RECOMMENDED ELECTRICAL DESIGN CRITERIA AND STANDARDS

AMERICAN WATER BUSINESS SERVICES ENGINEERING

March 27, 2018

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INTRODUCTION

Design of safe, reliable, and cost effective electrical power distribution systems is an essential aspect of the design of water and wastewater pumping, storage, and treatment facilities. Safety begins with proper sizing, coordination, selection, and installation of appropriate materials and power system components, all of which are critical to minimize the risk of worker injury and equipment damage from electrical hazards. Reliability is also tied to proper design and equipment selection because power system components are subject to unique thermal, magnetic, and vibration forces on an often continuous basis. Cost-effectiveness is impacted by numerous design decisions, including equipment location/layout, operating voltage, equipment specifications, design safety factors, environment, etc.

The purpose of this standard is to provide recommendations for electrical system design criteria and standards that American Water Engineering has found to be effective for maximizing value by assuring safe, reliable, and cost-effective electrical power system installations. None of the recommendations included herein shall be construed as superseding local building code requirements, and all facility designs and installations must fully comply with current electrical and building code requirements applicable to the project. In addition, it is the responsibility of the designer to develop a fully integrated and complete set of design plans and specifications based to the degree possible on these design recommendations.

Included with this guidance document are the following three attachments:

1. Attachment A – Power System Studies & Arc Flash Hazard Analysis Requirements. Provides detailed requirements for performing electrical coordination analysis and arc flash hazard assessments. These requirements are considered essential for a complete, coordinated design and should be included as part of a consultant's design scope of services.

2. Attachment B – Acceptable Electrical Equipment Manufacturers List. Identifies acceptable manufacturers for electrical equipment and systems. This listing is to be reviewed with the Owner prior to implementing the design in order to establish preferred sourcing of equipment and suppliers based on Owner preference, service/support and availability. The list is not intended to establish an order of preference; only manufacturers who have demonstrated capability to provide materials and quality of construction for the intended installations and applications. Other sources may be considered if accepted by the Owner in advance of the Design Memorandum submission. Any revisions are to be documented in writing with this submission.

3. Attachment C - SEL Device Monitoring Points (Modbus to SCADA /RTU): Identifies typical data acquired from the various SEL metering and protective relay devices provided on AW Projects. This list is not intended to capture all data that may be necessary nor is intended to limit the actual devices provided.

POWER DISTRIBUTION AND ARC FLASH HAZARD CONSIDERATIONS

Arc flash hazard evaluations have continually shown that the incoming (line-side) terminations on 277/480 VAC and/or 480 VAC services pose significant risk due to high incident energy levels. Frequently, incident energy at the incoming service exceeds 40 cal/cm2, or PPE-4 level of protective equipment. To address this issue, AW recommends installing the incoming main service disconnect

device in a separate enclosure, and then sub-feeding from this over-current protection device (OCPD) to a main lug panel or distribution assembly. While this may still pose the risks at this service-entrance location, it is intended that the design and selection of the main device will lower the incident energy associated with the downstream equipment to a level below the PPE-4 maximum protective equipment available for any energized work required.

AW recommends only circuit breakers (no fusible switch equipment) be used for this main service over-current protection device. This allows the operator to "reset" the main in the event of a "trip" incident without having to "open" the equipment (to check fuses, etc.). This "main" should also be provided with the metering input components and devices as outlined herein under item #12 – "Power Monitoring/Metering and Protective Relaying" where this metering is desired by the Owner.

For those facilities where it is intended to also provide permanent or portable standby generator power, the following recommendations should be considered.

1. On 120/208-240 VAC power systems, AW recommends considering the use of circuit breaker transfer equipment in lieu of the individually-mounted "main" circuit breaker and contactor-based transfer equipment (e.g., typical Asco transfer switch). Benefits include combined (but shielded) circuit breakers for the utility and generator protection, UL service-entrance listed as well as UL-1008 listed/labeled for automatic transfer switch (ATS) applications and non-automatic operation associated with portable generator installations. AW has developed a configuration including standard and "optional" features associated with this equipment. The potential for high Incident Energy levels above 40 cal/cm2 and resulting PPE in these low voltage installations typically does not exceed the PPE available to workers and contractors; the 277/480 VAC Systems are where the highest concerns regarding Incident Energy and "Danger – No Safe PPE Exists" equipment labeling have thus far been determined.

   Overall, this circuit breaker type ATS equipment typically represents a lower cost and requires less physical space within the facility providing a cost-effective solution where appropriate and where provided. For those facilities and service areas where contactor-based ATS equipment is already in service, the Owner may elect to continue to provide this type of equipment. However, the features and functions outlined as needed for OCP and Arc Flash Hazard isolation and protection shall be met.

2. On our 277/480 VAC Systems it is recommended to use the separately enclosed "Main" Circuit Breaker to isolate the Utility from the rest of the power distribution system. The use of contactor based ATS equipment requires the use of this separate "Main" as well as an additional "generator circuit breaker" for those applications involving portable generator connections. Additionally, and as a minimum, a shunt-trip interface (i.e. E-Stop control station) shall be provided at the Automatic Transfer Switch (ATS) for disconnection of power associated with any permanently installed generator.

3. Portable standby generator installations offer unique challenges. Many of our portable generators are over-sized for the smaller stations they serve. As such, the OCPD on the generator will typically be larger than the service equipment ampacity ratings in the facility. This is the reason for the "generator circuit breaker" recommended above. Without this additional device, the station equipment is not adequately protected against an over-current event. The shunt-trip device mentioned previously is necessary to "trip" the circuit breaker on the permanently installed generator in order to isolate this power from the building system in the event of an emergency (fire or similar event). The use of the circuit breaker type ATS equipment addresses this concern and is part of the reason AW recommends consideration of this type equipment.

Connection of portable generators is another area which is to be carefully considered. The use of portable generators with large cables and connector bodies poses risks during the installation and connection of these devices to the station. To address this, AW recommends using a color coded pin and sleeve type connector assembly similar to Trystar's Generator Docking Station (complete with cam-lock connections and generator cabling color coded for voltage rating) for those installations 200 Amperes and larger in lieu of the three-phase connector plug and receptacle method. This allows easier and safer connectivity of the equipment by operational staff during an event. In locations where portable generators may be connected for extended periods of time, the transfer switch's control conductors are to be wired to a twist-lock style two-pole grounding receptacle locally mounted near the generator's connector assembly. This will allow the portable unit with remote starting capability to auto-start upon loss of power. Also, where environmental conditions warrant, provide a separate receptacle of suitable voltage and rating for connection of the generator's battery charger and water jacket heater.

TECHNICAL CRITERIA AND DESIGN STANDARDS

1. Basic Electrical Materials and Raceways

a. All materials shall be suitable for the location and environment where installed. Specifically, AW Engineering has identified the following areas/environments as not being compatible with Stainless Steel (SS) enclosures and supports.
    1) Chlorine and chlorinous vapors
    2) Fluosilicic acid and vapors
    3) Orthophosphate and vapors (zinc orthophosphate, phosphoric acid)
    4) Other potential areas and compatibility of materials are to be reviewed with the Owner for final selection of installed systems

b. Control panels and related enclosures in corrosive areas shall generally be non-metallic type with non-metallic hardware; NEMA 12 metallic or non-metallic in non-corrosive areas unless otherwise accepted. The use of stainless steel enclosures should be limited to areas not exposed to chlorine fluoride fumes. Provide NEMA 4X non-metallic enclosures in these and other corrosive areas. It is acceptable to install NEMA 3R enclosures outdoors where the area of installation does not include corrosive atmosphere. VFDs are not recommended to be installed in NEMA 4X enclosures due to issues with localized heating within the enclosure. These enclosures do not have the ability to ventilate using outside air, which potentially overheats the enclosure where a VFD would be installed. It is recommended to install VFDs in NEMA 3R enclosures when installed outdoors and only installed in NEMA 1 or NEMA 12 enclosures when installed indoors in non-corrosive areas. For VFDs installed in corrosive areas indoors, a NEMA 4X enclosure would need to be evaluated to determine if a local mounted AC unit to cool the enclosure is required.

c. All feeders (and branch circuits rated 100 amps and larger) shall be provided in rigid hot-dipped galvanized steel (RGS) or aluminum conduit. The use of fiberglass conduit is an acceptable alternative where approved by the Owner. Other building areas to utilize raceway materials as outlined herein (see 2 below) unless otherwise indicated. Exposed exterior locations may utilize hot-dipped RGS or aluminum conduit where determined suitable for the application. Additionally, the use of fiberglass conduit is acceptable where determined to be suitable for the location and application. The use of intermediate metal conduit (IMC) is prohibited anywhere on the project. The use of electro-metallic tubing (EMT) is prohibited on any Industrial Buildings and Related Type Areas as outlined below.

d. All conduit fittings to utilize gasketed screw covers; clip cover fastening type fittings are prohibited. Provide “Myers hub” type connectors associated with exterior and wet location enclosures.

e. Where served from overhead or above, raceway penetrations into buried or below grade equipment / enclosures and exposed exterior equipment enclosures shall not enter the top; they shall enter the bottom side and be provided with a means for draining moisture from the raceway and sealed between the raceway and the enclosure with duct-seal material. These enclosures shall be provided with a vapor corrosion inhibitor (Cortec, or equivalent) sized appropriately for the interior volume of the cabinet.

f. Receptacles and switches to be heavy-duty rated, 20 ampere minimum rated; material type and configuration to be suitable for the application.

g. Control Station devices should be NEMA 12 minimum; NEMA 4X rated in corrosive and damp locations where available; all devices to be 30 mm minimum size for gloved operation. All pilot lights are to be high intensity 120 VAC LED type; red for “run”, green for ‘off” ”, amber for “alarm”, and white for general indication. Other colors to be coordinated with the Water Company to match existing conventions or as requested; generally in accordance with NFPA-79, Table 10.3.2.

h. All electrical distribution equipment (i.e., switchgear, switchboards, transformers, panelboards, control panels, etc.) are to be installed to allow required NEC working clearances. The walkway of this working clearance area is to be covered with industrial safety matting. Matting shall be non-slip corrugated style and shall meet ASTM D178-01 for Class 2, Type II installations and shall be resistant to UV, ozone and most standard industrial chemicals. At a minimum, the matting is to be 1/4” thick, dielectric strength of 30,000v, proof tested over entire length at 20,000v and have a maximum use of 17,000v.

2. Raceway Material and General Applications

a. GENERAL NOTE:

1) Raceways are not permitted to be installed concealed in water-bearing walls. All equipment, devices and raceways shall be installed on the dry-side wall surface using nominal 7/8" non-metallic channel support stand-offs installed vertically to allow ventilation air to pass behind equipment and raceways. Fastening hardware to be 316 Stainless Steel or other accepted materials where required due to the environmental conditions of the area
2) No raceway is permitted to penetrate the floor or wall into the containment area of a chemical room. Note: final connections and raceway installations serving equipment located within this containment zone shall be supplied from outlets and equipment enclosures mounted above the maximum containment level identified. All penetrations, outlets, and equipment are to be located above the containment zone in the room. This prevents a failure of the raceway system from potentially becoming a “drain”.

The following general criteria are to be used for raceway material selection and installations. This listing is not intended to address all applications and/or specific equipment requirements which may be outlined elsewhere on the Engineer’s Drawings or indicated in the Specifications.

b. Industrial Buildings and Related Type Facilities or Areas:

1) Chemical Storage and Dispensing (non-hazardous materials)

   i. Exposed from Finished Floor to 8"-0" AFF

      a. PVC Coated rigid galvanized steel (RGS) Conduit and Liquidtight Flexible Metal Conduit are recommended. PVC Schedule 40 Conduit and Non-Metallic Liquid-tight Flexible raceways may be used in areas where not subject to physical damage from O&M activities such as chemical deliveries or vehicular traffic.
         i. Alternate Materials: the selective use of fiberglass conduit provides another means of addressing corrosion resistance and maintaining a non-metallic installation. [Note: AW Engineering does not recommend the use of PVC conduit, even Schedule 80 PVC where subject to physical damage
      b. Outlet and Junction Boxes - PVC Coated, Cast Type, FD capacity for use with the PVC Coated RS Conduit. As above, where non-metallic raceways are utilized, the use of non-metallic outlet and junction boxes may be provided.
      c. All outlet cover plates to be "in-use", weather-protected type and gasketed.

   ii. Exposed 8'-0" AFF and above within the room

      a. PVC Schedule 40 Conduit may be used in lieu of PVC Coated RS Raceways. Where provided, the Contractor shall include the use of expansion and axial connectors as recommended by the non-metallic raceway Manufacturer (not just at building expansion points).
      b. Junction Boxes - PVC, FD capacity for use with the PVC Conduit System.

   iii. *NOTE: No "in-floor" conduit or floor penetrations are permitted within chemical containment areas.*

   iv. As above, the use of fiberglass conduit systems is permitted to be used in place of the PVC Coated RGS raceways and PVC Schedule 40 Conduit hybrid systems outlined above as well as other locations throughout the facility. As above, no penetrations within the chemical containment areas are permitted.

      Engineers NOTE - Potentially, a listing or some other form for identifying which chemicals / areas require the use of seal-offs will need to be determined and included in the Contract Documents (below)

   v. Transitions from Chemical Storage and Dispensing Areas to other building areas shall utilize PVC Coated RS Conduit within the area and transition to RGS material where extending to a non-chemical area. Provide seal-off fittings and appropriate sealing material (as specified) to prevent vapor transmission through the raceway system at this transition point inside the chemical area.

2) "Damp" Areas, including those areas involving enclosed tanks and piping, but do not involve direct wash-down or similar use of water, and where the ambient temperature of the space may drop below 65 degrees F.

   i. Rigid Galvanized Steel (RGS) Conduit and fittings.
   ii. Liquidtight Flexible Metal Conduit.
   iii. Exposed outlets - Cast Type, FD capacity.

iv. Recessed Outlets (where permitted) - one-piece galvanized steel (expandable metal outlets not permitted).
v. Cover plates – stainless steel or cast cover type or as specified and/or indicated on the Drawings.

3) "Wet" Areas, including those areas involving exposed/open tanks and direct wash-down and similar applications, where water is routinely present.

i. Rigid Galvanized Steel (RGS) Conduit and fittings or PVC Coated RGS Conduit and PVC Coated fittings as indicated on the Drawings.
ii. Liquidtight Flexible Metal Conduit.
iii. Exposed outlets - Cast Type, FD capacity (PVC Coated where coated raceway systems are indicated on the Drawings.
iv. Recessed Outlets (where permitted) - one-piece galvanized steel (expandable metal outlets not permitted).
v. All outlet device cover plates to be "in-use", weather-protected and gasketed type.

Engineers Note - "Damp" and "Wet" terms will need to be defined and included in the Contract Documents.

Owner's Note – AWBSE has found metallic raceway systems provide higher reliability and longevity than PVC systems, but Owner may consider the use of non-metallic raceway systems on projects involving limited conduit lengths and where risks for damage to raceway is considered minimal.

4) Electrical, Mechanical (HVAC) and General Equipment Storage Rooms

i. Rigid Galvanized Steel (RGS) Conduit and fittings.
ii. Flexible Metal Conduit - Lighting Fixtures and similar type equipment.
iii. Liquidtight Flexible Metal Conduit - motor (and similar equipment involving close proximity to water and/or oil) connections.
iv. Exposed outlets - Cast Type, FD capacity.
v. Recessed Outlets (where permitted) - one-piece galvanized steel (expandable metal outlets not permitted).
vi. Cover plates - companion type as specified and/or indicated in Specifications or on the Drawings.

5) Hangers, Supports and Fasteners

i. In chemical and corrosive areas, FRP Threaded Rod with non-metallic FRP channel supports and fasteners shall be provided. In areas other than Chlorine and Fluoride environments, the use of 316 Stainless Steel threaded rod and fasteners also is permitted. Where the weight of the installation exceeds that permitted by the FRP materials, the use of 316 SS channel supports and threaded rod will be considered acceptable. PVC Coated steel channel supports is not accepted.

ii. In all other areas channel supports shall be hot-dipped galvanized and threaded rod shall be galvanized steel. All fasteners shall be 316 Stainless Steel.

6) Cable Tray and Trough Systems

i. The use of aluminum or FRP cable tray is an acceptable practice for wiring of equipment; especially in pipe galleries, alongside of walkways and similar tight areas where access to equipment is very restricted.
ii. Solid-bottom (or ventilated bottom) cable trough systems are also considered acceptable for locations where ladder type cable tray is not appropriate due to special considerations of the work.
iii. The use of cable tray and / or trough systems is to be reviewed with and accepted by the Owner prior to the start of design. The Design Memorandum shall include a description of what is being proposed and wiring systems to be included.
iv. Cable types to be UL Listed for the applications and isolation between voltages, including low voltage and instrumentation systems shall be included in the design.

c. Administrative Buildings and Related Type Facilities or Areas

1) All areas within conditioned rooms (those spaces where heating and/or air conditioning/ventilation is provided to maintain a nominal ambient temperature of 68 degrees and higher).

