.0	25.	31.25	62.5	100
(5, 4)	<. 02	<. 02	<. 02	<. 02	<. 03	<. 03	<. 03	<. 04	<. 09	<. 15
(3, 6)	<. 02	<. 02	<. 02	<. 02	<. 03	<. 03	<. 03	<. 05	<. 14	<. 25
(1, 2)	<. 02	<. 02	<. 02	<. 02	<. 03	<. 03	<. 03	<. 04	<. 07	<. 10
(7, 8)	<. 02	<. 02	<. 02	<. 02	<. 03	<. 03	<. 03	<. 04	<. 07	<. 11

- (6) Near End Cross Talk Requirements*:

Attenuation (in dB) for Frequency (in MHz)

Jack Wire

No.'s	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
(5, 4) - (3, 6) 90		78	72	70	65	63	61	58	50	42.4
(5, 4) - (1, 2) 90		78	73	71	67	65	63	61	55	51
(5, 4) - (7, 8) 85		74	68	66	62	60	58	56	50	48
(1, 2) - (3, 6) >100		90	84	82	78	77	75	72	63	58
(3, 6) - (7, 8) 87		77	71	68	65	63	61	59	52	47
(1, 2) - (7, 8) 95		83	77	75	71	69	67	65	59	56

(7) Return Loss:

Return Loss (in dB) for Frequency (in MHz)

Pairs	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
1	60.6	51.0	46.0	44.4	40.9	39.2	37.4	35.7	30.1	26.1
2	63.1	54.6	49.7	48.1	44.7	43.0	41.2	39.7	34.2	30.3
3	56.5	45.2	39.6	37.8	34.0	32.1	30.2	26.4	22.7	18.8
4	61.9	52.4	47.2	45.5	41.9	40.1	38.3	36.7	31.2	27.3

* Near End Crosstalk (NEXT) and Attenuation measurements shall be made per EIA/TIA TSB40, Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware.

g. Physical – The modular jacks shall meet the following physical requirements.

- (1) Connector-insulation displacement connectors accepting 22 and 24 gauge AWG solid conductor wire.
- (2) Jack wires-square copper alloy wires with 50 micro-inch lubricated gold plating over 100 micro-inch nickel plate
- (3) Stamped crossover lead frame conductor paths
- (4) Wired to meet EIA 568A specifications
- (5) Stamped "CAT 5E" on facing surface above the jack opening

h. Mechanical – The modular jacks shall meet the following mechanical requirements

- (1) Plug insertion minimum 750 plug insertions
- (2) Contact Force 100 grams minimum using FCC-approved modular plugs
- (3) Plug Retention Force – 30 lb (133 N) minimum between modular plug and jack
- (4) Temperature Range - -40 to 150 degrees F

The outlet should be approved to work in all applications up to 100 Mb/sec, including, but not limited to 100 Mb/sec TP-PMD (100 meters over UTP, per ANSI X3T9.5), 16 Mb/sec token ring, 10 Base T and 4 Mb/sec token ring.

B. Category 6 Data Jacks Requirements (where required), General:

1. Construction:

- a. High impact, flame retardant UL-rated 94V-0 thermoplastic.
- b. The jack shall be designed with an integral locking mechanism which, upon insertion of a modular plug, provide maximum pullout strength at the plug/jack interface.
- c. Integral ID label holders and color keyed jack identifier inserts.

2. Performance – The jack shall meet or exceed the following standards.

- a. EIA/TIA 568 "Commercial Building Wiring Standard; Telecommunications Outlet Connector Specification
- b. TIA/EIA TSB40 "Telecommunications Systems Bulletin-Additional Transmission Specifications for Unshielded Twisted pair Connecting Hardware", Category 6.
- c. CSA Certified
- d. UL listed
- e. FCC Part 68, Subpart F
- f. Electrical – The modular jacks shall meet the following electrical performance and certification requirements.

(1) Insulation resistance – 500 MO maximum

(2) Dielectric withstand voltage

(a) 1000 VAC RMS, 60 Hz minimum, contact to contact

(b) 1000 VAC RMS, 60 Hz minimum to exposed conductive surface

(3) Contact Resistance – 20 mD maximum

(4) Current Rating – 1.5 amps at 68 degrees F (20 degrees C) per IEC Publication 51 2-3, Test 5b.

(5) Attenuation*:

Attenuation (in dB) for Frequency (in MHz)

Jack Wire No.'s	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
(5, 4)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .04	< .09	< .15
(3, 6)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .05	< .14	< .25
(1, 2)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .04	< .07	< .10
(7, 8)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .04	< .07	< .11

(6) Near End Cross Talk Requirements*:

Attenuation (in dB) for Frequency (in MHz)

Jack Wire No.'s	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
(5, 4) - (3, 6)90		78	72	70	65	63	61	58	50	42.4
(5, 4) - (1, 2)90		78	73	71	67	65	63	61	55	51
(5, 4) - (7, 8)85		74	68	66	62	60	58	56	50	48
(1, 2) - (3, 6)>100		90	84	82	78	77	75	72	63	58
(3, 6) - (7, 8)87		77	71	68	65	63	61	59	52	47
(1, 2) - (7, 8)95		83	77	75	71	69	67	65	59	56

(7) Return Loss:

Return Loss (in dB) for Frequency (in MHz)

Pairs	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
1	60.6	51.0	46.0	44.4	40.9	39.2	37.4	35.7	30.1	26.1
2	63.1	54.6	49.7	48.1	44.7	43.0	41.2	39.7	34.2	30.3
3	56.5	45.2	39.6	37.8	34.0	32.1	30.2	26.4	22.7	18.8
4	61.9	52.4	47.2	45.5	41.9	40.1	38.3	36.7	31.2	27.3

* Near End Crosstalk (NEXT) and Attenuation measurements shall be made per EIA/TIA TSB40, Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware.