2) General Installations

i. Conduits 1-¼" and smaller may be EMT. This raceway type may be provided for either exposed or concealed raceways. All EMT connectors and fittings shall be compression type only (the use of set-screw fittings is NOT permitted)
ii. Rigid Galvanized Steel (RGS) Conduit and fittings shall be used for all raceways 1-½" and larger.
iii. PVC Conduit is NOT to be used for any application other than for approved in-floor (or other encased in concrete) applications as outlined elsewhere in these Documents.
iv. Flexible Metal Conduit - Recessed Lighting Fixture connections and similar type equipment terminations. Alternatively, the use of MC Cable is permitted for lighting fixture installations where determined acceptable by the Owner.
v. Liquidtight Flexible Metal Conduit is to be used for motor and transformer terminations as well as other equipment where vibration and/or access is required that would otherwise be impeded by a fixed raceway installation. Connections are to utilize stainless steel fittings; PVC Coated where installed in chemical and corrosive atmospheres
vi. Exposed outlets - Cast Type, FD capacity.
vii. Recessed Outlets - one-piece galvanized steel (expandable metal outlets not permitted).
viii. Cover plates - companion type as specified and/or indicated on the Drawings.

3) In-floor (or other encased in concrete) Installations

i. PVC Schedule 40 for 120 volt and greater general power / branch circuits; transition to metallic or fiberglass raceway system for continuation in or on wall as identified above. (Note - refer to VFD cabling installation requirements for special installation considerations).
ii. EMT for Data, Instrumentation and low voltage signal (less than 50 V) circuits; maintain metallic raceway system for continuation in or on wall as identified above.
iii. All conduits embedded in concrete floor to be compliant with ACI-318 criteria for minimum embedment and spacing requirements to assure structural integrity of structure.

iv. All transitions from "in-floor" to above floor in any area or room where water is also supplied in the room shall utilize PVC Coated RS Conduit sweeps to provide corrosion / physical protection; extend PVC Coated raceway minimum 6" AFF. Alternatively, the use of fiberglass raceways may be accepted if approved by the Owner. No transitions to be installed where raceway penetrates floor finish on an angle of the radius.

d. Underground and Similar Raceway Applications

1) Encased in Concrete Raceway Installations - (Ductbanks, Equipment Bases, etc) as identified on the Drawings

i. Minimum size conduits for underground installation to be 1".
ii. Conduits smaller than 2" in diameter - PVC Schedule 40 Conduit with PVC Schedule 40 sweep radius horizontal bends and PVC Coated RS raceway sweep radius bends for vertical transitions to above grade or concrete surface.
iii. Conduits 2" in diameter and greater - PVC Schedule 40 Conduit with RGS or fiberglass sweep radius horizontal bends and PVC Coated RS Conduit sweep radius bends for vertical transitions to above grade or concrete surface.
iv. Alternative use of fiberglass raceways is acceptable where approved by the Owner for those underground horizontal and vertical transitions to above grade or floor / concrete base.
v. Note - Refer to VFD cabling installation requirements for special installation considerations that may alter the criteria outlined above.
vi. Conduit supports, spacing and concrete / reinforcement to be as specified.

2) Direct Burial Raceway Installations - Ductbanks, Branch Circuits and Feeders as Identified on the Drawings

i. Conduits smaller than 2" in diameter - PVC Schedule 40 Conduit with PVC Schedule 80 sweep radius horizontal bends and PVC Coated RS raceway sweep radius bends for vertical transitions to above grade or concrete surface.
ii. Conduits 2" in diameter and greater - PVC Schedule 40 Conduit with RGS sweep radius horizontal bends and PVC Coated RS Conduit sweep radius bends for vertical transitions to above grade or concrete surface. .
iii. Alternative use of fiberglass raceways may be considered acceptable where approved by the Owner for those underground horizontal and vertical transitions to above grade or floor / concrete base.
iv. Note - Refer to VFD cabling installation requirements for special installation considerations that may alter the criteria outlined above
v. Conduit spacing and protective concrete cover to be as specified below or as detailed on the Drawings. Note, Direct Burial installations do not use conduit "chairs" or separators; embedment is provided by screening material only.
vi. Provide 5" thick concrete protective pour with 10 x 10 WWF over top of screening backfill for physical protection and vehicular wheel loading. Where crossing roadways or drives, conduit work to be reinforced, concrete encased as in #d.1 above; extended a minimum 10' on either side of pavement.
vii. Transitions from underground to building or other structure to be provided as detailed on the Drawings

e. Special Applications and Locations:

i. Wastewater installations rating to be established by NFPA 820 and installations in compliance with Article 501 of the NEC
ii. Hazardous locations where determined are to be installed in accordance with the NEC while addressing the use of corrosive-resistant materials as outlined above.
Provide raceway seal-offs and fire seals as required by Code. Additional raceway seal-offs to be provided to prevent the migration of corrosive vapors from a chemical area into an adjoining area and sealed with a non-water soluble compound material

3. Lighting Systems

a. Indoor Locations:
1) Fluorescent lighting systems are typically considered very cost-effective and suitable for all interior applications; fixture types and source control as outlined in Appendix B. These systems allow for component replacement and enclosure types to address any normal application or location. Based on AWBSE and Manufacturer data, the proper selection of lamp, ballast and control components has shown long term life-cycle and maintainability benefits.

2) The use of LED lighting sources and devices has become more popular in recent time as their costs have become more competitive with other systems. As a result, AW Engineering recommends an initial evaluation be considered to address initial costs as well as maintainability of the systems. These systems are to be considered and used upon approval from the Owner and after review of the life-cycle costs associated with total installations. The Engineer shall identify and provide all information regarding potential rebates, off-setting cost programs, etc. available for the use

3) Night-lighting / means of egress lighting fixtures shall be incorporated in the normal lighting layout / scheme to ensure that all passages and exits remain illuminated in the event of a power failure. These fixtures may be switched in areas where required providing they include the lighting transfer device integral with the fixture. (i.e... training and AV presentation areas, operational control rooms, etc.). This pass-thru/night lighting should be otherwise be un-switched; other lighting in the area or room to be controlled by means of suitable occupancy sensors

4) Separate battery-powered emergency lighting units shall also be provided to augment this night-lighting system and provide Code required means of egress lighting in the event of a power failure of the Utility and/or Stand-By Power System. Provide a remote battery-controlled lamp on the exterior of building exit doors connected to the interior unit to provide illumination away from the building. These units are to be powered from the local area night-lighting circuits and wired ahead of any switching. . All emergency lights, including outdoor remote head, are to be provided with twin lamps so failure of one lamp does not leave area in total darkness

5) Lighting fixtures types are to be suitable for the environments where installed and shall be located (serviceable and accessible) for routine maintenance. Provide calculations and fixture catalog data/specification sheets for review and acceptance by the Water Company.

b. Outdoor Locations:
1) The use of LED type lighting fixtures shall be used in the design for the exterior of the building; HID lighting (HPS) shall be an acceptable alternative for exterior use where

providing similar type to match existing. Illumination levels to be as recommended by IES for the space and tasks being performed.

2) Wall mounted lighting units to be coordinated with AW Security Group for illumination of areas where specifically required.

3) Pole mounted fixtures to utilize tapered aluminum poles; height as required to meet lighting illumination levels in area. Pole heights and locations to also address maintainability issues for Owner replacement and repair.

4) Outdoor lighting design is to comply with local ordinances for trespass lighting, up-lighting, pole height, and additional requirements the AHJ may have for the installation location

c. Where otherwise required by the authority having jurisdiction , provide means of egress and emergency lighting systems in conformance with NFPA 101 (the Life Safety Code)

d. Illuminated Exit Signs: IF REQUIRED by CODE, provide LED type and placed inside the facility per the latest requirements of NFPA 101 (the Life Safety Code) as applicable. Otherwise, provide non-illuminated, non-metallic exit signage for general egress direction and identification as determined by the engineer/architect and/or building official.

4. Cables

a. Low Voltage Wire and Cable:

1) All conductors to be copper

2) Those rated for 480V and below shall be listed as XHHW-2 for general underground, damp and wet locations and other similar areas. In addition, only XHHW-2 insulated conductor material is to be used with any variable frequency drive application.

3) Dual-rated THHN/THWN type is for use ONLY in interior, *(Administrative Buildings and Related Type Facilities or Areas as previously defined)* dry locations. *[NOTE: on projects involving multiple environmental conditions, AW has found that allowing both types of insulation has often resulted in field errors of the wrong type wire being installed. As a result, AW Engineering recommends using the Type XHHW-2 insulated wire throughout the project to eliminate this situation.]*

4) Insulation shall be UL listed for at least 90 degrees centigrade but applied at its 75 degree ampacity rating (maximum). Provide specific information in the Documents outlining where each type of conductor insulation material for review and acceptance by the Water Company

5) Multi-conductor, Tray Rated Cable to be provided for cable tray applications as outlined. All cables to be 600 volt insulated, 90 ^{0}C rated / applied at 75 ^{0}C ampacity rating. In general, provide;
   i. Type A – XHHW-2 (XLP) insulated conductors with ICEA Method E-1 or E-2 color coding; note this info on the Drawings. Cable to have PVC outer jacket. Uses include power and control devices.

ii. Type B – THHN/THWN-2 with black insulated conductors with white printed numbers, #14 AWG, number of conductors as required; PVC overall jacket. Uses include control / monitoring interface with SCADA/RTU equipment and field devices
iii. Other types and specific color coding to be provided based on voltage application for power conductors and control wiring for interface with SCADA/RTU equipment in accordance with AW Standards for these applications.

6) VFD Cables
i. Acceptable Manufacturers (included herein to identify basis of material design for these special cables) Refer to AW Acceptable Manufacturers List for additional/supplemental information:

a. Belden 29 Series (600VAC Rated Cable); wire gauge as indicated on the Drawings
b. AmerCable, Inc. – CIR Type (600VAC Rated) VFD Power Cable Gexol Insulated; wire gauge as indicated on the Drawings.

ii. Description: Three-conductor plus ground with cross-linked polyethylene or polyolefin listed insulation with fully-rated and identified equipment grounding conductor(s); 90 degree C listed for Wet or Dry applications with outer PVC jacket.

iii. Conductor: Tinned-Copper, multi-conductor cable, size as indicated on the Drawings.

b. Medium Voltage Cable:
1) Provide Type MV-105 shielded medium voltage cable for all normal power and feeder installations unless specifically required otherwise by the serving Utility Company for materials associated with a medium voltage service entrance installation.

2) For medium voltage motor installations, provide shielded conductors (Type MV-105) along with means for terminating the cable shields (and bonding to the equipment grounding conductor) before entering the motor termination box on the motor.

3) All conductors to be copper.

5. Grounding

a. General - Unless otherwise indicated or required, all facility installations shall utilize grounded power distribution systems. Normally, all will be solidly-grounded; provide resistance-grounded systems only where determined to be required for equipment and/or life-safety protection.

b. The electrical system and equipment grounding is to be in compliance with the National Electrical Code. A buried grounding grid or counterpoise is to be provided for the new switchgear equipment, transformers and standby generators.

c. Conductors shall be No. 2 AWG stranded copper (minimum) for interconnecting ground rods and for connection to transformers and MCC's and other major electrical equipment. All connections to this underground earthing system shall be made using exothermic weld process. Connections to reinforcement steel in foundations shall utilize hydraulic compression fittings. Bolted connections shall only be provided where accessibility and temporary removal for testing is required. All electrical equipment shall be bonded to the grounding system including motors, transformers, panelboards, other equipment, metal stairs / ladders, etc. and metallic raceway systems. All conduits containing power and control wiring shall be provided

with a separate “green” grounding conductor; use of the raceway system as a sole means of grounding is not permitted.

d. Provide test well for grounding system testing at main service bonding to ground rod and other locations as determined appropriate by the Owner. Ground test well to be minimum 12’ x 12” with tamper-resistant stainless steel bolted cover and “Ground” cast into the cover plate.

e. Increased conductor sizing to be as required by Code and/or grounding calculations where associated with switchgear substations and lightning protection system installations.

f. Instrumentation Grounding – review and provide grounding associated with the special requirements for this system.

6. Medium Voltage Equipment

a. The following criteria apply to 5 KV – 15 KV maximum installations *(higher voltage applications to be coordinated with AWBSE).*

b. Medium Voltage Transformers
   1) AWBSE recommends the use of dry-type transformers over liquid-cooled units to avoid potential environmental concerns and risks as well as reduced maintenance requirements and associated O&M costs. Our preferred equipment uses cast-coil, epoxy encapsulated windings on the primary and secondary windings. Other possible solutions involve the use of VPE insulated assemblies which provide a higher degree of protection over the standard VPI insulated units.
   2) The use of liquid-cooled units is generally only recommended where transformers are needed for 5 MVA and larger service applications; the type and associated ratings, cooling capabilities and auxiliary features and appurtenances to be coordinated with Utility and Owner criteria as outlined in the RFP for the project.
   3) Provide alarm monitoring for reporting to the process control system and include provisions for forced air cooling were appropriate
   4) All transformers are to utilize copper winding material – primary and secondary coils.

c. Medium Voltage Switchgear
   1) Type of Equipment: Plated copper bus as determined suitable for the installation/location and environmental conditions, 3-phase, 3-wire plus ground operating at 60 Hz. Utilize draw-out vacuum circuit breakers and/or fusible type switchgear assemblies where specifically identified in the RFP. All components are U.L. listed. Switchgear equipment shall consist of standardized, freestanding structures bolted together for form a single dead-front panel assembly containing circuit breakers, control devices, protective relay and metering units and all interlocking and miscellaneous control / interface devices.
   2) Fusible sections (where applicable) to be configured from left to right; use of front to back fuse arrangements are not permitted.
   3) Protective relaying and/or metering to be as outlined in #12 below. Relay coordination settings and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A
   4) In general, Metal-Enclosed Switchgear is considered acceptable. Provide Metal-Clad Switchgear type design where required or indicated or otherwise due to specific design and/or Utility considerations.

d. Medium Voltage Motor Controllers
   1) Type of Equipment: Tin-plated copper bus (phase and ground), 3-phase, 3-wire plus ground operating at 60Hz. All components are U.L. listed. MCC equipment shall consist of standardized, freestanding structures bolted together for form a single dead-front panel assembly containing combination vacuum contactor motor controller units; feeder units; metering, relaying, and interlocking and miscellaneous control devices. Provide magnetically-held or mechanically latched type of vacuum contactor controllers as required for the application or equipment served.
   2) Fusible sections to be configured from left to right; use of front to back fuse arrangements are not permitted. Fuse types and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A
   3) Starters:
      i. Full-Voltage or Reduced Voltage NEMA rated fusible switch / contactor type combination controllers as outlined in the RFP or otherwise determined by the Engineer and Owner. The use of IEC rated controller is prohibited.
      ii. Solid-state reduced voltage motor starters shall be utilized where required due to power utility requirements, process control of hydraulic transients, and/or engine-generator sizing considerations.
      iii. The Engineer shall coordinate starter types with the Water Company.
   4) Control power – provide each starter with individual 120 VAC CPT rated for minimum 100 VA above that required for loads served; min 150 VA. CPT's to be fused on primary and secondary.
   5) Control devices – provide minimum 30 mm diameter devices for all control switches, push buttons and pilot lights. Pilot lights to be high intensity, 120 VAC LED type; color as outlined herein or otherwise required by Owner.
   6) Protective relaying and/or metering to be as outlined below. Relay coordination settings and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A.

7. Low Voltage Motor Control Centers/Motor Controllers

a. Type of Equipment: Tin-plated copper bus (phase and ground), 600V, 3-phase, 3-wire plus ground operating at 60Hz; provide a neutral bus (3-phase, 4-wire plus ground applications) only in those MCC assemblies where required. All components are U.L. listed. MCC equipment shall consist of standardized, freestanding structures bolted together for form a single dead-front panel assembly containing combination motor control units; feeder units; metering, relaying, and interlocking and miscellaneous control devices and will be of the per definitions in the latest edition of NEMA ICS 3 and UL 845.

b. Starters:
   1) Full-Voltage NEMA rated (Size 1 minimum) combination magnetic starters shall be utilized as required. The use of IEC rated starters is prohibited.
   2) Solid-state reduced voltage motor starters may be utilized where required due to power utility requirements, process control of hydraulic transients, and/or engine-generator sizing considerations.
   3) The Engineer shall coordinate starter types with the Water Company.

c. Circuit Breaker Compartments and Circuit Breakers: Control center disconnects shall be three-pole, single-throw, 600-volt, molded-case circuit breakers
   1) Feeder and branch circuit breakers to be thermal-magnetic or solid-state trip type as required for the loads served, protective coordination and arc-flash hazard considerations.

2) Circuit breakers associated with combination starters shall be magnetic motor circuit protector (MCP) type where appropriate.
3) All shall be manually operated with quick-make, quick-break, trip-free toggle mechanism.

d. Control power – provide each starter with individual 120 VAC CPT rated for minimum 100 VA above that required for loads served; min 150 VA. CPT's to be fused on primary and secondary

e. Control devices – provide minimum 30 mm diameter devices for all control switches, push buttons and pilot lights. Pilot lights to be high intensity, 120 VAC LED type; color as outlined herein or otherwise required by Owner.

f. Protective relaying and/or metering to be as outlined in #12 below. Relay coordination settings and ratings to be selected by the Engineer based on the Protective Coordination and Arc Flash Hazard analysis outlined in Attachment A.

g. VFD Installations – while not recommended, where VFD's are required to be installed in MCC type construction, locations and general arrangements to address ventilation requirements of equipment. These installations typically will necessitate use of NEMA 1 configurations to avoid undue costs for the overall assembly; special attention to this is required to coordinate the design. Where it is determined NEMA 12 (or NEMA 4X) is necessary, VFD's shall not be included in MCC type construction.

h. Enclosure Type: Typically NEMA 1 is acceptable for conventional MCC construction utilizing only starters and circuit breakers. Match existing NEMA ratings in equivalent areas of the plant. Engineer shall also propose modifications to the NEMA rating if appropriate for intended service.

8. Variable Frequency Drives (VFDs)

a. In general, 6 pulse VFDs with line reactors are to be used for motor loads 50 HP and smaller. On motors greater than 50 HP but less than 100 HP evaluation of drive type to be determined based on base load versus non-linear loading. On all drives where harmonics at the Owner's equipment bus is potentially determined to be greater than 5% TDD. Provide VFD with passive or active harmonics filter / line conditioning unit.

b. In general, 18 pulse VFDs are to be used on motors 100 HP and larger. However, final determination from harmonics analysis and evaluation of linear versus non-linear loading is to be taken into account in making final selection. Harmonics at the Owner's equipment is to be below 5% TDD. Provide harmonics filtering / line conditioning as required to meet these criteria.

c. For motor applications involving long cable feeders between the VFD and the motor (e.g., ~100'+ or as defined by manufacturer), provide dv/dt output filters based on VFD and motor criteria for selected equipment.

d. VFD's installed in damp locations to be provided as NEMA 12 type equipment; those installed in locations such as dedicated electrical equipment rooms may be NEMA 1 type. However, all drives to be provided with door filter units mounted on exterior for access where possible.

e. All VFDs shall be rated as Industrial Duty / Heavy Duty type and be rated for a 50 ^{0}C ambient location. The use of 40 ^{0}C rated equipment and "HVAC" rated VFDs are not permitted.

f. Unless specifically accepted, all VFDs shall be stand-alone enclosed, wall or floor mounted equipment; do not combine in common enclosures or MCC construction.

g. VFDs shall be provided with Bypass starters where outlined in the RFP. Bypass starter type and rating to be as outlined; FVNR or RVSS types are typically required based on starting and hydraulic concerns in the system.

Note: Ventilation / Air Conditioning – AWBSE recommends ventilation air be used as the primary means of cooling for VFD applications and installation locations. The use of Air Conditioning (A/C) is not typically required in most geographic locations. Where A/C is determined to be necessary, the units shall be provided with an economizer mode which uses outside air as the first stage. Additionally, ventilation system should be designed to withdraw heat from above VFD enclosures and introduce cooling air near lower air intake section of VFD.

9. Miscellaneous Power Distribution:

a. Panelboards and Switchboards: Circuit breakers will be of the "Bolt-On" type;"Push-On" / "Plug-On" type circuit breakers are not allowed. Use plated copper bus and ensure U.L. labeling of entire system.
b. Provide a Surge Protective Device (SPD) on the main of each power distribution panel where applicable. In addition, provide an SPD on panels serving sensitive electronic equipment and instrumentation devices. For more specific requirements for the protection of sensitive electronic instrumentation, see Instrumentation section.

c. Lighting and General Power Transformers: Dry type to limit maintenance items. A minimum of (2) taps will be provided above rated voltage (in 2.5% increments) and a minimum of (2) taps will be provided below rated voltage (in 2.5% increments). Open type transformer cases are not allowed. All units located in wet or chemical areas will be of sealed type construction. Provide open ventilated type enclosures for other general dry, environmentally ventilated/conditioned spaces. All transformers to utilize copper windings; 115 degree C rated. The Engineer shall examine the need to install transformers with a higher than average Basic Impulse Level (BIL) that is not normally required in the 480V class.

10. **Power Monitoring/Metering and Protective Relaying**

a. General: AW objective is to provide power monitoring to allow trouble-shooting, harmonics assessment, and data collection for evaluating efficiency, etc.

b. AW has a national contract agreement with SEL and is our preferred manufacturer for new work. Refer to RFP for systems involving modifications / upgrades to existing installations

c. Low Voltage Systems: For small stations involving a limited number of motors / loads, metering as outlined below alone is sufficient. On larger low voltage systems, addition protective relays and monitoring may be appropriate to allow evaluation of sub-distribution equipment and systems and data collection of power characteristics to be captured by the SCADA system for evaluation and reporting. Specific criteria associated with metering and equipment monitoring/protection is to be reviewed with the Owner at the initial design memorandum stage of the project.

d. Make provisions for power monitoring/metering on incoming three-phase electrical services (main) as follows:
   - All 480/277 VAC services are to provide 3-PTs and CTs wired to field terminal blocks for connection to metering equipment.
   - On installations where the metering is provided by Owner, allow physical space next to main incoming OCP device for meter enclosure installation.
   - On installations where metering is to be provided with equipment, refer to the RFP for specific criteria or review with Owner to define requirements.

e. Medium Voltage Systems: Power distribution systems involving medium voltage motors and equipment are to be provided with the protective relaying/monitoring devices for not only equipment protection, but also to allow data collection of power characteristics to be captured by the SCADA system for evaluation and reporting. Provide 3- PT / CT input devices and control voltage for power metering and protective relays as required for system protective schemes required by the design.

f. Data Collection: The use of fiber-optic interface between devices and to SCADA is a preferred method of communicating the data transfer between devices and into the process control system. Applications involving the use of copper are to be specifically approved by the Owner. Where available, dual-port communications capabilities of the protective relays shall be utilized and the devices configures in a loop with IP addressing. The design and configuration of the communications loop and serial connectivity is to be developed as part of the instrumentation design effort.

g. Power Monitoring/Metering;
   1) Provide microprocessor based SEL 735 metering unit on main incoming feeder circuit breaker. Unit shall compute voltage, amperes, power factor, kilowatt-hour, etc. Communications will be via fiber-optic cable back to a port on a plant's process control system.

h. Protective Relaying;
   1) Provide SEL 710 motor protective units on all medium voltage motors wired to plant's process control system for monitoring, trending and archiving.
   2) Provide SEL 849 motor protective units on 480 VAC motor loads typically larger than 50 horsepower *(exact application to be coordinated with Project requirements and Owner*) wired to plant's process control system RTU for monitoring, trending and archiving
   3) Provide SEL 751A Feeder protective units on MV Feeders wired to plant's process control system for monitoring, trending and archiving
   4) Other protective relays as outlined in Attachment C and provided as applicable to the Project

i. Other SEL protective relays to be provided as determined through the design; reviewed and accepted by the Owner.

j. SCADA / RTU communications and data acquisition information to be monitored is outlined in Attachment C - SEL Device Monitoring Points (Modbus to SCADA /RTU. This baseline data is to be evaluated and supplemented as appropriate for the project as well as other potentially beneficial data for trend analysis, wire-to-water calculations, and preventative maintenance.

k. Refer to RFP for additional and/or supplemental information regarding protective relays, applications and coordination of Ethernet communications requirements.

ATTACHMENTS

A. American Water Power System Study Requirements – Short Circuit, Protective Coordination, and Arc Flash Hazard Analysis/Evaluation

B. Acceptable Electrical Equipment Manufacturers and Suppliers

C. SEL Device Monitoring Points (Modbus to SCADA /RTU)

AMERICAN WATER

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POWER SYSTEM STUDY AND
ARC FLASH ANALYSIS REQUIREMENTS

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Version Date: April 2018

AMERICAN WATER POWER SYSTEM STUDY AND ARC FLASH ANALYSIS REQUIREMENTS

1. DESCRIPTION OF WORK REQUIRED

A. Provide all items of labor, materials and equipment necessary for data collection, development, evaluation and report generation of the work described in this Section. The entire power distribution system (all equipment), new and existing is to be included in the study being provided for this Project.

B. Visit the site to determine actual conditions, equipment and settings and related elements necessary to prepare a complete oneline diagram of the entire power distribution system. Provide a complete oneline diagram including all equipment (loads/ratings), cable and raceway information and other data associated with the installations to allow evaluation and calculation of the various Studies to be provided in the Report outlined herein. Where required, coordinate field work with the Owner and shall follow all applicable safety standards for the activities required.
   1. Those involved with the field data collection work shall review / compare the Owner's operational and safety standards with their own and provide adequate Personal Protective Equipment (PPE) for those individuals involved in any data gathering activities as outlined by applicable Regulatory Agencies. No extra compensation will be allowed by failure to determine existing conditions.

C. Furnish a complete Short-Circuit, Protective Coordination, and Arc Flash Hazard Analysis Study per the requirements set forth in the criteria established for the Project, the criteria outlined herein this document, and as identified in the latest version of NFPA 70E– 2015 Edition; *Standard for Electrical Safety in the Workplace and as outlined herein regarding American Water Site Specific PPE Category Labeling criteria*. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-1992 including latest revisions and IEEE 1584-2004 and IEEE 1584-2011 addenda; the IEEE *Guide for Performing Arc-Flash Calculations;* modified as hereinafter identified.

D. Arc-Flash Equipment Labeling shall be provided upon acceptance of the Engineer's final report. Labeling shall be provided for all equipment as identified herein this document.

E. In addition, where indicated in the Scope of Work identified by the Owner, provide a Load Flow analysis using the power systems software identified herein to model the operational scenarios required for the project and requested by the Owner. These Load Flow analysis reports are to be provided in accordance with the Owner's criteria for loading and report submission.

F. Any Drawings and Material Data Sheets / Product Information provided by the Owner is considered as generally indicative of Power System but is not to be considered as matching actual site conditions. Modifications/field changes may have occurred which were not recorded; therefore, provide field verification as necessary to validate the Power System as Work under this project in preparation of the Short-Circuit, Protective-Coordination and Arc-Flash Study and Analysis.

G. The general (not limited) approach to the evaluation and analysis work included in this assignment shall include the following effort;
   1. Collect system and "as-installed" data associated with all electrical equipment, feeders, and devices associated with this Study/Report. This effort shall also include obtaining the necessary load-history and available fault current (max and min) and Utility Overcurrent

Protective Device (OCP) device(s) from the serving Power Utility Company along with the technical data associated with their system and transformer equipment being provided.
2. Determine system modes of operation by conducting interviews with Owner's Operational / Production Staff
3. Determine bolted short-circuit and arc fault currents
4. Determine protective device characteristics and duration of arcs
5. Document system voltages and classes of equipment
6. Evaluate existing equipment short circuit ratings against computed available fault currents.
7. Arc Flash Hazard Analysis to select working distances as outlined herein, determine incident energy for all equipment and determine flash-protection boundary zones for all affected equipment. Conduct arc flash analysis based on the utility fault current and at a value approximately 50% of this or as otherwise determined from the fault current range as provided by the serving Utility Company.
    a. In addition, where Standby power (generator) is also provided as part of the Project, evaluate the arc flash hazard based on this power source. Summarize each evaluation and develop arc flash labeling based on the worst case scenario or as otherwise accepted by the Owner.
        1) Where the installation includes the use of a portable generator, provide a cautionary label on both the transfer switching equipment and on the outdoor generator termination enclosure as outlined in Attachment D.
    b. Furthermore, provide analysis of any arc flash reduction methods being utilized or included for the equipment. While these devices are not considered in actual labeling, they are to be clearly identified and reported for potential use by maintenance staff when required activities include conducting work on energized and exposed electrical equipment. Provide full analysis of these devices including effects on the downstream equipment being served where applicable.
    c. Finally, where power distribution systems involve the application of "Main – Tie – Main" or similar multi-operational configurations, provide analysis for these schemes in order to determine effects of the operational differences with regard to loading, short-circuit, protective coordination and arc flash hazard. As above, each operational scenario is to be clearly identified in the reports submitted.

2. REFERENCES

A. ANSI – American National Standards Institute, Inc.
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

B. ASTM – American Society for Testing and Materials

C. IEEE – Institute of Electrical and Electronic Engineers
1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 1584, Latest Edition – Guide for Performing Arc-Flash Hazard Calculations; including all Addenda

D. IPCEA – Insulated Power Cable Engineers Association

E. NEMA – National Electrical Manufacturers Association

F. NESC – National Electrical Safety Code

G. NFPA – National Fire Protection Association
   1. NFPA 70 – National Electrical Code, latest edition
   2. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition

3. STUDY REQUIREMENTS

A. The Work associated with this assignment must comply with all Federal and State, municipal or other authority's laws, rules and/or regulations. These services shall be provided by a qualified, licensed Professional Engineer (hereinafter referred to as Engineer and/or Engineer-of-Record) to conduct the actual analysis, evaluation and development of the Report and Arc Flash labeling.

B. The Power System Study / Analysis is to include all electrical equipment; and specifically include / address the following:
   1. In general (not limited to) and starting at the Utility, all electrical equipment including the main service transformer, Utility OCP device and system ratings shall be evaluated and included in this Study.
   2. Where included, all medium voltage equipment, motors, transformers (primary and secondary) shall be included as applicable, as well as all 480 VAC low voltage equipment, motors nominally 25 HP (or as otherwise outlined) and larger, all transfer switch equipment, safety disconnect switches rated 100 amps and above, all automatic and manual transfer switches, panelboards, transformers (primary and secondary locations) and other electrical equipment requiring routine inspection or maintenance while energized (including Infrared (IR) Scans).
      a. 120/208-240 VAC equipment shall be included in the Study in accordance with the latest information and Addenda issued with IEEE / NFPA criteria, and as outlined herein below
      b. 120/240 VAC Single phase equipment need not be included in the actual analyses where the fault current is determined to be less than 10 kAIC, but these panelboards and related transformers, etc. shall be shown on the facility's oneline diagrams for identification and labeling shall be provided as outlined herein below.
   3. Refer to other criteria and reporting requirements are outlined elsewhere in this Document.

C. 120/208-240 VAC, Three Phase Power Systems – American Water Corporate Engineering has developed the following recommendations for Arc Flash Hazard labeling on 120/208 – 240 VAC, three-phase grounded and ungrounded power systems:
   1. Service-Entrance and sub-distribution locations: AW Engineering recommends the application of a "standard" label (see Attachment B herein) at those locations where the Main OCP device is equal to or less than 250 amps and the following criteria has been verified. Typically, this equates to a nominally rated 100, 150 or 200 amp self-contained metered electrical service application as well as those installations served from a transformer 112.5 KVA *(3-phase system)* and smaller.

a. Based on criteria evaluated, and the with specific reference to the 2015 NFPA-70E Tables ("Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems"), AW recommends that the AW standardized Arc Flash Hazard Warning Labels indicating an Arc Flash PPE Category 2 hazard be used where the following criteria has been determined and/or otherwise verified.
    1) Voltage is
        a. 120/208 VAC, 3-phase, 4-wire (grounded WYE); or
        b. 120/240 VAC, 3 –Phase, 4-wire ("High-leg Delta"); or
        c. 240 VAC, 3-phase, 3-wire (Ungrounded Delta)

b. NOTE: Where the ampacity rating for the electrical service is greater than 250 amps or the transformer is greater than 112.5 KVA, calculations shall be performed utilizing the "2-Second" clearing time of the over-current protective device as permitted in NFPA-70E and IEEE – 1594 Standards. NOTE: The use of this "2-Second" criteria associated with max clearing time is **ONLY** permitted for use on these low voltage installations.

D. 120/240 VAC, Single-Phase Power Systems – American Water Corporate Engineering has developed the following recommendations for Arc Flash Hazard labeling on 120/240 VAC, single-phase grounded power systems:
    1. All 120/240 VAC Single Phase installations shall be provided with the application of a "standard" label (see Attachment C herein) at those locations.

E. The Report(s) with calculations must be supplied to the Owner before final equipment labels are printed and applied before the work is considered accepted or approved. The Engineer shall provide documentation for all presumptions / assumptions related to machine impedances, cable impedances (both resistance and inductance), transformer impedances and other equipment values used to complete the computations where obtaining actual data is not available.

F. The Engineer shall consider fault conditions under minimum, maximum, and average power consumption scenarios based on facility operations as well as in the varying Utility fault conditions outlined previously. The Engineer shall also develop fault scenarios with standby power generators where included and used instead of or in conjunction with the electric utility source along with the other scenarios outlined. Arc Flash Hazard analysis and equipment evaluations to be provided as hereinafter indicated.

G. All oneline diagrams included in the Study / Report shall utilize naming conventions and identifiers matching the Design Documents or actual equipment field labels; generic identifiers are not considered appropriate. Coordinate equipment naming / identifiers with the Owner taking into account any existing terminology used. Individual oneline diagrams are required for each of the following evaluations as well as each scenario associated with the work outlined for various operational modes, arc reduction methods/devices and multiple configuration capabilities within the power distribution system. The following ones identified are listed only to establish the primary categories associated the overall scope of evaluations to be included; include supplemental documentation as necessary to clearly and individually identify the study scenario and/or evaluation being considered.
    1. Provide annotated onelines for the Power Distribution System identifying all equipment and naming conventions as stated above.