- g. Physical – The modular jacks shall meet the following physical requirements.
 - (1) Connector-insulation displacement connectors accepting 22 and 24 gauge AWG solid conductor wire.
 - (2) Jack wires-square copper alloy wires with 50 micro-inch lubricated gold plating over 100 micro-inch nickel plate
 - (3) Stamped crossover lead frame conductor paths
 - (4) Wired to meet EIA 568A specifications
 - (5) Stamped "CAT 5E" on facing surface above the jack opening

- h. Mechanical – The modular jacks shall meet the following mechanical requirements
 - (1) Plug insertion minimum 750 plug insertions
 - (2) Contact Force 100 grams minimum using FCC-approved modular plugs
 - (3) Plug Retention Force – 30 lb (133 N) minimum between modular plug and jack
 - (4) Temperature Range - -40 to 150 degrees F

The outlet should be approved to work in all applications up to 100 Mb/sec, including, but not limited to 100 Mb/sec TP-PMD (100 meters over UTP, per ANSI X3T9.5), 16 Mb/sec token ring, 10 Base T and 4 Mb/sec token ring.

C. Category 5E Data Jacks Performance Requirements, General:

- 1. Construction:
 - a. High impact, flame retardant UL-rated 94V-0 thermoplastic.
 - b. The jack shall be designed with an integral locking mechanism which, upon insertion of a modular plug, provide maximum pullout strength at the plug/jack interface.
 - c. Integral ID label holders and color keyed jack identifier inserts.

- 2. Performance – The jack shall meet or exceed the following standards.
 - a. EIA/TIA 568 "Commercial Building Wiring Standard;, Telecommunications Outlet Connector Specification
 - b. TIA/EIA TSB40 "Telecommunications Systems Bulletin-Additional Transmission Specifications for Unshielded Twisted pair Connecting Hardware", Category 5E.
 - c. CSA Certified
 - d. UL listed
 - e. FCC Part 68, Subpart F
 - f. Electrical – The modular jacks shall meet the following electrical performance and certification requirements.

- (1) Insulation resistance – 500 MO maximum
- (2) Dielectric withstand voltage
 - (a) 1000 VAC RMS, 60 Hz minimum, contact to contact
 - (b) 1000 VAC RMS, 60 Hz minimum to exposed conductive surface
- (3) Contact Resistance – 20 mD maximum
- (4) Current Rating – 1.5 amps at 68 degrees F (20 degrees C) per IEC Publication 51 2-3, Test 5b.
- (5) Attenuation*:

Attenuation (in dB) for Frequency (in MHz)

Jack Wire No.'s	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
(5, 4)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .04	< .09	< .15
(3, 6)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .05	< .14	< .25
(1, 2)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .04	< .07	< .10
(7, 8)	< .02	< .02	< .02	< .02	< .03	< .03	< .03	< .04	< .07	< .11

- (6) Near End Cross Talk Requirements*:

Attenuation (in dB) for Frequency (in MHz)

Jack Wire No.'s	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
(5, 4) - (3, 6)	90	78	72	70	65	63	61	58	50	42.4
(5, 4) - (1, 2)	90	78	73	71	67	65	63	61	55	51
(5, 4) - (7, 8)	85	74	68	66	62	60	58	56	50	48
(1, 2) - (3, 6)	>100	90	84	82	78	77	75	72	63	58
(3, 6) - (7, 8)	87	77	71	68	65	63	61	59	52	47
(1, 2) - (7, 8)	95	83	77	75	71	69	67	65	59	56

- (7) Return Loss:

Return Loss (in dB) for Frequency (in MHz)

Pairs	1.0	4.0	8.0	10.0	16.0	20.0	25	31.25	62.5	100
1	60.6	51.0	46.0	44.4	40.9	39.2	37.4	35.7	30.1	26.1
2	63.1	54.6	49.7	48.1	44.7	43.0	41.2	39.7	34.2	30.3
3	56.5	45.2	39.6	37.8	34.0	32.1	30.2	26.4	22.7	18.8
4	61.9	52.4	47.2	45.5	41.9	40.1	38.3	36.7	31.2	27.3

* Near End Crosstalk (NEXT) and Attenuation measurements shall be made per EIA/TIA TSB40, Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware.

g. Physical – The modular jacks shall meet the following physical requirements.

- (1) Connector-insulation displacement connectors accepting 22 and 24 gauge AWG solid conductor wire.
- (2) Jack wires-square copper alloy wires with 50 micro-inch lubricated gold plating over 100 micro-inch nickel plate
- (3) Stamped crossover lead frame conductor paths
- (4) Wired to meet EIA 568A specifications
- (5) Stamped "CAT 5E" on facing surface above the jack opening

h. Mechanical – The modular jacks shall meet the following mechanical requirements

- (1) Plug insertion minimum 750 plug insertions
- (2) Contact Force 100 grams minimum using FCC-approved modular plugs
- (3) Plug Retention Force – 30 lb (133 N) minimum between modular plug and jack
- (4) Temperature Range - -40 to 150 degrees

The outlet should be approved to work in all applications up to 100 Mb/sec, including, but not limited to 100 Mb/sec TP-PMD (100 meters over UTP, per ANSI X3T9.5), 16 Mb/sec token ring, 10 Base T and 4 Mb/sec token ring.

E. Modular Receptacle Plates, 6 Receptacles, Single Gang:

1. Construction:

- (a) Modular, with snap-in receptacle options as scheduled.
- (b) Single gang plate size and mounting.

- (c) Options for 6 receptacles per plate.
- (d) Stainless steel plate construction.
- (e) Integral labeling provided for plate identifier and identifier for each receptacle on the plate. Provide as follows:
 - (1) Plat Nominally 1-1/2" by 1/2" recessed slot with clear plastic cover over paper label. See labeling requirements in Part 3.
 - (2) Receptacle Identifiers: Iconic or literal descriptions of each receptacle type. Label shall be molded or silk-screened on the receptacle in high contrast colors. Removable components less than 1/2" by 1/2" shall not be acceptable where such components are provided, they shall be permanently secured with cyanoacrylate adhesive or similar means.
- (f) System shall provide at minimum the following receptacle options:
 - (1) Category 5, 5E and 6, RJ45 data jack, 568A Color Code. Refer to performance requirements elsewhere herein.
- (g) Provide blank plate filler as required.