2. Provide annotated onelines identifying the available short-circuit current at each piece of equipment; include this in the Report; tabbed as associated with this topic.
3. Provide annotated onelines identifying the settings associated with the protective device settings at each piece of equipment; include this in the Report; tabbed as associated with this topic. Additional setting details associated with electronic trip devices, relays, etc. are to be clearly identified and included on the partial oneline clips associated with the protective coordination TCC diagrams.
4. Provide annotated onelines identifying the Incident Energy and Arc Flash Hazard Level at each piece of equipment; include this in the Report; tabbed as associated with each Topic and Evaluation
5. All onelines shall be legible and readable with a minimum 10 point (Arial or similar) font size; coordinate drawing size (not to exceed 22" x 34") accordingly. Provide sleeved drawing holders where printed size is larger than 11" x 17".

H. Short Circuit, Protective Coordination and Arc Flash Hazard Analysis Study
1. A short circuit, protective coordination and arc flash hazard analysis study shall be made for the entire distribution system in accordance with ANSI/IEEE C37.10 & C37.13, IEEE Std. 141, 242 and 399 beginning at Utility connections and ending at the largest feeder from each motor control center or panel as applicable for the system and analysis being conducted in coordination with paragraph "B" above.
2. Actual Utility data including system and equipment impedances, X/R Ratios, OCP device(s) and other applicable ratings are to be obtained by the Engineer; include this data as provided by the Utility Company in the Report provided.
3. The protective coordination study shall consist of the following:
    a. All protective devices contained in the scope of work shall be evaluated. The coordination study shall include computer generated log-log plots of phase overcurrent and where applicable, ground overcurrent protection devices on log-log time-current characteristic paper as produced by the engineering software used for these evaluations and analyses. Complete plots of these devices will be accurately plotted through their operating range. Each TCC Plot shall include a oneline sketch showing the device identifications and ratings. The Engineer shall identify areas of non-coordination where considerations for modification may be determined. Actual modifications are not necessarily considered included in the scope of services under this project. Any suggested modifications affecting equipment and modifications to the system that the Owner may wish to consider will be handled as a change in the Contract. Appropriate maximum fault levels, transformer inrush currents, conductor insulation withstand curves and transformer damage curves / withstand points shall be plotted on each coordination plot sheet to assure adequate component protection and maximum system reliability.
    b. Where included in the power distribution system, each current transformer shall be checked for saturation to insure that they accurately translate all fault currents which may be available on the system.
    c. All protective relay and solid-state device settings; fuse sizes; and low-voltage circuit breaker settings shall be tabulated and included on the respective TCC.
    d. A complete set of coordination curves (complete with device settings indicated on the TCC) are to be prepared starting with the Utility Company's OCP device(s) and the main distribution devices protecting the Owner's service down through and including all on-site services, feeders, sub-

feeders, transformers and secondary main and branch circuit devices, shall be included in the Study. These shall be arranged to provide a uniform approach to the review and device coordination for the system and shall include a “snap-shot”/annotated oneline diagram on each TCC sheet outlining the devices included. Provide sufficient overlap on the TCC evaluations included to demonstrate “upstream / downstream” coordination.

e. The Engineer shall also evaluate ground fault protection where provided in conjunction with the project. Provide Time Current Characteristic (TCC) curves for all GFI circuit breaker equipment protection as outlined above.
f. Motor starting current profiles for all large motors (over 25 HP or as otherwise determined and accepted by the Owner) shall be included on the appropriate TCC’s to identify coordination and provided based on the starter type being provided; other motors to be configured as combined loads as applicable to the application
g. Tabulations shall include a listing of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings. This tabulation shall also include indication of acceptability or, in the event of a noted deficiency, provide recommended solution for corrective action.
h. As indicated, points of non-coordination shall be brought to the attention of the Owner; provide existing TCC identifying the issue and a separate TCC outlining proposed modifications and/or adjustments recommended for corrective action.
i. The Study shall include all electrical equipment as included in the Scope of Work for this assignment. The use of documentation and record information as may be provided by the Owner shall not be construed as providing all data necessary; the EOR shall be responsible to conduct or obtain field verification necessary to determine / obtain all required data in establishing the power distribution one-line diagram for the system being evaluated.
j. Submissions and approval of these studies are required as outlined herein after in this document.

4. Arc Flash Hazard Analysis
   a. The arc flash hazard analysis shall include the incident energy and flash boundary calculations.
      1) Unless otherwise specified or approved in writing by the Owner, the EOR shall utilize a Working Distance of 18 inches for ALL voltage levels (low & medium voltage values). Typical other typical distances (i.e... 24” or 36”) for low voltage systems and/or 36” for medium voltage systems as otherwise permitted under NFPA-70E / IEEE are not permitted.
      2) As indicated, calculated incident energy values shall be provided for both line and load sides of all transformers and the overcurrent protective devices served from these transformers or other separately derived sources and labeling developed to identify both calculated Incident Energy and Site-specific Arc Flash PPE Category values in addition to other equipment and devices as previously outlined herein. Equipment Arc Flash Hazard Analysis labeling to be provided with this and other labeling information as outlined herein to properly identify and notify workers to the hazards present.
   b. The Engineer shall furnish the Arc Flash Hazard Analysis Study per the latest edition of NFPA 70E - *Standard for Electrical Safety in the Workplace*, reference Article 130.3 and as indicated in Annex D to these specifications.

c. The analysis shall utilize the appropriate short-circuit and clearing times associated with the over-current protective devices. Where this information is not available, alternative methods for similar devices shall be identified and submitted in the study for review and comment by the Owner.
    1) The arc flash study shall be run under a minimum of the following scenarios in order to account for varying source conditions and available Utility deviations. The worst case from these scenarios shall be considered in developing the PPE and Arc Flash Labeling for the equipment unless otherwise discussed and accepted by the Owner. Power Study scenarios to be considered include;
        a) Utility at nominal short circuit contribution,
        b) Utility at 50% of nominal contribution (or as otherwise determined based on available range of Utility data), and
        c) Standby (generator) contribution (where applicable)
        d) Other scenarios as previously indicated.
    2) Incident energy is greatly influenced by protective device clearing time, which is determined by the available short circuit current at that location. The intent for utilizing a 50% source is to provide some measure of assurance that a “low” utility source will not result in incident energy values higher than those indicated on the equipment labels.
    3) The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system as outlined herein.
d. The Arc-Flash Hazard Analysis shall include all medium voltage and 480/277 volt locations, as well as those three phase locations associated with the 240 volt and 208 volt systems as previously outlined..
e. All electrical equipment as herein outlined shall be labeled regardless of the arc-flash energy / incident energy level determined.
f. Safe working distances shall be identified for calculated fault locations based upon a calculated arc flash boundary considering a minimum Incident Energy level of 4 cal/cm^2; site-specific Arc Flash PPE Category as identified in Attachment D. Working distances shall be based on 18” as outlined previously and in accordance with the general criteria as outlined in IEEE 1584. The calculated arc flash protection boundary shall be determined using this working distances.
g. The Arc Flash Hazard analysis shall include calculations for contributions of fault current magnitude (based on the available fault-current values and not the AIC ratings of the equipment) as previously outlined herein. The calculations shall include all motor and other sources that can contribute to the available fault current. Where necessary, the Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
h. As previously noted, Arc flash computations shall include line and load side calculations associated with the “main” (service-entrance) breaker as well as any other transformer OCP devices associated with internal power distribution. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. AW does not consider the use of this IEEE Exception to be appropriate. (Maximum clearing time of 2 seconds *based on IEEE 1584 is not acceptable*)
i. Results of the Analysis shall be submitted in tabular form, include device or bus name, (based on actual naming ID as identified on the Facility Oneline Diagram; not simply an ID assigned by the software), bolted fault and arcing

fault current levels at the various scenarios outlined herein, flash protection boundary distances, personal-protective equipment classes and the arc flash incident energy levels determined. These results shall also be included on the oneline diagram associated with the specific study/scenario being evaluated.

j. The Report shall also include identification of the Personnel-Protective Equipment (PPE) Categories and identify minimum PPE required for each location. This information shall be included in the Report but not shown on the equipment labels.

k. Arc Flash Labeling of Electrical Equipment: Provide copies of the Arc Flash Labels (see sample attached below) in the Report for documentation of the information being identified on the equipment in a separately tabbed section of the report. Include in this section definitions of the terms and distances outlined along with information on the various PPE equipment classifications indicated.

4. POWER SYSTEM STUDY AND ARC FLASH ANALYSIS QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled (*minimum of 10 years of demonstrated experience in conducting power systems studies; provide qualifications upon request*) in performing and interpreting the power system studies. The final report, including copies of the Arc Flash Labels, shall be sealed and signed by the EOR.

5. ENGINEERING STUDY / REPORT SUBMISSIONS

A. Submit the following Reports for AW Engineering / Owner Review and Comment. Coordinate these submission with the Design Criteria / Documentation Submissions as outlined for the Project. In general, the “Preliminary” Report should be provided with the 30% Design (or otherwise defined Project) Submission; the “Pre-Final” Report with the 60% submission and the “Final” Report provided with the 100% submission. Final adjusted report information, including final equipment labels to be provided once all field adjustments and acceptance testing has been completed. This Record Document Report shall be provided as part of the Operation and Maintenance Documents.

1. Preliminary – Submission to contain an annotated One-line Power Riser Distribution Diagram with OCP devices and other basic configurations associated with the power distribution system included; not a completely detailed and documented diagram. This diagram is intended to show the available power sources and devices which comprise the system and it’s configuration for operation. Additionally, this initial diagram is to include the major loads and presumptions for miscellaneous general power requirements which may be appropriate in considering Load Flow evaluations where necessary.
    a. As part of this Preliminary effort, consideration related to new equipment selections shall be included. Provide initial discussion and/or indication related to proposed equipment for Owner consideration and comment.
    b. Include the overall oneline diagram utilizing this simplified computer modeling approach. This information and modeling will allow basic configuration, operations and evaluations associated with equipment short-circuit ratings and types of devices to be considered / developed with the Owner.

2. Pre-Final – Report to contain an annotated One-line Power Riser Distribution Diagram with OCP devices, device ratings/settings and cable feeders (conductor size/type and raceway size/type) identified.
    a. As part of this continuing effort, consideration related to equipment selections shall include type of device and over-current protective features needed for protective coordination with other elements of the power distribution system and loads served. (including type of trip unit, potential arc flash reduction methods as applicable, etc.).
    b. Calculations associated with Short-Circuit AIC values and Equipment suitability along with Arc-Flash Hazard Analysis Report and sample of proposed / typical ANSI Z535.* label information (**current edition*) documentation are to be included.
    c. Included in this Report, Oneline Drawings for the overall Power Distribution Power Riser diagram, an annotated oneline outlining the Short-Circuit ampacity values calculated, and an annotated oneline showing the Arc Flash Incident Energy and PPE Levels calculated.
    d. In addition, a copy of the oneline diagram with the OCP devices indicated shall be included with the Protective Coordination TCC's. Each TCC shall include the partial oneline drawing associated with the protective coordination elements being evaluated and included.

3. Final - Provide a written response to Owner comments provided regarding Pre-Final Study Report. Finalize the information; update data, settings and other appropriate information including any accepted recommendations and/or modifications.
    a. Provide three hard-copies of each submission Report as well as editable Word electronic formatted Report document with the Final submission. Power Distribution Riser Diagrams shall be provided for all analysis configurations conducted including, but not limited to, short-circuit models for minimum and maximum operational scenarios and arc flash hazard models. Include hardcopies of equipment reports and calculations performed.
    b. Submit an electronic copy of the final Arc Flash Hazard Analysis and One-line Power Riser Diagram, complete with all associated equipment databases formatted with the engineering software used and as outlined herein.
    c. It is recommended that the final report include the following sections:
        1) Executive Summary including Introduction, Scope of Work and Results/Recommendations
        2) Short-Circuit Methodology Analysis Results and Recommendations
        3) Short-Circuit Device Evaluation Table
        4) Protective Device Coordination Methodology Analysis Results and Recommendations
        5) Annotated and revised oneline diagrams (all) as outlined in "2" above shall be provided with the Final Report.
        6) Protective Device Settings Table associated with the field installed devices.
        7) Time-Current Coordination Graphs and Recommendations
        8) Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.

9) Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as actual copies of the label images.
10) One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

B. Upon acceptance of the Final Report, provide labeling of the power distribution equipment in accordance with ANSI Z535.4– Product Safety Signs and Labels; label size to be 4" x 6". Labels to be provided as outlined in Articles 1.03, C and 3.03 below. Label materials furnished to be suitable for either the interior or exterior locations where they are to be applied; provide samples for review and approval by the Owner along with data sheets from the Manufacturer outlining these applications.

C. As part of the final documentation associated with the project Record Drawing data, provide a copy of the oneline diagram that includes the essential equipment and devices without ratings to provide a concise representation of the power distribution system. All equipment and devices shall be identified based on the actual nameplates and identifiers developed under the project design; coordinate with final nameplates provided. Drawing size to be based on size of power distribution system but shall be large enough to provide clear reading of the text based on an Arial 10 point font or equivalent of the equipment naming and identifiers; maximum sheet size to be 22" x 34". Provide multiple drawings for systems where information cannot be legibly contained on a single sheet. This diagram is to include all revisions and modifications determined through the course of construction.

6. COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using ETAP power systems software as provided by Operation Technology, Inc. (OTI), or SKM Systems Analysis Power Tools for Windows (PTW) software program.

B. Provide a final electronic file copy of all data, reports and the oneline diagram in electronic engineering database (ETAP or SKM) format to the Owner prior to final acceptance of the Project. This information is to be validated by the EOR as representing "As-Built" conditions including all over-current protective devices and their settings, feeder conductors and raceway information and load data; including inductive, resistive and combination loads.

C. The files shall contain all Reports (in Microsoft Word) conducted including Short-Circuit evaluations, Protective Coordination and Load Flow Studies as well as the Arc Flash analysis values determined as well as copies of the Arc Flash labels. The EOR for the Study shall attest to this validation in writing when submitting the final electronic copy of the project.

7. FIELD INVESTIGATION / DATA COLLECTION AND IMPLEMENTATION ACTIVITIES

A. The Engineer (or authorized designee of the Engineer) conducting the field data collection work shall review and provide compliance with the following:
   1. Continuity of Service:
      a. If any service or system must be interrupted, the Engineer shall request permission in writing stating the date, time, etc. the same will be interrupted and the areas affected. This request shall be made in sufficient time (approximately 1 week minimum in advance) for proper arrangements to be made. Written permission shall be obtained from the Owner before any interruption to electrical power is permitted.
   2. Lock-Out / Tag-Out Procedures
      a. The Engineer shall provide his own lock-out / tag-out equipment in coordination with the Owner's program; coordinate with the Owner's field operational and maintenance staff.
      b. The Engineer shall have in effect a written safety program that includes a lock-out / tag-out safety program in accordance with OHSA under Part 1910, Subpart S.
   3. Electrical Safety Program
      a. The Engineer shall review the Owner's Electrical Safety Program and take the necessary precautions, in conjunction with his own safety program for employee protection.
      b. The Engineer is to have in effect a written electrical safety program that includes all applicable provisions of the NFPA-70E which has been adopted by OHSA under Part 1910, Subpart S.

B. The Engineer shall provide written documentation indicating that his employees, those working on American Water projects, have been trained and certified on all provisions applicable to B and C above upon request from the Water Company.

C. The Engineer's employees shall follow all provisions of "B" and "C" above including, but not limited to, the use of personal protective equipment (PPE), establish protective barriers, approach boundaries and documentation for such activities. Provide a written statement attesting to the above requirements prior to the start of the Field Investigation / Data Collection activities.

D. Field Adjustment
   1. The Engineer shall adjust protective devices settings based on the final accepted Study/Report provided by the Engineer; settings to be listed in a table format and submitted as part of the final O&M Manual for the equipment / system.

E. Arc Flash Warning Labels
   1. Provide an ANSI Z535.4 compliant (size 4 in. x 6 in.) thermal transfer or equivalent type two color die-cut arc flash label as provided by DuraLabel or Brady for each work location analyzed and included in this project. Material type to be suitable for the locations; IE indoor, outdoor, chemical resistively, etc.
   2. The label shall have either an orange header with black lettering and the wording, "**WARNING, ARC FLASH HAZARD**", or a red header with white lettering and the wording, **"DANGER, ARC FLASH HAZARD".** Include the ANSI Safety Symbol in the header as recommended. The Danger signal wording shall be provided for all calculated incident energy values greater than 40 Cal/cm^2; Warning to be used for all calculated incident energy values below 40 Cal/cm^2. These labels shall include the following information:

a. Location designation
b. Shock Hazard Information including; Nominal voltage, Limited Approach and Restricted Approach with Covers Removed
c. Flash protection boundary
d. Site-specific Arc Flash PPE Category
e. Available Fault Current – include reference to Power Study as outlined on sample labels included in the Attachments to this criteria
f. Incident energy (calculated based on Incident Energy Analysis Method)
g. Working distance (18" typical for all equipment and applications)
h. Engineer, report number, revision number and issue date
i. Reference to "Owner's Arc Flash Procedures Manual" in lieu of actual listing of clothing and glove requirements.

Refer to Attachment at end of this document for Sample Label and Information to be included

3. Labels shall be machine printed, with no field markings. The size of the lettering is to be in accordance with ANSI-Z535.4 recommendations for a safe viewing distance of 3' minimum based on favorable viewing conditions and information to be included.
4. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended over-current device settings. Coordinate the data provided with the Arc Flash Study results and the ANSI labeling requirements. Quantities outlined below are considered minimum quantities necessary; provide additional labeling as may be required by Regulatory or Inspection Agencies at no additional cost to the project.
    a. For each transformer, 480 and applicable 240 and/or 208 volt panelboard, individually-mounted circuit breaker and safety disconnect device, one arc flash label shall be provided
    b. For each motor control center, one arc flash label shall be provided at the top of each vertical section *(see footnote below).*
    c. For each low voltage switchboard, one arc flash label shall be provided at the top of each vertical section *(see footnote below).*
    d. For each low voltage switchgear, one arc flash label shall be provided at the top of each vertical section *(see footnote below).*
    e. For each medium voltage switchgear, one arc flash label shall be provided for each cell within each vertical section *(see footnote below).*
    f. For medium voltage switches one arc flash label shall be provided at the top of each vertical section *(see footnote below).*
    g. For each motor power terminal box, 25 horsepower and larger, one arc flash label shall be provided.
    h. Additional arc flash labels to address installations and specific equipment requirements to be provided based on an individual evaluation basis and coordinated with the Owner.
    i. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

    (Footnote – where control center, switchboard, or switchgear assemblies are dual-fed, provide an arc flash label at each main entrance device or section as well as at any "Tie" device location. For equipment that is front and rear accessible, provide the same labeling on the rear sections as outlined above.)

5. Labels shall be field installed by the (Contractor or Engineer) at the conclusion of the project after acceptance by the Owner.

8. ATTACHMENTS

A. Sample Labels - Three Phase Systems involving calculated incident energy analysis:
   1. DANGER
   2. WARNING

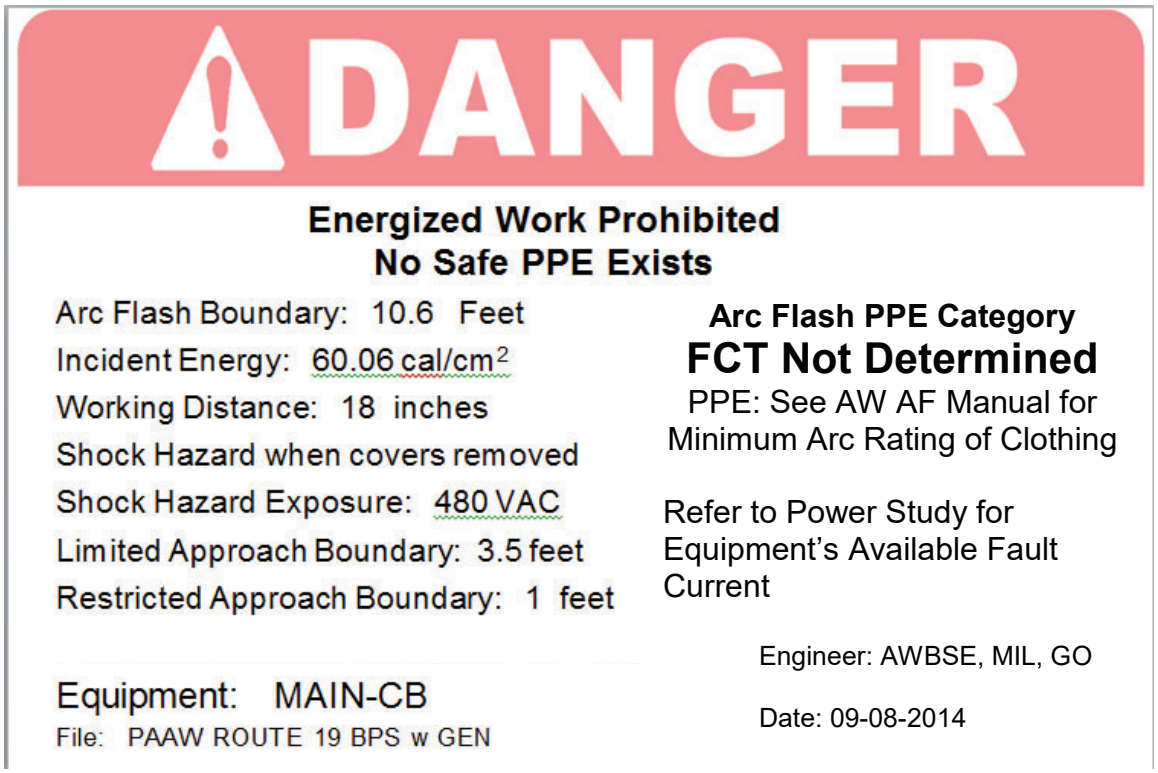
B. Sample Labels – Three Phase 120/208-240 VAC Systems associated with AW Standardized labeling
   1. WARNING

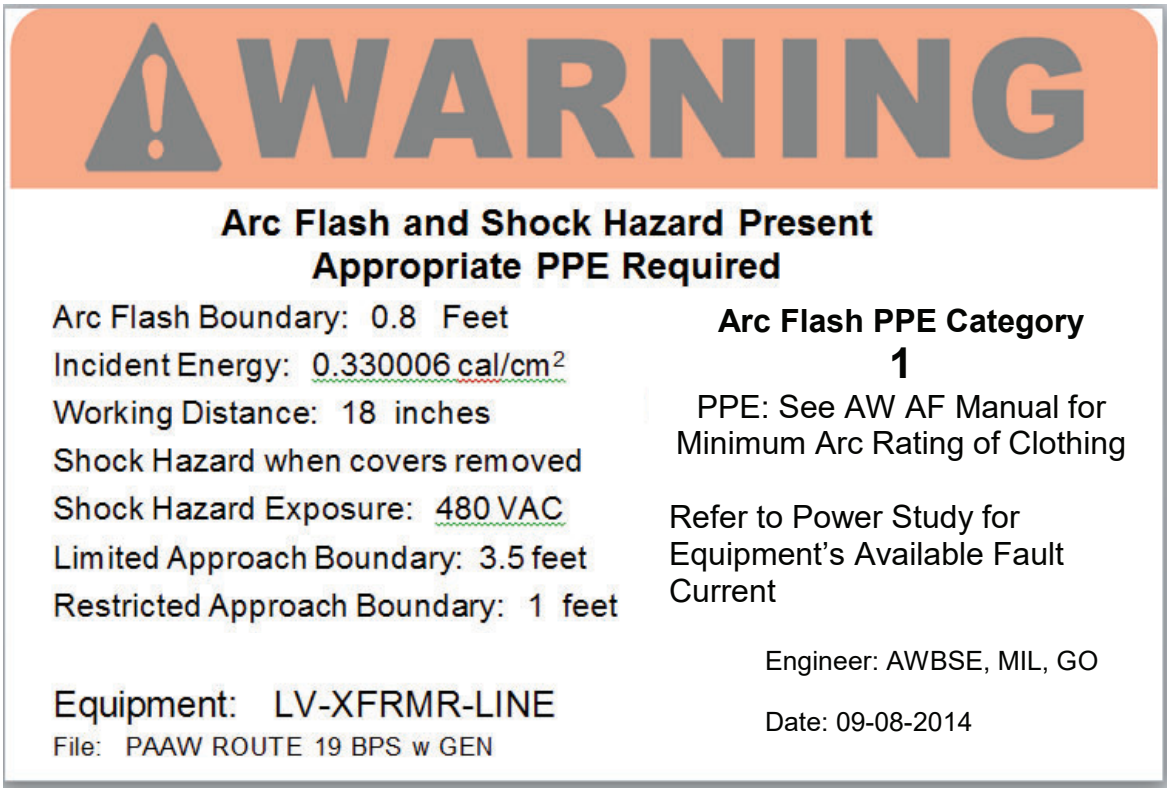
C. Sample Labels – Single Phase 120/240 VAC Systems associated with AW Standardized labeling
   1. WARNING

D. AW Engineering Criteria for Portable Generator Transfer Switch and Termination Enclosure Identification

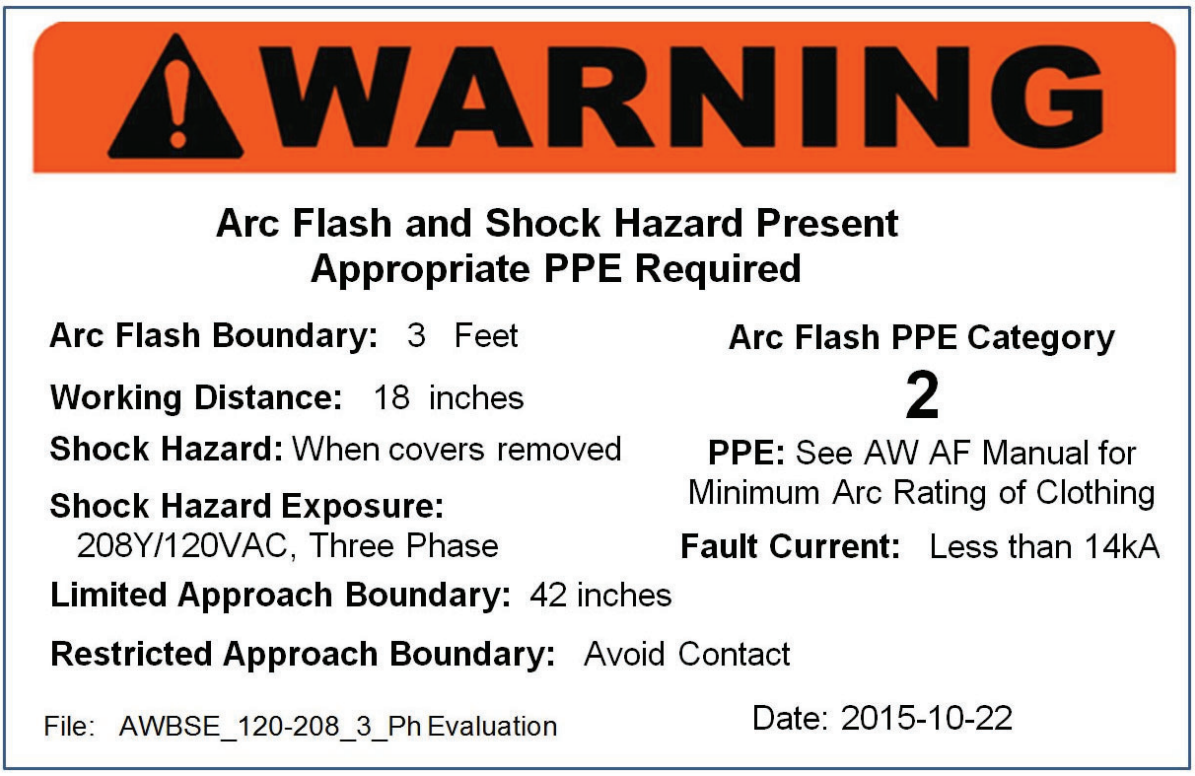
E. AW Engineering Criteria for Site Specific Arc Flash PPE Category Identification

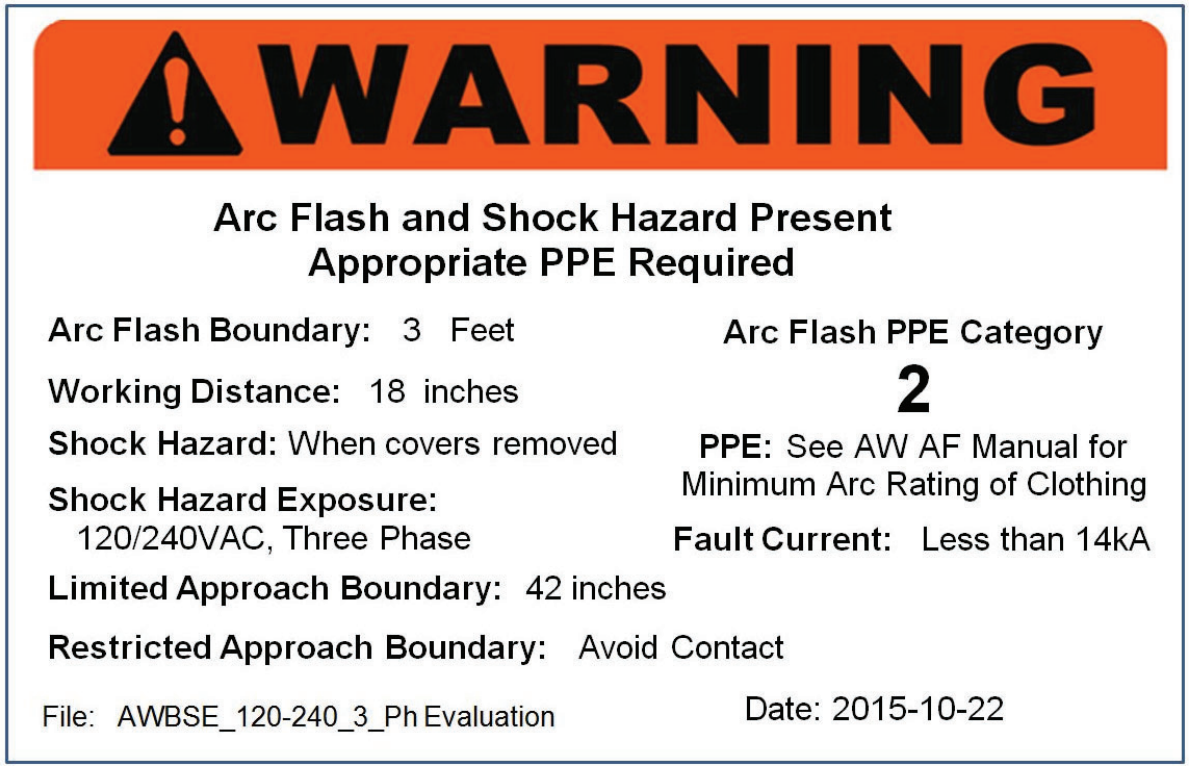
ATTACHMENT A –
Three Phase Systems involving calculated incident energy analysis





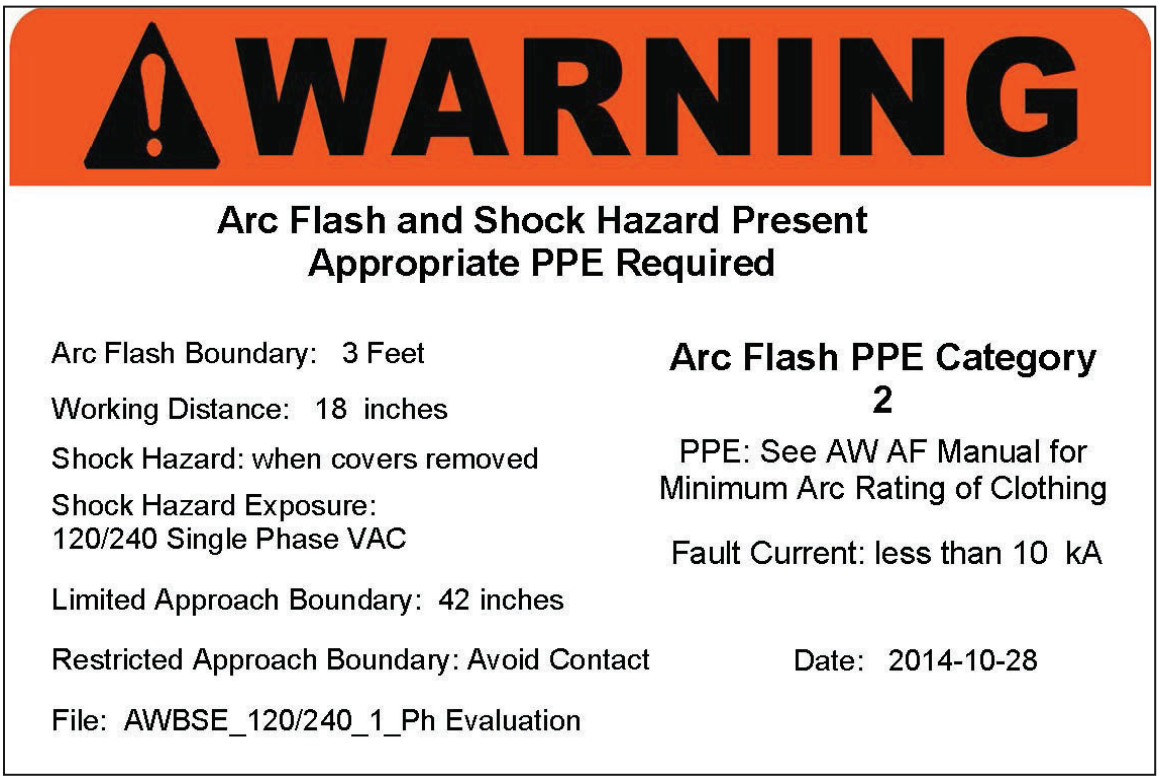
ATTACHMENT B -
Three Phase 120/208-240 VAC Systems associated with AW Standardized labeling





ATTACHMENT C –

Single Phase 120/240 VAC Systems associated with AW Standardized labeling



ATTACHMENT D –

AW Engineering Criteria for Portable Generator Transfer Switch and Termination Enclosure Identification

ATTACHMENT E –

American Water Engineering Criteria for Site Specific Arc Flash PPE Category Identification

Incident Energy Range (cal/cm^2)	Arc Flash PPE Category
0 – 4.0	1
4.01 – 8.0	2
8.01 – 25.0	3
25.01 – 40.0	4
40.01 and above	DANGEROUS (No Safe PPE Exists)

ATTACHMENT B
AMERICAN WATER
ACCEPTABLE ELECTRICAL EQUIPMENT MANUFACTURERS AND SUPPLIERS

The following listing is intended to identify those manufacturers that are generally acceptable and capable of meeting American Water's Recommended Design Standards, and provides a unified approach in design, maintenance and operation across the entire Company.