2. Acceptable, subject to the above:

- a. 558510 Plate
 - (1) 558908-1 Cat 5E Jacks
 - (2) 555644-* Blank
- b. 110 Connect Plate
 - (1) 557818-* Cat 5E Jacks
 - (2) 557626 Blank
- c. Hubbell FP or 77 Series Plate – coordinate receptacles with plate construction.
 - (1) 511081 Cat 5E Jacks
 - (2) SF* Blank
- d. Leviton Quickport Multiport Wall Plates
 - (1) 41108-K*5 Cat 5E Jack
- e. Mod-Tap System 100 Series
 - (1) 17 Series Inserts

f. Ortronics Series 11 Snap-In Modules (Design Basis) in IMO's single or dual gang plate, including (where required to accommodate indicated uses at single plate).

(1) OR-60950047 – Single Cat 5E.

g. Siemon CT Series.

(1) CT-5 Series Cat 5E Jacks

(2) CT BLNK Blank

h. Wiremold/Just Data Flexplate Outlets

(1) J-12597-5 Cat 5E RJ45

(2) J-12590-5 Blank

i. Equal by AT&T

J. Approved equal

2.5 CABLE TERMINATION DEVICES AND RELATED

A. Data Patch Panels, Category 5E Rated, Rack Mounted:

1. Function/Features:

a. 19" EIA rack mountable.

b. At least 24 ports per EIA rack unit (1.75").

c. Keyed, block form RJ-45/Cat 5E Jack and 110 terminations meeting specifications elsewhere herein,

(1) arranged in rows on steel panel,

(2) jacks on front,

(3) termination on rear.

d. Port identifier label space on front.

e. Provide wire management rings in a ratio of at least 4 for every 20 ports.

2. Acceptable, provide additional wire management system to conform:

a. AMP 110 Connect.

b. AT&T 1100 Modular Patch Panel

c. (1) Category 5E 110 Panels

d. Leviton Infotap High Density 110 Patch Panels

(1) 24 Port – T568A, 49485-C24

(2) 48 Port – T568A, 49485-C48

- (3) 64 Port – T568A, 49485-C64
- (4) 96 Port – T568A, 49485-C96

- e. System 110 Patch Panels
- f. Siemon HD5 Patch Panels
- g. Cat 5E Mod to 110 HD Panels.
- h. Wiremold 110 IDC Panels – Category 5E.

B. Data Patch Panel, Category 5E Rated, Rack Mounted:

1. Functions/Features:

- a. 19" EIA rack mountable.
- b. At least 24 ports per EIA rack unit (1.75").
- c. Keyed, block form RJ-45/Cat 5E Jack and 110 terminations meeting specifications elsewhere herein,
 - (1) arranged in rows on steel panel,
 - (2) jacks on front,
 - (3) termination on rear.
- d. Port identifier label space on front.
- e. Provide wire management rings in a ratio of at least 4 for every 20 ports.

2. Acceptable, provide additional wire management system to conform:

- a. AMP 110 Connect.
- b. AT&T 1100 Modular Patch Panel
- c. (1) Category 5E 110 Panels
- d. Leviton Infotap High Density 110 Patch Panels
 - (1) 24 Port – T568A, 49485-C24
 - (2) 48 Port – T568A, 49485-C48
 - (3) 64 Port – T568A, 49485-C64
 - (4) 96 Port – T568A, 49485-C96
- e. System 110 Patch Panels
- f. Siemon HD5 Patch Panels
- g. Cat 5E Mod to 110 HD Panels.
- h. Wiremold 110 IDC Panels – Category 5E.

C. Category 5E Terminal Block:

- 1. Provide as required per quantity of voice cables as indicated on plans.

2. General: Insulation displacements connector blocks consisting of oxygen free mechanical fastening system arranged in a flame-retardant molded plastic fastened to a mounting bracket.
3. Features/Functions
 - a. Category 5E 110 type punchdown type.
 - b. 50-pair block size
 - c. 24-gauge stub type equipped with top-mounted cable subs, polyethylene insulated with an overcoat of polyvinyl chloride (PVC) for flame resistance.
 - d. Cable routing space behind the blocks.
4. Acceptable, provide complete with standoff mounting brackets and at least four distribution posts or rings per block:
 - a. AT&T 110 Wiring Block, 110 C-4 Connecting Block, 100 Labels and Jumper Trough, label per 568A.
 - b. Siemon S110 or S110M Modular Tower System with S110B1 RMS Cable Mangers.
 - c. Equal by Hubbell
 - d. Equal by Leviton
 - e. Approved equal

D. Category 6 Terminal Block:

1. Provide as required per quantity of voice cables as indicated on plans.
2. General: Insulation displacements connector blocks consisting of oxygen free mechanical fastening system arranged in a flame-retardant molded plastic fastened to a mounting bracket.
3. Features/Functions
 - a. Category 6 110 type punchdown type.
 - b. 50-pair block size
 - c. 24-gauge stub type equipped with top-mounted cable stubs, polyethylene insulated with an overcoat of polyvinyl chloride (PVC) for flame resistance.
 - d. Cable routing space behind the blocks.
4. Acceptable, provide complete with standoff mounting brackets and at least four distribution posts or rings per block:
 - a. AT&T 110 Wiring Block, 110 C-4 Connecting Block, 110 Labels and Jumper Trough, label per 568A.
 - b. Siemon S110 or S110M Modular Tower System with S110B1 RMS Cable Mangers.
 - c. Equal by Hubbell
 - d. Equal by Leviton
 - e. Approved equal