Unless specifically indicated, the naming of the manufacturers outlined below is not intended to provide the specified "order" for equipment selections. The list should be reviewed with the Water Company during the initial design phase to add or eliminate any manufacturers that are preferred or rejected by the local Operations team. The Consultant may propose other suppliers/manufacturers for Owner review and acceptance based on the specific nature of the Work and site location and/or conditions. The Consultant shall include a listing of proposed major electrical equipment manufacturers with the Design Memorandum for consideration by the Owner. The Basis of Design shall be established based on the Owner's preferences.

Note: These manufacturers and descriptions below are intended to outline the basis for the equipment design and criteria for development in the project; not exclusive approval.

Equipment Description	Manufacturers
MV Switchgear – Vacuum Breaker, Draw-Out	Cutler-Hammer Square D ABB Siemens General Electric
Medium Voltage Automatic Transfer Switchgear (Circuit Breaker Transfer Equipment – Manual or Automatic)	Cutler-Hammer Square D ABB Siemens General Electric Or Acceptable Manufacturer from above provided by Generator Equipment Manufacturer (subject to Owner approval)
MV Fusible Switchgear	Cutler-Hammer Square D *(Note - HVLcc Type Equip Not Accepted)* ABB Siemens General Electric S&C
MV Switchgear – SF6 Type	*Not Preferred Equipment*
MV Motor Control Equipment, MC Lineups (FVNR, RVSS Equipment)	Cutler-Hammer ABB Siemens General Electric
MV Variable Frequency Drives	Toshiba Allen Bradley – Voltage Source Equipment (not Current Source Drive) Cutler-Hammer Siemens/Robicon

Equipment Description	Manufacturers
LV Power Distribution Equipment – (Swgr, Swbds, Panelboards, Circuit Breakers, etc)	Cutler-Hammer Square D ABB Siemens General Electric
Transformers – Dry Type, VPI, VPE Insulation	Cutler-Hammer Square D/Sorgel Siemens ABB
Transformers – Cast-Coil	Square D/Sorgel ABB
Transformers – Liquid-Filled	*Not Preferred Equipment*
Protection Relays & Monitoring Relays for Voltage, Current, Phase Loss, Etc.	SEL (Schweitzer Engineering Laboratories) *Other acceptable manufacturers may include the following (subject to prior approval by AW Engr / Owner)* All to be provded with Fiber-Optic Communications over Ethernet / Modbus TCP/IP
Power Quality Metering, Motor Monitoring & Feeder Protection Relays	SEL 735, SEL 710, SEL 751A, SEL-489 Other SEL devices as applicable for the design of the power distribution system. *Communications to utlilize fiber-optic interface; dual-port for loop configuration where available. Copper communications to be utilized only where specifically indicated. All to be provded with Fiber-Optic Communications capability Ethernet / Modbus TCP/IP and DNP3*
Low Voltage Motor Control Centers	Cutler-Hammer Square D ABB Siemens General Electric
Full Voltage Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric
Reduced Voltage (Solid-State, Soft Start) Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric Danfoss Benshaw

Equipment Description	Manufacturers
Low Voltage Variable Frequency Drives – Stand Alone Applications (Free-Standing or Wall Mounted Units) *NOTE: Basic Criteria - All VFD equipment to be "Heavy Duty" / "Industrial Duty", rated for 50 C. and suitable for full load rating with 3% voltage unbalance. Cooling fans shall be accessible without requiring total dismantling of the drive assembly; top outlet discharge preferred.* *"HVAC Rated" Drives are Not Permitted* *** NEMA4X Note: Drive assembly to be rated NEMA 4x by manufacturer; use of open chassis or NEMA 1 drives installed in NEMA 4x enclosure is not suitable in meeting this criteria.*	<u>Free-Standing – Wall or Floor Mounted</u> Square D Cutler-Hammer Allen Bradley Toshiba ABB Siemens/Robicon Danfoss Benshaw Yaskawa <u>NEMA 4X Type (where required)**</u> Allen Bradley Yaskawa T B Woods Others as determined suitable for the application Harmonic Filters (where required) TCI Mirrus MTE
Low Voltage Variable Frequency Drives – Part of MCC Lineup/Equipment *(Not an AW preferred method)*	Cutler-Hammer Square D ABB Seimens General Electric
Low Voltage Automatic or Manual Transfer "Switches" – Contactor Type assembly	ASCO 4000 Series (unless otherwise suitable) Other potential Suppliers include: Cutler-Hammer GE/Zenith Russelectric
Low Voltage (*Service Entrance Rated where applicable*) Automatic Transfer Equipment (Circuit Breaker Transfer Equipment – Manual or Automatic) *NOTE: Circuit Breaker – Main and Circuit Breaker – Standby (where identified) REQUIRED unless specifically accepted otherwise*	Cutler-Hammer/Eaton Square D ASCO 4000 Series Russelectic Switchgear General Electric
Uninterrupted Power Supplies	APC Powerware General Electric Mesta Liebert MCG

Equipment Description	Manufacturers
Surge Protective Devices (UL-1449, Rev 4 Compliant and **Listed/Labeled**) *Note: use of integral SPD with panelboards and equipment not permitted; provide stand-alone external devices only unless otherwise specifically approved*	APT – Advanced Protection Technologies "XDS" Series MCG Cutler-Hammer "SPD" Series
NOTE: The following descriptions provide general guidelines for lighting fixtures and applications. As LED technology continues to be available at lower costs, American Water recommends evaluation between LED and Fluorescent lamps/fixtures. Where fluorescent fixtures are used (T-5 and T-8 fluorescent lamps), provide Programmed / Rapid-Start Ballasts. (*note- the use of Instant-Start ballasts is prohibited*) The use of LED technology is recommended for all exterior applications unless special aesthetic and/or other site-specific criteria is established by the Owner or Regulatory Authority	
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Enclosed and Gasketed Fluorescent for Damp and Wet Locations (Process and Chemical Rooms)	EPCO GFF Series w/SS Latches, Simkar EN 2 or 3 w/SS Latches, Holophane ERS Series, Lithonia FSW or FHE Series, ILS Others as accepted by Owner *(Note – the use of fixtures similar to Lithonia DMR Series, Columbia LUN Series, Simkar OV450, etc are generally prohibited due to on-going physical / performance issues associated with this type of design (limited latches retaining sealed integrity of the assembly)). Fixture selection is to take into consideration lamp output, lumen maintenance, and environmental factors associated maintainability of the overall system.*
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor dry applications	Benjamin, Philips, Keene, Lithonia and Others as accepted by Owner
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Hazardous Locations	Appleton Crouse-Hinds Killark Others as accepted by Owner
Lighting Fixtures – LED Indoor	Lithonia Philips Cree Others as accepted by Owner
All LED luminaires must be UL Listed (e.g. UL8753 / UL8750) and tested to IESNA LM-79 and LM-80 standards and that the results of those tests must be submitted to the Owner as part of the submittal review process. LED fixtures to be provided with a minimum 5 year warranty covering the driver, the LED components and the luminaire.	
Lighting Fixtures – LED Outdoor	RAB Cree Philips Dialight Lithonia Others as accepted by Owner
Lighting Fixtures – HPS Outdoor	Holophane, Infranor Devine, Philips Others as accepted by Owner

Equipment Description	Manufacturers
Lighting Control - Occupancy Sensors	Sensor Switch (High Humidity / Low Temperature Type) – process & chem. Areas Leviton, Hubbell, P&S along with others mfgrs and products to be provided as determined suitable for the location and environment where installed. *NOTE: Technology (passive IR, ultrasonic, or dual) to be based on location where installed*.
Lighting Control – Daylight Harvesting and/or Special Function and Dimming	Lutron Wattstopper Day Light Controls Others as accepted by Owner
Control and Timing Relays (“Ice-cube” relay style)	Diversified Potter Brumfield Syrelec Allen Bradley Square D Cutler-Hammer Seimens Releco Others as accepted by Owner
Push Buttons, Selector Switches & Pilot Lights (30 mm minimum size devices, NEMA 4X style preferred and high-intensity LED pilot lamps)	Cutler-Hammer Square D Seimens Allen Bradley Kraus & Naimer
Definite Purpose Relays and Contactors	Cutler Hammer Square D Siemens Allen Bradley
PVC Coated Rigid Steel Conduit	Ocal Robroy
Fiberglass Conduit	Champion FRE
Power Generation Equipment – (Diesel engine driven units)	Onan/Cummins Caterpillar Kohler Others only as determined accepted by Owner
Industrial and Corrosion Resistant Wiring Devices	Cooper Industries Legrand Leviton Hubbell Meltric Woodhead, http://www.woodheadsales.com

Attachment C -

SEL Device Monitoring Points (Modbus to SCADA /RTU)

The following Information represents typical data monitoring from many of the SEL metering and protective relays identified in the AW Recommended Electrical Design Criteria and Standards.

The information provided herein should be used as a starting point for baseline data acquisition; additional information may also be required for specific maintenance assistance, trend analysis, etc. and does not include all of the data points/registers available.

The Engineer is to review with the Owner potential supplemental data and configuration that may be needed or recommended based on the specifics of the project, preventative maintenance, alarm reporting as well as other devices.

SEL-735:

TCP Modbus Register	Signal
912	PFT3_True_Power_Factor_3_Phase
351	IA_Phase_A_RMS_Current
353	IB_Phase_B_RMS_Current
355	IC_Phase_C_RMS_Current
1016	VAB_RMS_Voltage
368	VBC_RMS_Voltage
370	VCA_RMS_Voltage
901	Frequency
1020	W3_3_Phase_kWatts

Attachment C -

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-710

TCP Modbus Register	Signal
689	ApparentPwr
714	BearingTempMax
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
692	MWhOut_Total
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA
685	VoltageImbal
713	WindingTempMax

Attachment C -

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-751A

TCP Modbus Register	Signal
689	ApparentPwr
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA
685	VoltageImbal
692	MWhOut_Total
144	BreakerClosed

Attachment C -

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-351

TCP Modbus Register	Signal
689	ApparentPwr
193	BreakerClosed
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
692	MWhOut_Total
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA

Attachment C -

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-787

TCP Modbus Register	Signal
729	ApparentPwr
176	BreakerClosed
685	CurrentA
687	CurrentB
689	CurrentC
8	Enabled
732	Frequency
733	MWhOut_Total
730	PowerFactor
728	ReactivePwr
727	RealPwr
759	TotDemand
764	TotPeakDemand
169	TripAlarm
710	VoltageAB
712	VoltageBC
714	VoltageCA
152	TemperaureAlarm
207	FaultAlarm
771	THD_IA_Pri
772	THD_IB_Pri
773	THD_IC_Pri
777	THD_VA_Pri
778	THD_VB_Pri
779	THD_VC_Pri
784	WindingTempMax

Attachment C -

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-700G

TCP Modbus Register	Signal
689	ApparentPwr
651	CurrentA
653	CurrentB
655	CurrentC
664	CurrentImbal
1806	Enabled
1827	Fault
690	Frequency
691	MWhOut_HighWord
692	MWhOut_LowWord
689	PowerFactor
687	ReactivePwr
686	RealPwr
1694	TotDemand
1699	TotPeakDemand
1806	TripAlarm
668	VoltageAB
670	VoltageBC
672	VoltageCA
685	VoltageImbal
692	MWhOut_Total
144	BreakerClosed

Attachment C -

SEL Device Monitoring Points (Modbus to SCADA /RTU)

SEL-849

TCP Modbus Register	Signal
	ApparentPwr
	CurrentA
	CurrentB
	CurrentC
	CurrentImbal
	Enabled
	Fault
	Frequency
	MWhOut_HighWord
	MWhOut_LowWord
	MWhOut_Total
	PowerFactor
	ReactivePwr
	RealPwr
	TotDemand
	TotPeakDemand
	TripAlarm
	VoltageAB
	VoltageBC
	VoltageCA
	VoltageImbal

Other devices and monitoring data should be evaluated based on project requirements and specific criteria needed.

VIRGINIA AMERICAN WATER
HOPEWELL WATER TREATMENT PLANT

INDUSTRIAL PUMP STATION, ELECTRICAL BUILDING,
CHEMICAL & UV FACILITIES

DESIGN CONCEPT

APPENDIX J

AMERICAN WATER

INFRASTRUCTURE WIRING SPECIFICATION

Infrastructure Wiring
Bid Specification

Version 21

Updated – February 2018

American Water

AMERICAN WATER

TABLE OF CONTENTS

Owner
Technical Specification

PART 1 GENERAL

1.1 SUMMARY

A. This Technical Specification defines requirements for the installation of the structured cabling infrastructure to support communications for Information Technology, Security, and SCADA systems for all new/remodeled Owner (also referred to as Owner Company) facility locations. This specification provides a detailed description of the products to be used and the layout of the subsystems of the network infrastructure architecture. The product instructions and layout must be strictly adhered to.

B. Product specifications, general design considerations, and installation guidelines are provided in this document.

C. This document does not apply to the installation field instruments for Production instrumentation and control systems.

D. All references to Legrand, Legrand/Ortronics, and Ortronics are noted only as Ortronics throughout this document.

1.2 RELATED SECTIONS

A. Division 17 – Instrumentation

B. Division 16 – Electrical

C. Division 27 – Communications

C. Division 28 – Electric Safety and Security

D. Section 01300 Submittals

1.3 ABREAVATIONS

A.	ANSI	American National Standards Institute
B.	BICSI	Building Industry Consulting Services International
C.	ESSDRM	Electronic Safety and Security Design Reference Manual
D.	TDMM	Telecommunications Distribution Methods Manual
E.	CIP	Certified Installer Plus
F.	CIP-ESP	Certified Installer Plus – Enterprise Solutions Partner

G.	CSA	Canadian Standards Association
H.	CSI	Construction Specifications Institute
I.	EMR	Electromagnetic Radiation
J.	EMT	Electro Metallic Tubing
K.	ETL	Intertek Testing Service (ETL Logo)
L.	F	Fahrenheit
M.	IDF	Intermediate Distribution Frame (Wiring Closet)
N.	LIU	Lightguide Interface Unit
O.	MAC	Moves, Adds, and Changes
P.	MDF	Main Distribution Frame (Telecom Room)
Q.	NEC	National Electrical Code
R.	NFPA	National Fire Protection Agency
S.	RCDD	Registered Communications Distribution Designer
T.	TBB	Telecommunications Bonding Busbar
U.	TIA	Telecommunications Industry Association
V.	UL	Underwriters Laboratories
W.	UTP	Unshielded Twisted Pair

1.4 DEFINITIONS

A. Backbone: A facility (e.g. pathway, cable or bonding conductor) for cabling Subsystem 2 and Cabling Subsystem 3.

B. Horizontal: Cabling installed within the same subsystem.

1.5 REFERENCES

A. ANSI/TIA-568.0-D, Generic Communications Cabling for Customer Premises, September 2015

B. ANSI/TIA-568.1-D, Commercial Building Communications Cabling Standard Part 1: General Requirements, September 2015

C. ANSI/TIA-568-C.2, Balanced Twisted-Pair Communications Cabling and Components Standard, August 2009

D. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standards, June 2008

E. ANSI/TIA–569-D, Commercial Building Standard for Communications Pathways and Spaces, November 2015

F. ANSI/TIA–606-B, Administration Standard for Communications Infrastructure of Commercial Buildings, June 2012

G. ANSI/TIA–607-C, Commercial Building Grounding and Bonding Requirements for Communications, November 2015

H. TIA–758-B, Customer-Owned Outside Plant Communications Cabling Standard, March 2012.

I. BICSI - TDMM, Building Industries Consulting Services International, Communications Distribution Methods Manual (TDMM) –13th^{h} Edition.