E. Category 5E Patch Cords

1. Provide to match active port count plus 20%.
2. Factory fabricated
3. EIA/TIA 568A.
4. 24 ga AWG, Cat 5E portable cordage cable.
5. Lengths: 5 feet.
6. Category 5E rated assembly including RJ-45 type ends and cabling.
7. Acceptable:
 - a. Leviton
 - b. Hubbell C504P24J2DEN Series
 - c. Siemon MC5-8T-**-B** Series color coded plugs
 - d. Approved equal

F. Category 6 Patch Cords

1. Provide to match active port count plus 10%
2. Factory fabricated
3. EIA/TIA 568A.
4. 24 ga AWG, Cat 6 portable cordage cable.
5. Lengths: 5 feet.
6. Category 5E rated assembly including RJ-45 type ends and cabling.
7. Acceptable:
 - a. Leviton
 - b. Hubbell C504P24J2DEN Series
 - c. Siemon MC5-8T-**-B** Series color coded plugs
 - d. Approved equal

2.6 FIBER CABLE TERMINATION DEVICES AND RELATED

A. Fiber Optic Connectors and Related:

1. Mechanical Splices:
 - a. Permanent application, integral matching index gel.
 - b. Insertion Loss: <.25 dB
 - c. Reflection: < 35 dB
 - d. Minimum Strain Relief, Fiber retention: .75 lbs
 - e. Acceptable:
 - (1) 3M
 - (2) AMP
 - (3) AT&T Lightsplice
 - (4) As recommended by cable manufacturer
2. Breakout Kits:

- a. AMP
- b. Siecor
- c. by cable manufacturer

3. Connectors:

- a. ST-type to suit equipment, with integral strain relief
- b. Ceramic tip to suit application.
- c. Acceptable:

- (1) 3M 6100
- (2) AMP Lightcrimp
- (3) AT&T
- (4) Siecor
- (5) As recommended by cable manufacturer

B. Fiber Optic Jumpers:

- 1. Provide as required for quantity of cable as indicated on plans plus 10%.
- 2. For use in-rack and in attaching to fiber optic terminal cabinet.
- 3. Acceptable:

- a. AMP
- b. AT&T
- c. Optical Cable Corp.

C. Fiber Terminal Cabinets, Rack Mount:

1. Fiber Optic Terminal Rack

- a. Provides a location for maintenance and cross-connecting of fiber optic cables.
- b. Constructed of 0.125 inch minimum thick aluminum or powder coated steel.
- c. Two compartment

- (1) Interior fiber coil rings and splice compartment.
- (2) Connectorized interface compartment

2. Acceptable:

- a. AT&T Lightguide
- b. Amp
- c. Siecor
- d. Approved equal

D. Fiber Distribution Panels:

1. Features/Functions/Performance:

- a. Suitable for housing fiberoptic mechanical splices in a neat and orderly fashion.
- b. Stores a minimum of one meter of cable without kinks or twists.
- c. Provides individual strain relief for each splice.
- d. Suitable for reentry, if required for future maintenance or modification, without damage to the cable or splices.
- e. All required splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors shall be provided in the organizer kit.
- f. Rack mount, 19" EIA enclosure
- g. Incorporates cable tie downs and routing rings.
- h. Provides a location for splice, maintenance and cross-connecting of fiber optic cables.

2. Acceptable:

- a. AMP 5025 Series and associated trays, splice holders and adaptor plates (Design Basis – High Density).
- b. ADC Telecommunications FL-2000
- c. AT&T Lightguide Shelf
 - (1) 24 fiber – LSC2U-024/5 with rack rails, coupling panels, etc. as required.
 - (2) 48 fiber high density – LST1P-48ST/2.5 with rack rails.
 - (3) 144 fiber – LSC1 U-1 44/21 with rack rails.
- d. equal by 3M.
- e. equal by Siecor.
- f. Equal by Telect.

3. Acceptable:

- a. Ortronics Ornmac Series combination fiber/Cat 5 data termination cabinets.
- b. Equal by Siemon, CT Modular series.
- c. Approved equal.

F. Fiber Patch Panels.

- 1. Drawing reference: Fiber Patch Panel
- 2. Features/Functions/Performance:
 - a. Rack mount, 19" EIA frame.

3. Connectors which interface the inside plant fiber optic jumper cable with the outside plant fiber optic cable.
 - a. High Density.
 - b. Hinged access to rear side.
 - c. ST, connectors.
4. Acceptable:
 - a. Amp 5025**-* Series with Patch cord organizer tray.

PART 3 - EXECUTION

3.1 GENERAL

- A. All system cabling and terminations be installed in accordance with the manufacturer's instructions and as shown.
- B. All necessary interconnections, services, and adjustments required for a complete and operable system shall be provided. All installation work must be done in accordance with the safety requirements set forth in the general requirements of ANSI C2 and NFPA 70.

3.2 TEST EQUIPMENT

- A. Provide at least one (1) each of the following items or approved functional equivalents for the duration of each test:
 1. Level 11, Cat 5E cable Pair Tester – Microtest, HP, Scope, Fluke or Siemon
 2. Time Domain Reflectometer (Canoga-Perkins 1201 or equal)
 3. True RMS Audio Digital Volt-Ohm-Millimeter (Fluke 8060A).
 4. Tone Test Sets.
 5. Optical power meter (HP, Siecor, 3M, Fotec).
 6. Site portable communications systems.
 7. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.
 8. Voice Cabling Plant Tester – Capable of detecting shorts, opens, reversals, mis-wiring and crosstwists. Siemon STM -8 or equal by Mod-Tap.

3.3 WIRE AND CABLE INSTALLATION

- A. All wire and cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.
- B. Identify data and voice cables distinctly by using different color overall jacket or insulation.

- C. Verify that all raceways have been de-burred and properly joined, coupled and terminated prior to installation of cables. Verify that all raceway is clear of foreign matter and substances prior to installation of wire or cable.
- D. Inspect all conduit bends to verify proper radius. Comply with Code for minimum permissible radius and maximum permissible deformation.
- E. Apply a chemically inert lubricant to all wire and cable prior to pulling in conduit. Do not subject wire and cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is pulled in place around bends. Do not pull reverse bends.
- C. Provide a box loop for all wire and cable routed through junction boxes or distribution panels. Provide tool formed thermal expansion loops at cable at manholes, handholes and at both sides of all fixed mounted equipment. Cable loops and bends shall not be bent at a radius greater than that recommended by the manufacturer.
- D. Cable Tray Exposed Cable Installation. Where drawings specifically permit use of cable installation in Cable Trays, conform to the following:
 1. Conform to EIA/TIA 569, 10.4 with respect to separation from power and radio frequency (RF) sources per table 10.4-1, reproduced below. Provide at least twice the listed separation at fluorescent light fixtures, ballasts and similar high intensity EMF sources (including but not limited to motors, transformers and copiers).

EIA/TIA 569 – Table 10.4-1
(Revise per latest edition)

Separation of Telecommunications Pathways from ≤ 480 V Power Lines

<u>Separation Distance</u> Condition	<u>Minimum</u>		
	< 2kVA	2-5 kVA	> 5kVA
unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	5 in.	12 in.	24 in.
Unshielded power lines in proximity to a grounded metal conduit pathway.	2.5 in.	6 in.	12 in.
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	N/A	3 in	6 in.

1. Placement: do not obscure access to access doors, hatches, air dampers, valves, cable trays, junction boxes, pull boxes or similar areas of access.
2. Place pipe sleeves at all wall penetrations. Fire proof and seal all penetrations.

3.4 SIGNAL POLARITY & COLOR CODE CONVENTION

A. RJ45 – Per EIA 568A:

<u>Pin</u>	<u>Color</u>	<u>Designation</u>
1	White/Green	T3
2	Green/White	R3
3	White/Orange	T2
4	Blue/White	R1
5	White/Blue	T1
6	Orange/White	R2
7	White/Brown	T4
8	Brown/White	R4

3.5 WIRING AND CABLE INSTALLATION, SUPPLEMENTAL OUTSIDE PLANT PROCEDURES

- A. Cable Pulling: Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Accumulate cable slack at each manhole or junction box where space permits by training cable around the interior to form one complete loop. Maintain minimum allowable bending radii forming such loops. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into outdoor pedestals or other enclosures. Cable with tape shield shall have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.
- B. Cables in Manholes and Handholes. Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. In existing manholes and handholes where new ducts are to be terminated or where new cables are to be installed, locate the existing installation of cables, cable supports and grounding as required for a uniform installation with cables carefully arranged and supported. Support cable splices in underground structures by racks on each side of the splice. Located splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top

space opening or future cables, except as otherwise indicated for existing installations.

- C. Cable Tags in Manholes and Handholes. Provide cable markers (or tags) per EIA/TIA 606.

3.6 WIRING PRACTICE

- A. Coordinate insulation displacement (quick connect) terminal devices with wire size and type. Comply with manufacturer's recommendations. Make connections with automatic impact type tooling set to recommended force.
- B. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections. No wire or cable shall be supported by a connection point. Provide service loops where harnesses of different classes cross, or where hinged panels are to be interconnected.
- C. Correct any and all of the following unacceptable wiring conditions:
 - 1. Deformed, brittle or cracked insulation.
 - 2. Torn or worn cable jacket.
 - 3. Excessively scored cable jackets.
 - 4. Insulation shrunken or stripped further than 1/8" away from the actual point of connection within a connector, or on a punch block.
 - 5. Ungrommetted, unbushed, or uninsulated wire or cable entries.
 - 6. Deformation or improper radius of wire or cable.

3.7 DATA CABLING WIRING PRACTICE

Conform to the following, in addition to the general requirements above:

- A. Limit cable bends to a minimum radius of eight (8) times cable diameter except where otherwise noted herein.
- B. Box Loops: At data cabling, from circular radius bends of eight times cable diameter minimum. Up to two (2) flat bends of 90 degrees or less are permitted in any single cable run where necessary to accommodate field wiring conditions. Flat bends exceeding 90 degrees will not be accepted.
- C. Receptacle Loop: At the receptacle, a single bend of 90 degrees or less and a 1 inch radius shall be permitted subject to the cable manufacturer certification of such an installation meeting Category 5 requirements. Contractor to field verify the performance of the proposed installation in a mockup using the proposed cabling, jacks, raceway and listed test equipment prior to proceeding.
- D. Secure: Tie wraps to be hand (not tool) tightened. @:
- E. Run Lengths:

1. Station, Horizontal and Closet Links:
 - a. Horizontal Distribution runs (including vertical portions) shall not exceed 90 meters (295 feet) from station outlet to the associated communications closet.
 - b. Station cabling runs to be 3 meters (10 feet) or less.
 - c. Closet distribution wiring not to exceed 6 meters (19.5 feet)
2. Alternately, total length not to exceed 100 meters (328 feet).
3. Report to the Architect conditions exceeding these requirements.

3.8 LABELING

- A. Provide permanent identification of run destination at all raceway terminations. Identify at each manhole, vault, handhole, terminal cabinet, pull box, equipment rack and receptacle/outlet.
- B. Unless otherwise noted, conform to the standards and methods of EIA/TIA 606.
- C. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one (1) inch of each connection. Provide any of the following:
 1. Continuous permanent imprint, equivalent to Clifford of Vermont, Inc. "Quik-Pull".
 2. Direct hot stamp.
 3. Heat shrinkable factory hot stamped; equivalent to Bradysleeve Heatshrink.
 4. Adhesive strip printed labels wrapped the full circumference of the wire and sealed with clear heat shrink tubing; equivalent to Thomas and Betts or Panduit Insta-code with clear heat-shrunk tubing equivalent to Alpha.
 5. Lead tags, 2" square, drilled for cable attachment. Use THWN #12 or 2 #14 wrapped twice around the cable bundle and secure to tag using a crimp fastner.
- D. Indicate;
 1. Indicate the number designated on the associated field or shop drawing or run sheet, as applies. Assign wire or cable designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations.
 2. Indicate installation date.
- E. Pull Box Manhole, Handhole, vault or similar locations subject to abuse. Plastic labels shall be engraved and filled or silk screened with identification, or shall be provided with 1/16" (min.) thick laminated plastic labels with engraved block characters at least 1/8" high fastened to the equipment by stainless steel screws

or rivets. Provide white characters on black background unless otherwise noted. Embossed plastic (Dymo) or Brother Lettering Machine labels shall not be acceptable