J. BICSI ESS, Electronic Safety and Security Design Reference Manual (ESSDRM) – 2nd Edition.

K. National Fire Protection Agency (NFPA – 70), National Electrical Code (NEC) -2014

1.6 SCOPE OF WORK

A. The work included under this section consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The Communications contractor will provide and install all of the required material necessary to create a complete system whether specifically addressed in the technical specifications or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install a complete communications wiring infrastructure per provided drawings or requirements

2. Furnish, install, and terminate all UTP, F/UTP and Optical Fiber cable

3. Furnish and install all wall plates, jacks, patch panels, and patch cords

4. Furnish required cabinets and racks as required and as indicated

5. Furnish any other material required to form a complete system

6. Perform link or channel testing (100% of horizontal and/or backbone links/channels) and certification of all components

7. Furnish test results of all cabling to the owner in electronic format or on disk listed by each closet, then by workstation ID. Provide owner training and documentation. (Testing documentation and As-built drawings)

8. Installation of open relay racks and/or cabinets and enclosures

9. Installation of vertical and horizontal pathway support systems

10. Installation of fire stopping systems, sleeves and other approved penetration methods

11. Installation of cable runway, racks and cable management

12. Testing and certification of the installed system

13. Patch cabling based on owner requirements

C. Quantities of communications outlets, typical installation details, cable routing and outlet types will be provided as an attachment to this document. If the bid documents are in conflict, this specification shall take precedence.

D. The Communications Contractor shall use only material from the Owner approved parts, referenced throughout this document, during installation. The Telecommunications Contractor shall provide normal consumables for this project. Owner reserves the right to purchase and supply material components.

1.7 REGULATORY REFERENCES:

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association (NFPA), the local Construction Codes and present manufacturing standards.

B. All materials shall be UL Listed and shall be marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

C. The cabling system described in this document is derived from the recommendations made in recognized communications industry standards.

D. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.8 SUBMITTALS FOR REVIEW

A. Submittals at Bid Time

1. A copy of the company certification documents or approval letter from Ortronics must be submitted with the bid response in order for such response to be valid.

B. Shop Drawings

Under the provisions of this request for proposal, prior to the start of work the communications contractor shall:

1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this specification.

2. Submit proof from manufacturer of contractor's good standing in manufacturer's program.

3. Submit appropriate cut sheets and samples for all products, hardware and cabling.

C. Work shall not proceed without the Owner's approval of the submitted items.

D. The approved communications contractor shall receive approval from the Owner on all substitutions of material. No substituted materials shall be installed except by written approval from Owner.

1.9 SUBMITTALS FOR CLOSEOUT

A. Furnish test results of all cabling to the owner in electronic format or on disk listed by each closet, then by workstation

B. Furnish nCompass™ Limited Lifetime Premium Warranty documentation. The nCompass System includes Ortronics and Superior Essex products. Ortronics is a product brand name manufactured by Legrand.

C. Provide As-Built Drawings

D. Provide manufacturers O&M information

1.10 COMMUNICATIONS CONTRACTOR QUALIFICATIONS

The Communications Contractor **must,** at a minimum, possess the following qualifications:

A. Ortronics certified installer at the CIP or CIP-ESP (preferred) level and follow the CIP-ESP protocols (see appendix A).

B. Have a favorable Experience Modification Rate (EMR)

B. Be in business a minimum of five (5) years

C. Communications Contractor shall demonstrate satisfaction of sound financial condition and shall be adequately bonded and insured per owners' requirements.

D. Possess those licenses/permits required to perform communications installations in the specified jurisdiction.

E. Personnel knowledgeable in local, state, province and national codes and regulations. All work shall comply with the latest revision of the codes and regulations. When conflict exists between local and national codes or regulations, the most stringent codes or regulations shall be followed.

F. Must possess and provide proof of current owner's insurance certificates

G. Communications Contractor must be registered with BICSI and have at least one RCDD or equivalent who is responsible for the implementation of this project.

H. The Communications Contractor must be an approved Ortronics Certified Installer Plus and/or ESP (CIP-ESP preferred). The Communications contractor is responsible for workmanship and installation practices in accordance with the Ortronics CIP-ESP Program. The Ortronics CIP and/or CIP-ESP communications contractor shall be a company specializing in communication cabling installation. At least 30 percent of the approved contractor's installation crew must be Ortronics certified on proper installation and testing of copper and fiber structured cabling systems. Technicians with BICSI Level 1 and 2 Copper and Fiber credentials or BICSI Technician credentials are also acceptable.

I. The Contractor must have prior experience with this type of installation or work activity. The customer may, with full cooperation of the contractor, visit client installations to observe equipment operations and consult with references. Specified visits and discussion shall be arranged through the contractor; however, the contractor's personnel shall not be present during discussions with references. The contractor must provide a minimum of three (3) reference accounts at which similar work, both in scope and design, have been completed by The contractor within the last two (2) years. If the contractor has performed work for owner and wishes to list their previous project(s) as a single reference, they may do so.

1.11 PREFERRED NATIONAL DISTRIBUTOR

A. Primary Distributor:

Graybar is our preferred logistics supplier and all material for the project should be purchased through Graybar. The Owner material pricing has been negotiated with Graybar. The Telecommunications Contractor shall be in good credit standing with Graybar before responding to the Request For Quote (RFQ). Bill Maney or Aldo Ambrogio at 201.596.2600.

Secondary Distributor:

As a secondary distribution partner, all material for the project should be purchased through Communication Supply Corporation (CSC). The Owner material pricing has been negotiated with CSC. The Communications Contractor shall be in good credit standing with CSC before responding to the Request For Quote (RFQ). All quotes shall go through Marilyn Mroposki 732.346.1550 x122, mmroposki@gocsc.com.

1.12 DRAWINGS

A. It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the communications contractor in bidding the job. The communications contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.

B. The communications contractor shall verify all dimensions at the site and be responsible for their accuracy.

C. Prior to submitting the bid, the communications contractor shall call to the attention of the engineer any materials or apparatus the communications contractor believes to be inadequate and to any necessary items of work omitted.

PART 2 PRODUCTS

2.1 APPROVED PRODUCTS

A. 4-pair UTP Cable: Superior Essex DataGain Category 6 Cable (Plenum):

B. 4-pair F/UTP Cable: Superior Essex 6T-272-xB ScTP Cable (Plenum):

C. Optical Fiber Cable manufacturer: Superior Essex

D. UTP connector product manufacturer: Ortronics Clarity 6 TracJac

E. F/UTP connector product manufacturer: Ortronics Clarity 6 Shielded TracJack

F. Fiber Optic cabinet product manufacturer: Ortronics FC Series

G. Fiber Optic connectors/splices/couplers: Ortronics Infinium Field-Installable Anaerobic Connectors.

H. Open Rack manufacturer(s): Ortronics, Great Lakes, and Chatsworth Products, Inc. (CPI)

I. Cabinet manufacturer: Ortronics, Great Lakes, and IBM.

J. Patch Panel manufacturer: Ortronics Clarity 6, 24 and/or 48 ports in an angled configuration.

K. Patch Panel manufacturer: Ortronics Clarity Shielded 6, 24 and/or 48 in an angled configuration

L. UTP Patch Cord manufacture: Ortronics Clarity 6

M. F/UTP Patch Cord manufacturer: Ortronics Clarity Shielded 6

N. Cable tray manufacturer: Cablofil all size requirements per construction documents

O. Surface Mount Boxes: Wiremold all size and model requirements per construction documents.

P. Poke Through and Floor Boxes: Wiremold all size and configuration requirements per construction documents.

Note: See applicable sections in this document for detailed information on products required. Legrand is the manufacturer for Ortronics, Cablofil, and Wiremold products.

2.2 WORK AREA OUTLETS

A. Faceplates

1. Shall be Ortronics TracJac 2, 4, or 6 port faceplate to accommodate the Clarity 6 modular jack.

2. Acceptable part numbers:

Part Number	Color	Description
OR-40300548	Fog White	2 port TracJack Faceplate
OR-40300546	Fog White	4 port TracJack Faceplate
OR-40300545	Fog White	6 port TracJack Faceplate
OR-403STJ12	Stainless Steel	2 port TracJack Faceplate
OR-403STJ14	Stainless Steel	4 port TracJack Faceplate
OR-403STJ16	Stainless Steel	6 port TracJack Faceplate

B. Voice / Data Jacks

1. Voice/Data jacks shall be 8-position modular jacks and shall be Category 6 performance as defined by the references in this document including ANSI/TIA/EIA-568-C.2. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.

2. The modular jack shall be the following for a nCompass™ Cat6+ Solution:

Part Number	Color	Description
OR-TJ600	White	Cat-6 jack, 180 deg exit

OR-TJ600-36	Blue	Cat-6 jack, 180 degree exit
OR-TJS600		Shielded Cat-6 jack 180 degree exit
OR-42100002	White	Blanks – Pack of 10

The four port faceplate shall be terminated with white module on the top left and blue module on the top right and blanks in the two bottom openings.

Figure 1.0 (White & Stainless 2 Position Faceplate Layout)

Figure 2.0 (White & Stainless 4 Position Faceplate Layout)

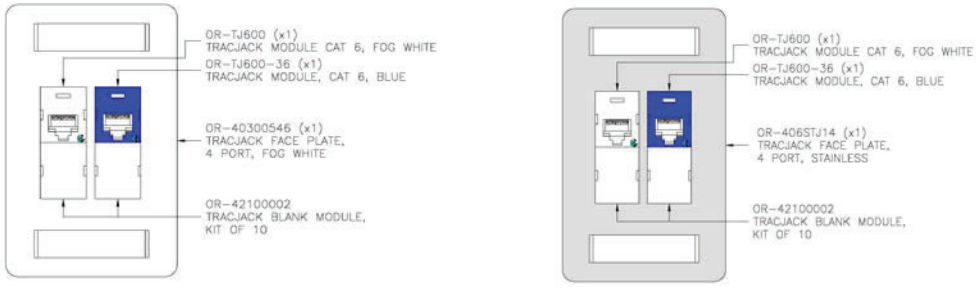
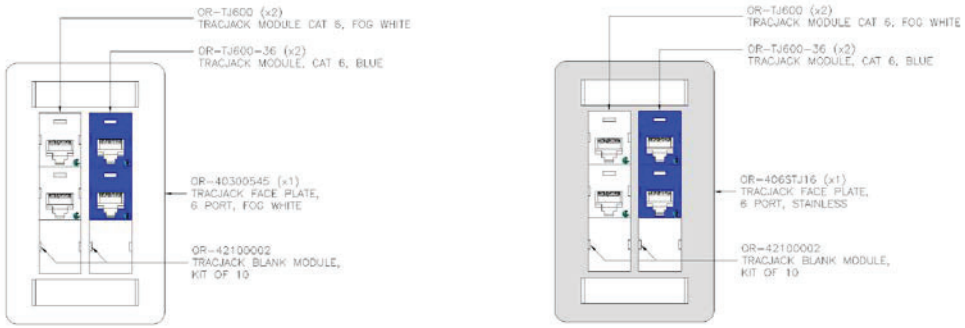


Figure 3.0 (White & Stainless 6 Position Faceplate Layout)



2.3 110 COPPER TERMINATION BLOCK

A. 110 Block Kits

1. Shall include both the wiring block in a 50, 100 and 300 pair footprint and the connecting block C6110C4

2. Approved part numbers:

Part Number	Description
OR-110ABC6050	110 Block Kit: 50-Pair
OR-110ABC6100	110 Block Kit: 100-Pair
OR-110ABC6300	110 Block Kit: 300-Pair

B. 110 Cross-Connect System Backboard Channels Shall

1. Approved part numbers:

Part Number	Description
OR-806003246	110 Wall Mount Backboard Channel, 300-pair
OR-30200132	110 Wall Mount Backboard Channel, 900-pair

C. 110 Wall Mount Vertical Trough Shall

1. Be available in single channel or dual channel configurations.

2. Approved part numbers:

Part Number	Description
OR-806003194	110 Wall Mount Vertical Trough, Single Channel, 300-pair
OR-806003196	110 Wall Mount Vertical Trough, Single Channel, 900-pair
OR-806003197	110 Wall Mount Vertical Trough, Dual Channel, 300-pair
OR-806003199	110 Wall Mount Vertical Trough, Dual Channel, 900-pair

2.4 MODULAR PATCH PANELS

A. The Modular Patch Panels shall

1. Modular patch panel shall be one of the following for a nCompass Cat6+ Solution:

OR-PHA66U24	Angled Clarity 6 Modular 110 Patch Panel, 24-port
OR-PHA66U48	Angled Clarity 6 Modular 110 Patch Panel, 48-port
OR-PHDTKSU24	Shielded Unloaded patch panel 24-port
OR-PHDTKSU48	Shielded Unloaded patch panel 48-port
OR-TKS6A	Shielded tool less Cat6A jack for patch panel

2.5 RACKS & CABINETS

A. RACKS

The equipment rack shall provide vertical cable management and support for the patch cords at the front of the rack and wire management, support, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Racks and wire management shall be black in color to match the patch panels and cable management. All racks and wire management shall be Chatsworth Products, Inc. (CPI) or Ortronics.

1. Free-Standing Rack - Indoor
    a. **Chatsworth 2 post 7’ Rack** – 55053 703
    b. Chatsworth double sided vertical manager – 14831 703
    c. Ladder rack and hardware shall be 12” Chatsworth or Ortronics
    d. **Ortronics 2 post 7’ Rack** – OR-19-84-T2SD
    e. Ortronics double side vertical manager – OR-DVMS0706
2. Overhead Rack System (Data Center)
    a. Mighty Mo Overhead Cable Pathway Rack – OR-60401001

B. CABINETS / ENCLOSURES

All racks and wire management shall be Ortronics, IBM, or Great Lakes specific. The equipment rack shall provide vertical cable management and support for the patch cords

at the front of the rack and wire management, support, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Cabinets shall be black in color to match the patch panels and cable management.

1. Wall Mounted Cabinet - Indoor

    a. **Great Lakes Wall Mount/Swing Out Enclosure** 24H x 24W x 24D Part #GL24WS-PS 11 RU Enclosure w/Glass Door

    b. Great Lakes Fan Assembly w/Guards Part #7217WS. (2) 75 CFM Fans w/Guard

    c. Great Lakes 6 Position RM Power Strip w/Breaker Part #7219 19” RM w/Cord

2. Wall Mount Cabinet (Low Profile)- Indoor

    a. **Great Lakes Wall Mount Low Profile** 36"H x 27"W x 10"D Part # GL36WLP *(GL24WLP for 24”H and GL48WLP for 48”H)*

    b. Great Lakes Single Fan Assembly with fan guard, 75 CFM Part # 7217-04

3. Wall Mounted Cabinet NEMA 12 (Harsh Environment) - Indoor

    a. Great Lakes Wall Mount Enclosure 24H x 24W x 24D Part #GL240N12 12RU, can accept 1 FFKN12-A4 filtered fan pack

    b. Great Lakes Wall Mount Enclosure 36H x 24W x 24D Part #GL360N12 19RU, can accept 2 FFKN12-A4 filtered fan packs

    c. Great Lakes Wall Mount Enclosure 48H x 24W x 24D Part #GL480N12 26RU, can accept 3 FFKN12-A4 filtered fan packs

    d. Filtered Fan Pack, Part #FFKN12-A4

4. Free-Standing Full Cabinet NEMA 12 (Harsh Environment) – Indoor

    a. Great Lakes Enclosure 84H x 24W x 42D Part #GL840N12-2442 45RU, can accept FFKN12-A1 / A2 / A3 filtered fan pack

    b. Filtered Fan Pack, Part #FFKN12-A1 (230CFM)

    c. Filtered Fan Pack, Part #FFKN12-A2 (295CFM)

d. Filtered Fan Pack, Part #FFKN12-A3 (368CFM)

5. Free-Standing Full Cabinet – Indoor

   a. Ortronics GX Series Cabinet 42U Server Cabinet part # OR-GXC422442-A1-B and Network Cabinet part # OR-GXC422942-A1-B

   b. Configurable cabinet available upon request.