- F. Patching Bays and jacks and Receptacles containing six or fewer jacks/outlets: Provide designation strip holders with clear plastic covers to retain replaceable designation strips. Provide designation strips with block lettering on permanent background in contrasting color. Use photographic print, laser print on acid free paper, plotting ink on Mylar, or equivalent nonfading process. Alternatively, provide black on white adhesive labels equivalent to those produced by Brother brand P-Touch Letter Machine. Embossed plastic (Dymo) labels shall not be acceptable. The presence of manufacturer provided silk screen iconic identification labels shall not relieve the contractor from the requirement to identify the receptacle with its associated cabling and circuit.

3.9 TESTING

A. Category 3 System (where required):

1. Test and report on each segment separately, including station cabling, horizontal distribution (each segment, if multiple) and telecommunications closet wiring.
2. Test each collective segment as a whole.
3. Using the listed transmit/receive meter, test and report on at least the following:
 - a. Attenuation at 5 MHz (dB)
 - b. Attenuation at 10 MHz (dB)
 - c. Noise, all Building systems powered and operating: 1 0 Hz- 1 50 kHz (mV)
 - d. Noise, all Building systems powered and operating: 150 kHz- 16MHz (MV); 7@--
 - e. Noise, all Building systems powered and operating: 16 MHz-100 MHz (mV)
 - f. Near end crosstalk (dB).
 - g. Measured qualification of the link (Meets Category 3).
4. Note exceptions to Category 3 standards, as applies. Remedy and retest.
5. Submit copy of final results on paper and in IBM PC format disk based copy, organized by Circuit Number, consistent with circuit numbering scheme used in preparing submittal drawings and in labeling receptacles and terminations.

B. Category 5 System (where required):

1. Test and report on each segment separately, including station cabling, horizontal distribution (each segment, if multiple) and telecommunications closet wiring.
2. Test each collective segment as a whole.
3. Using the listed transmit/receive meter, test and report on at least the following:
 - a. Attenuation at 5 MHz (dB)
 - b. Attenuation at 10 MHz (dB)
 - c. Noise, all Building systems powered and operating: 1 0 Hz- 1 50 kHz (mV)
 - d. Noise, all Building systems powered and operating: 150 kHz-16MHz (MV); 7@--
 - e. Noise, all Building systems powered and operating: 16 MHz-100 MHz (mV)
 - f. Near end crosstalk (dB).
 - g. Measured qualification of the link (Meets Category 5).
4. Note exceptions to Category 5E standards, as applies. Remedy and retest.
5. Submit copy of final results on paper and in IBM PC format disk based copy, organized by Circuit Number, consistent with Circuit numbering scheme used in preparing submittal drawings and in labeling receptacles and terminations.

C. Category 5E System:

1. Test and report on each segment separately, including station cabling, horizontal distribution (each segment, if multiple) and telecommunications closet wiring.
2. Test each collective segment as a whole.

Category 5E Worst Case Channel Performance

Frequency MHz	NEXT	ATTN	ACR	ACR Spec	ACR Margin	PSACR Spec	PSACR Margin	Return Loss	ELFEXT
1	72.7	2.0	70.8	57.8	13.0	54.8	14.6	31.7	72.2
4	63.2	4.0	59.3	49.1	10.2	46.4	11.7	28.6	61.3
8	59.8	5.7	54.2	42.3	11.9	39.4	13.3	22.8	55.4
10	57.1	6.4	50.8	39.9	10.9	37.0	12.5	23.0	53.8
16	55.2	8.1	47.3	34.5	12.8	31.6	12.9	24.6	48.3
20	55.4	9.1	46.7	31.8	14.9	28.8	15.0	25.5	45.1
25	51.4	10.2	41.5	28.9	12.6	25.9	14.0	24.5	41.9
31	50.1	11.4	39.0	25.9	13.2	22.8	14.9	27.6	39.1
63	46.1	16.6	30.1	15.0	15.1	12.0	15.6	24.2	33.5
100	41.1	21.4	20.1	6.1	14.0	3.1	14.4	20.0	28.4

155	36.7	27.3	9.9	#N/A	#N/A	#N/A	#N/A	16.5	26.6
200	31.0	31.6	0.3	#N/A	#N/A	#N/A	#N/A	16.3	24.2
250	29.3	35.9	-5.9	#N/A	#N/A	#N/A	#N/A	17.9	19.7

3. Using the listed transmit/receive meter, test and report on at least the following:
 - a. Attenuation at 5 MHz (dB)
 - b. Attenuation at 10 MHz (dB)
 - c. Noise, all Building system powered and operating: 10 Hz- 150 kHz (mV)
 - d. Noise, all Building systems powered and operating: 150 kHz- 16MHz (MV);
 - e. Noise, all Building systems powered and operating: 16 MHz-100 MHz (mV)
 - f. Near end crosstalk (dB).
 - g. Measured qualification of the link (Meets Category 5E).
4. Note exceptions to Category 5E standards, as applies. Remedy and retest.
5. Submit copy of final results on paper and in IBM PC format disk based copy, organized by Circuit Number, consistent with Circuit numbering scheme used in preparing submittal drawings and in labeling receptacles and terminations.

3.10 EQUIPEMENT ENCLOSURE (RACK) AND EQUIPMENT BACKBOARD FABRICATION

- A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.
- B. Within each equipment enclosure, provide a full-height multi-circuit ISOLATED GROUND outlet strip locate on the left side of the equipment enclosure, as viewed from the rear. Provide flexible steel raceway and junction box for connection of power service. Bond internal raceway to rack frame.
- C. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.
- D. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawer to insure complete access to terminal and interior components.
- E. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an

adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.

- F. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels-which will remain in place when active equipment is removed for possible service.
- G. At jackfields, provide service loop to permit removal of jackfields from rack sufficient to conveniently access all jack contact for routine cleaning and maintenance. Organize the service loop and harness such that reasonable reconnection of jacks and jack normals is possible - without cutting apart the harness.
- H. Coordinate the design and execution of wire harnessing of multi-bay rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for the test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.
- I. At each equipment backboard, provide UL Listed surge suppressing multioutlet assembly with at least six (6) receptacles.

3.11 ACCEPTANCE REVIEW AND TESTING PROCEDURES

Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the Architect in writing that the Work of this Section is complete and fully complies with the Contract Documents. Request Acceptance Review and Testing. The representative of the Architect will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These Procedures may be performed at any hour of the day or night as required by the representative of the Architect to comply with the Project Schedule and avoid conflict with these procedures from possible ongoing work of other sections. Provide all specified personnel and equipment at any time without claim for additional cost or time.

- A. Personnel: Provide services of the designated supervisor and additional technicians familiar with work of this, Section. Provide quantity of technicians as required to comply with Project Schedule.
- B. In Addition, Provide:
 - 1. All test equipment.
 - 2. Complete set of latest stamped, actioned submittals of record for reference.
 - 3. Complete set of Shop and Project Site Test Reports.
 - 4. Complete set of manufacturer's original operation, instruction and service manual for each equipment item for reference.

- C. Demonstrate: Complete operation of all systems.
- D. Adjust: As directed by the representative of the Architect.
- E. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the representative of the Architect.

3.12 CLOSEOUT

- A. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify Architect completion of Punch List.
- B. Portable Equipment: Furnish all portable equipment and spares to the designated representative of the Owner, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.
- C. Operating and Maintenance Data: Instructions. Submit Manuals.
- D. Project Record Documents: Submit.
- E. Keys: If applicable, replace construction locks with permanent locks. Transmit keys to Owner.
- F. Training: Conduct specified training.
- G. Warranty: Submit Warranty dated to run from date of Acceptance of the Work of this Section.

3.13 OWNER'S RIGHT TO USE EQUIPMENT

Acceptance of the Work of this Section will be after completion of corrections and adjustments required by the "Punch List" which results from Acceptance Review and Testing of the completed installation. The Owner reserves the right to use equipment, material and services provided as part of the Work of this Section prior to Acceptance without incurring any obligation to Accept any equipment or completed systems until all Punch List work is complete and all systems comply with the Contract Document, or accept any claim for additional cost or time.

END OF SECTION

SECTION 27 53 13

WIRELESS CLOCK SYSTEM

PART 1 - GENERAL

1.1 Section Includes

A. Transmission Systems

- a. G.P.S. Receiver
- b. Primary Transmitter
- c. Satellite Transmitter

B. Clocks

- a. Digital

1.2 Related Sections

- A Division 26 – Electrical (120 volt grounded outlet required for transmitter).

1.3 References

- A. This Technical Specification and Associated Drawings
- B. Primex Wireless GPS Satellite Time System User Manual.

1.4 Definitions

- A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

1.5 System Description

- A. GPS wireless clock system shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired.
- B. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.

- C. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- D. The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
- E. The system shall incorporate a "fail-safe" design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
- F. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.
- G. The system must operate in accordance with a "Radio Station Authorization", Form FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

1.6 Regulatory Requirements

- A. Equipment and components furnished shall be of manufacturer's latest model.
- B. The end user will hold a license, known as a "Radio Station Authorization" granted by the FCC.
 - 1. This license grants the end user protected use for wireless transmission at the designated frequency.
 - 2. This license will designate a unique "call sign" for each end user.
- C. Transmitter and receiver shall comply with Part 90 of FCC rules as follows:
 - 1. This device may not cause harmful interference, and
 - 2. This device must accept interference received, including interference that may cause undesired operation.
 - 3. Transmitter frequency shall be governed by FCC Part 90.35.
 - 4. Transmitter output power shall be governed by FCC Part 90 257 (b)
- D. System shall be installed in compliance with local and state authorities having jurisdiction.

1.7 Submittals

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.

- B. Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license must be delivered to the Owner/End User.
- C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
- D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.
- E. Floor plans indicating the location of system transmitter(s), approved by manufacturer, will be submitted to owner prior to installation.

1.8 Substitutions

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days prior to bid date.
- C. Other systems requiring wiring and/or conduit between master and clocks will not be accepted.
- D. Other systems using wireless technology in an unlicensed frequency range will not be accepted.
- E. Other systems using wireless technology where the license is held by any party other than the end user will not be accepted.

1.9 Quality Assurance

- A. Permits: Obtain operating license for the transmitter from the FCC.
- B. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 30 continuous years of documented experience including 4 years experience producing GPS wireless time systems.
 - 2. Installer: Company with documented experience in the installation of commercial time systems.
- C. Prior to installation, a site survey must be performed to determine proper transmitter placement.

1.10 Delivery Storage and Handling

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in finished building, unopened containers until ready for installation.

1.11 Project Site Conditions

- A. Clocks shall not be installed until painting and other finish work in each room is complete.
- B. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.12 System Startup

- A. At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all clocks are functioning.

1.13 Warranty

- A. Manufacturer will provide a 5 year warranty on GPS receiver, transmitter, and satellite transmitter. All other components will have a 1 year warranty.

PART 2 – PRODUCTS

2.1 Manufacturer

- A. GPS wireless clock system shall be manufactured by Primex Wireless, Inc., N3211 County Road H, Lake Geneva WI 53147 (800) 537-0464 FAX (262) 248-0061 www.primexwireless.com.

2.2 Sequence of Operation

- A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.

B. Analog Clock Operation:

1. Apply power or insert batteries. Follow set up procedures detailed in manufacturer's instructions.
2. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
3. If the clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Non signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

2.3 Equipment

A. General: The clock system shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.

B. GPS Receiver: GPS roof mounted, with 50 foot cable attached. Provide ¾" conduit and weatherhead from receiver location through roof (and roof flashing) down to telecommunication room. Provide mounting as required.

1. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
2. The GPS Receiver cable must be plenum rated where required by local code.

C. Transmitter: Primex Wireless Model 14400, consisting of wireless transmitter with GPS receiver, a surge suppressor/battery backup, and a mounting shelf. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.

1. Transmission:

- a. Frequency Range: 72.100 to 72.400 MHz.
- b. Transmission Power: 1 watt (30dBm) maximum
- c. Radio technology: narrowband FM
- d. Number of channels: 16
- e. Channel bandwidth: 20 kHz maximum
- f. Transition mode: one-way communication
- g. Data rate: 2 KBps
- h. Operating range: 32 degree F to 158 degrees F (0 degrees C. to 70 degrees C).

2. Transmitter:

- a. Transmitter output power: +26 to +30 dBm
- b. Frequency deviation: +/- 4 kHz
- c. Transmitter power requirements: 120 VAC 60 Hz
- d. Internal power requirements: 5 VDC

- e. Carrier frequency stability: +/- 20 ppm
 3. Transmitter shall have 16 selectable channels to assure interference-free reception.
 4. Transmitter shall have the following switches:
 - a. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
 - b. Daylight Saving Time bypass switch.
 - c. 12-hour or 24-hour display.
 5. Transmitter housing shall be black metal case, 16-3/4 inches (424.4mm) by 12 inches (304.8mm) by 1-7/8 inches (46.4mm) in size.
 6. Antenna shall be 46 inches (1168mm) high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be < 2.2 dB. Antenna polarization shall be vertical.
 7. Transmitter housing shall incorporate a display which shall include the following:
 - a. Time readout
 - b. AM and PM indicator if 12-hour time display is set
 - c. Day and date readout
 - d. Indicator for daylight savings or standard time
 - e. LED which shall flash red in event of reception problem
 - f. GPS reception indicator
 8. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.
- D. Power supply (included)
Input: 120 volt AC 50/60 Hz, 0.4 amps.
Output: 9 volt DC, 1.5 amps.
- E. Surge Protector/Battery Backup (included).
Input: 120 volt AC 60 Hz +/- 1 Hz.
Output: 120 volt AC, 500VA, 300 watts
Surge Energy Rating: 365 joules
- F Additional Equipment
1. Wireless Receiver Switches: Switches shall receive time packets from the Primary Transmitter and relay the synchronized time to the Satellite Transmitter connected to it. The unit shall include the following:
 - a Antenna mounted on top of the switch housing, 11-1/2 inches (292mm) long.
 - b Power Supply:
Input 120 VAC 50/60 Hz, 0.4 amps
Output: 9 volt DC, 1.5 amps

- c. RS 232 data cable, 5 feet (1.5mm) long
 - b. Daylight Savings Time bypass switch
 - c. Dimensions: 4-1/4 inches (108mm) long, 5-3/4 inches (146mm) wide, 1-1/4 inches (31.75mm) deep.
 - d. Weight: 12 ounces (.34kg)
 - e. Operating Range: 32 degrees F to 158 degrees F (0 to 70 degrees C)
2. Satellite Transmitters Primex Wireless Model 14401: Satellite Transmitters shall receive the signal from the Wireless Receiver Switches and transmit the signal to the devices in its vicinity, which are out of the range from the Master Transmitter. The unit shall include the following:
- a. Antenna mounted on top of the housing, 46 inches (1168mm) long.
 - b. Wireless Receiver Switch.
 - c. Power Supply
Input: 120 VAC, 50/60 Hz, 0.4 amps
Output: 9 volt DC, 1.5 amps.
 - d. 6 foot (1.83m) cord
 - e. Surge Suppressor/Battery Backup
 - f. Mounting Shelf.
 - g. Transmission Power: 1 watt maximum
 - h. 72 MHz frequency.
- G. Digital Clocks: Primex Wireless Model 14201, 4 inch (101.6mm), 7 segment LED display. Clocks shall have polycarbonate frame and polycarbonate lens. LED digits shall be red. Overall dimensions: 18 inches (457.2mm) long, 8 inches (203.2mm) wide, 3 inches (76.2mm) deep.
- 1. Digital clocks must be able to receive synchronized time signal from Primex Wireless master transmitter.
 - 2. Digital clocks must have time and date option.
 - 3. Digital clocks shall be capable of automatically adjusting for Daylight Savings Time
 - 4. Power Supply: 120 VAC, 50-60 cycle.
 - 5. Digital clocks must be viewable from 150 feet (45.7m)
 - 6. Route 3/4" conduit and 3 #12AWG from Panel L2 circuit # 14 to each clock indicated on the drawings.
- H. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.

PART 3 – EXECUTION

3.1 Examination

- A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.

- B. Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.

3.2 Installation

- A. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.
- B. Transmitter:
 - 1. Locate transmitter where indicated, a minimum of 2 to 3 feet (.6 to 1 meter) above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls. Transmitter(s) will be placed at locations indicated below:
 - 2. Attach receiver to transmitter using cable.
 - 3. Connect antenna to transmitter, using care not to strip threads.
 - 4. Connect power supply to the transmitter.
 - 5. Set the channel number on the display to correspond to the FCC license.
 - 6. Plug power supply into electrical outlet.
- C. Digital clocks (AC): Perform the following operations with each clock:
 - 1. Apply power (24 VAC or 120 VAC)
 - 2. Observe clock until valid time signals are received and analog clock adjusts itself to correct time.
 - 3. Install the clock on the wall in the indicated location, plumb, level, and tight against the wall. Attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.

3.3 Adjusting

- A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.4 Cleaning

- A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.5 Demonstration

- A. Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

3.6 Protection

- A. Protect finished installation until final acceptance of the project.

3.7 Testing

- A. All devices must be tested at their operational location under normal operational conditions to assure reception of signal.

END OF SECTION