6. Enclosures – Special Use

   a. Outdoor enclosure NEMA 3R – Hoffman WEATHERFLO with Fan, Part Series #WFxxLP

   b. Telephone Enclosure (Indoor / Outdoor) NEMA 4 with standard modular wall jack – GAI-Tronics Part #255-001

2.6 HORIZONTAL DISTRIBUTION CABLE

A. 100 OHM Category 6 UNSHIELDED TWISTED PAIR CABLE (UTP)

Category 6+ Horizontal Cable:

B. Superior Essex DataGain® Cable
C. UL listed CMP or CMR as required by installation location
D. Support of sustainable design and installation through
E. Environmental Product Declarations (EPDs) and Health Product Declarations (HPDs) documented via third party
F. Manufactured in a facility that is third party certified as Zero Waste to Landfill
G. Green Circle Multi-Attribute Label qualified per federal mandates
H. Superior Essex Part Numbers:
I. Plenum Rated Blue Cable is 66-240-xB; where x = color
J. Riser Rated Blues Cable is 66-240-2A; where x = color

1. Approved Part Numbers: Superior Essex DataGain UTP (CMP Plenum-PVC Alloy)

Color	Box
White	66-240-4B
Blue	66-240-2B

2.7 HORIZONTAL DISTRIBUTION CABLE (SHIELDED)

A. 100 OHM Category 6 Shielded Twisted Pair F/UTP

B. Superior Essex Cat 6 Shielded Cable

C. UL listed CMP or CMR as required by installation location

D. Support of sustainable design and installation through
E. Environmental Product Declarations (EPDs) and Health Product Declarations (HPDs) documented via third party
F. Manufactured in a facility that is third party certified as Zero Waste to Landfill
G. Green Circle Multi-Attribute Label qualified per federal mandates
H. Superior Essex Part Numbers:
I. Plenum Rated Blue Cable is 6T-272-xB; where x = color
J. Riser Rated Blues Cable is 6T-272-xA; where x = color

Color	Box
White	6T-272-4B
Blue	6T-272-2B

2.8 BACKBONE CABLE

A. Indoor/Outdoor Optical Fiber Non-Conductive Plenum (OFNP) Loose Tube with Laser Enhanced 50/125 Optical Fibers approved Part Numbers base on final design of specific environment:

1. Superior Essex optical fiber cable with TeraFlex Bend Resistant Laser Optimized 50/125

a. Part #-F460-006U30-E991 (6 strands)

b. Part # F460-012U30-E991 (12 strands)

c. Part # F460-024U30-E991 (24 strands)

d. Part # F460-048U30-E991 (48 strands)

B. Optical Fiber NON CONDUCTIVE Plenum (OFNP) Tight Buffered with 10 Gigabit Laser Optimized 50/125 Optical Fibers approved Part Numbers base on final design of specific environment:

1. Superior Essex Premise Distribution fiber optic Cable with TeraFlex Bend Resistant laser optimized 50/125 micron Multimode fiber

a. Part # 44006NG01 (6 strands)

b. Part # 44012NG01 (12 strands)

c. Part # 44024NG01 (24 strands)

d. Part # 44048NG01 (48 strands)

A. Indoor/Outdoor Superior Essex TeraFlex Bend Resistant Laser Optimized 50/125 Loose Tube with Enhanced (Low Water Peak) **Single-mode** Optical Fibers

1. Superior Essex TeraFlex I/O

a. Part # F460-006U10-E991 (6 strands)

b. Part # F460-012U10-E991 (12 strands)

c. Part # F460-024U10-E991 (24 strands)

d. Part # F460-048U10-E991 (48 strands)

2.9 FIBER OPTIC CONNECTOR OPTIONS

A. LC Fiber Optic Connectors shall be utilized for all locations.

1. Be an Ortronics Infinium Field-Installable Anaerobic fiber connector

2. Approved Part Numbers:

Part Number	Description
OR-205KAN9GA-MM	LC, multimode, single pack
OR-205KAN9GB-MM	LC, multimode, 25-pack
OR-205KAN9GA-SM	LC, singlemode, single pack
OR-205KAN9GB-SM	LC, singlemode, 25-pack

B. Contractor shall install LC connectors using termination kits from Ortronics (p/n OR-85400010) and related polishing kits (p/n OR-85400012 for multimode and OR-85400011 for single mode).

C. Fiber patch cabinet Ortronics - FC series

Part Number	Description
OR-FC01U-P	LC, 36 Fibers 1RU
OR-FC02U-P	LC, 72 Fibers 2RU
OR-FC03U-P	LC, 108 Fibers 3RU
OR-FC04U-P	LC, 144 Fibers 4RU

D. Wall mount LIU surface mount fiber cabinet

Part Number	Description
OR-615SMFC-LX-12P	LC, 24 Fibers
OR-615SMFC-24P	LC, 48 Fibers
OR-615SMFC-48P	LC, 96 Fibers

E. For both the fiber patch and wall mount cabinets use LC Connector adapter number OR-OFP-LCD12LC

2.8B Data Center Fiber Optics (pre-terminated)

A. Fiber Optic Cassettes Ortronics M4 Series and Premium Components

Part Number	Description
OR-RFPHD01U	High Density Flush Mounting Rails
OR-M4LCQ24-50EA3A1	M4 High Density Cassette LC quad 24fiber 50mc OM4
OR-TADPLFFUAUA075F	Premium Performance Fiber Optic Trunk cable 50mc OM4
OR-P3DFG1PAZAZ003M	Premium Performance Fiber Patch Cord 50mc OM4

2.10 COPPER CABLE PROTECTION UNITS

A. All copper circuits shall be provided with protection between each building with an entrance cable protector panel. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TC ground point. Approved manufacturers of protection units are Porta Systems, Edco, and ITW. Protection units shall be approved for use with CISCO PoE products.

2.11 PATCH CORDS (COPPER AND FIBER)

A. The contractor shall provide Ortronics factory terminated and tested Category 6 UTP, F/UTP and optical fiber patch cords and equipment cords for the complete cabling system per owner's color requirements. Fiber patch cords shall have color coded boots per owner's color requirements. Other patch cords are not acceptable.

B. Copper (UTP) patch cords:

1. Approved part numbers:

Part Number	Description
OR-MC603-xx	Clarity 6 Modular Patch Cord, 3ft.
OR-MC605-xx	Clarity 6 Modular Patch Cord, 5ft.
OR-MC607-xx	Clarity 6 Modular Patch Cord, 7 ft.
OR-MC610-xx	Clarity 6 Modular Patch Cord, 10 ft.
OR-MC615-xx	Clarity 6 Modular Patch Cord, 15 ft.
OR-MC625-xx	Clarity 6 Modular Patch Cord, 25 ft.

Note: “xx” designates color, where 02=red, 04=yellow, 06=blue, 08=gray, 09=white, 00=black.

C. Copper (F/UTP) Shielded Patch Cords:

1. Approved part numbers:

Part Number	Description
OR-MCS603-xx	Clarity 6 Modular Patch Cord, 3ft. - shielded
OR-MCS605-xx	Clarity 6 Modular Patch Cord, 5ft. - shielded
OR-MCS607-xx	Clarity 6 Modular Patch Cord, 7 ft. - shielded
OR-MCS610-xx	Clarity 6 Modular Patch Cord, 10 ft. - shielded
OR-MCS615-xx	Clarity 6 Modular Patch Cord, 15 ft. - shielded
OR-MCS625-xx	Clarity 6 Modular Patch Cord, 25 ft. - shielded

Note: “xx” designates color, where 02=red, 04=yellow, 06=blue, 08=gray, 09=white, 00=black.

D.Optical Multimode Fiber patch cords shall:

1. Approved part numbers:

Part Number	Description
OR-P1DF2LRGZGZ0xxM	OptiMo Duplex LC-LC, multimode
OR-P1DF2LRFZGZ0xxM	OptiMo Duplex SC-LC, multimode
OR-P1DF2LREZGZ0xxM	OptiMo Duplex ST-LC, multimode

Note: “xx” designates length in meters.

E. Optical SingleMode Fiber patch cords shall:

1. Approved part numbers:

Part Number	Description
OR-P1DC21RSZSZ0xxM	OptiMo Duplex LC-LC, single-mode
OR-P1DC21RRZSZ0xxM	OptiMo Duplex SC-LC, single-mode
OR-P1DC21RQZSZ0xxM	OptiMo Duplex ST-LC, single-mode

Note: “xx” designates length in meters.

Note: The standard boot colors for fiber patch cords are white and black to maintain the correct polarity, which apply to the above part numbers. The required colors for this specification are determined by the Owner. Part numbers will be assigned by Ortronics at time of order.

2.12 BONDING AND GROUNDING

A. All installed products shall be properly grounded and bonded per national electric code

B. Products shall be from Ortronics

2.13 FIRESTOP

A. A fire stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Fire stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.

B. Products shall be Flame Stopper from Wiremold. An example of a UL System to utilize when installing the Flame Stopper is WL-3264.

2.14 POKE-THRU & FLOOR BOXES

A. Poke-Thru and Floor Boxes will be utilized per the construction documents with sizes of 6” or 8” as specified for the Poke-Thru. These will be configured based on the construction and design requirements.

B. Products shall be Poke-Through Devices and/or Floor Boxes from Wiremold

C. Flush mount boxes are preferred

2.15 BASKET TRAY

A. The basket tray shall be basket in nature and colored per the specific design.

B. Products shall be Cablofil

PART 3 EXECUTION

3.1 GENERAL

A. Work Sequence

1. Review of all Contract Documents, including specifications, drawings, appendices, examples pictures and addenda.

2. Review of related electrical and communication drawings for coordination with other trades.

3. Preparation of all pre-construction submittals.

4. Field surveys of all plywood, electrical outlets, conduits, sleeves, and cable tray, provided by others, to be used in the installation of the Communications Cable Plant.

5. Complete installation, testing, and commissioning of all Communications Cable Plant and preparation of progress report submittals.

6. Participation during all move-in phases of the project.

7. Preparation of post-construction submittals including as-built drawings, field test reports, warranty, and closeout documentation.

8. Provide digital pictures of 20% of the Communications Room's, the outlets and 1 picture of the Main Telecommunication Room at completion of job to be compared to appendix drawings.

3.2 DELIVERY, STORAGE, HANDLING AND PROTECTION

A. Delivery and receipt of products shall be at the site described in the Scope Section.

B. Cable shall be stored according to manufacturer's recommendations at a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable shall be stored off site at the contractor's expense.

C. If the communications contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.

D. Installation shall include the delivery, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustments, and all other work whether or not expressly required herein which is necessary to result in complete operational systems.

E. During the installation, and up to the date of final acceptance, the Communication Contractor shall be under obligation to protect his finished and unfinished work against damage and loss. The Telecommunication Contractor shall also be under obligation to protect the finished work of other contractors while the communication installation is underway.

3.3 SAFETY

The Communication Contractor shall comply with all Owner's and the Construction Manager's safety guidelines and regulations and those established for the project. Contractor is required to have an established safety program and is responsible for the safety of his staff. The Contractor will adhere to all Federal, State and Local occupational health and safety regulations applicable to the project.

3.4 GENERAL

A. All cables, connectors, hardware, and equipment that comprise the Communications Cable Plant shall be installed according to ANSI/TIA -569-D Commercial Building Communications Standards and ORTRONICS Clarity® Installation Practices and Owner requirements. The installation must result in a Clarity® Category 6 Certification, which includes a nCompass Warranty.

B. The Telecommunication Contractor shall purchase or otherwise procure installation guides from vendors and become familiar with the installation requirements prior to commencement of the work. Any discrepancies between specifications, drawings, field conditions, and the manufacturers' recommendations shall be brought to the attention of the Construction Manager immediately in writing. The Construction Manager shall forward to the Telecommunication Engineer for review and comment.

C. The plans and specifications indicate the general arrangement and scope of work. To facilitate the installation and coordination with other trades, the Telecommunication Contractor may deviate from this general arrangement so long as the scope does not change. All such changes shall be submitted to Owner prior to implementation. The Telecommunication Engineer must approve the work prior to the implementation of the proposed change. The approved change must be noted on shop drawings.

3.5 CABLING DISTRIBUTION

A. General

1. All cables shall be inspected as they are pulled off the reel for any obvious defects. Report immediately any defects to the Telecommunication Engineer and Owner then halt further use of the cable from that reel, pending a determination of the quality of the reel by the manufacturer.

2. Pulling and laying cable on sharp edges is not permitted.

3. The pulling tension for a 4-pair balanced twisted pair cable shall not exceed 110 N (25 lbf) during installation. For multipair cable, manufacturer’s pulling tension guidelines shall be followed.

4. The Communication Contractor shall not exceed the prescribed maximum pulling tension recommended by the manufacturer.

5. All cables shall be continuous, with no factory or field splices.

6. At no time shall a cable be supported on the fluorescent light fixtures, ceiling tiles, electrical conduits, HVAC ducts, ceiling tiles, or other building system fixtures.

7. All copper circuits shall be provided with protection between each building with an entrance cable protector panel. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the MDF/IDF ground point.

B. Copper Station Cable

1. Install a complement of two (2) Category 6 4 pair-UTP Station cables to each communication outlet location (WLN), unless otherwise indicated on the construction drawings.

2. 10-feet of slack for every modular furniture work station cable bundle shall be coiled and stored in the ceiling above the outlet, provided the 285-foot limit is not exceeded.

3. The copper station cable shall be terminated at the station end into Category 6 jacks. The termination shall be T568B

4. The copper station cable shall be terminated at the MDF or IDF end onto Category 6 568B 24-port or 48-port patch panels. A-Side station cables shall be terminated on the 19-inch rack designated for A-Side station cables and B-Side station cables shall be terminated on the 19-inch rack designated for B-Side station cables as shown on the construction drawings.

5. Cables entering the MDF/IDF shall enter through 4” EMT conduit

6. Each cable shall be uniquely identified on the faceplate and patch panel. Additionally, all station cables shall be labeled at both ends prior to termination. The labels should be typed or machine produced with a label making device. Hand written labels will not be allowed or accepted.

7. When terminating the station cables at the communications outlets and patch panel, untwisting of the pairs shall be kept to a minimum but no greater than a ½ inch.

8. Route the station cable in the cable tray in the ceiling. Where cable tray or conduit is not provided, use j-hooks mounted 4-foot on center with Plenum Hook & Loop ties bundling the cables.

9. UTP cables shall be run a minimum of 5-inches from AC power distribution cable unless in separate steel channels. In the floor a speed bump should be utilized to comply with this requirement of the installation.

C. Work Area

1. Work area cables shall each be terminated at their designated work area location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a front loading TracJack® faceplate.

2. ORTRONICS Clarity® TracJack Category 6 connector modules shall be installed at each workstation outlet with ORTRONICS faceplates and surface mount boxes.

3. The Communications Outlet Assembly shall accommodate:

a. A minimum of two (2) front loading modular jacks

b. Additional accommodations for specific locations as noted in the plans for optical fiber and/or additional copper cables as necessary

c. A blank/filler will be installed when extra ports are not used.

d. Modular Snap-In dust covers (part number OR-20300121) to be used where appropriate.

e. Multiple jacks that are identified in close proximity on the drawings (but not separated by a physical barrier) may be combined in a single assembly. The communications contractor shall be responsible for determining the optimum compliant configuration based on the products proposed.

f. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the communications contractor shall submit the proposed configuration for each outlet assembly for review by the Owner.

g. The modular jack shall incorporate printed label strip on the dust cap module for identifying the outlet.

4. Communications Outlets

a. Install two (2) four (4) or six (6) Category 6 in each faceplate, as shown on Section 2.2.

b. Each jack should be identified with the appropriate label

3.6 MDF/IDF

A. The Telecommunication Contractor is responsible for surveying the work area and coordinating with other trades.

B. Provide and install the termination hardware for a complete cable plant, as shown on the detail drawings, appendix drawings and described in this specification.

C. All termination hardware shall be mounted in the open bay racks, as shown on the construction drawings. Bolt the racks to the floor slab, support from cable tray, and bond to the building structure with the manufactures approved method.

D. Station Cable within the MDF/IDF shall be tie wrapped in bundles of 48 cables (where applicable) using black Plenum Hook & Loop ties. Cables in a particular bundle shall be terminated on the same patch panel.

E. Cable bundles shall route along the overhead cable tray maintaining their bundles of 48 cables (where applicable) until after they leave the MDF/IDF and enter the

distribution pathway system. Cables shall exit the MDF/IDF through designated A-Side and B-Side penetrations.

3.7 WORK AREA OUTLETS

A. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/ -568.1- D, manufacturer's recommendations and best industry practices.

C. Pair untwist at the termination shall be as close to zero as possible and not exceed 12 mm (one-half inch).

D. Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the cable.

E. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.

F. Blue jacks in horizontally oriented faceplates shall occupy the right-most position(s).

G. Blue jacks in vertically oriented faceplates shall occupy the bottom most position(s)

H. Refer to drawings in section 2.2

3.8 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

A. All horizontal data station cable and voice cable shall terminate on modular patch panels (copper or fiber), 110 cross-connecting blocks (copper), or patch/splice cabinets (fiber) in their respective Communications Room or Equipment Room as specified on the drawings.

B. All cables shall be inspected as they are pulled off the reel for any obvious defects. Report immediately any defects to the Telecommunication Engineer and Owner, then halt further use of the cable from that reel, pending a determination of the quality of the reel by the manufacturer

1. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.

2. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

3. Cable raceways shall not be filled greater than the ANSI/TIA -569-D maximum fill for the particular raceway type or 40%.

4. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.

5. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

6. The cable's minimum bend radius and maximum pulling tension shall not be exceeded.

7. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 4-foot on center (1.2 meter) intervals. J-hooks should be staggered in distance to avoid harmonics. At no point shall cable(s) rest on acoustic ceiling grids or panels.

8. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

9. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

10. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.

11. At no time shall a cable be supported on the fluorescent light fixtures, ceiling tiles, electrical conduits, HVAV ducts, ceiling tiles, or other building system fixtures.

12. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.

13. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA/ -606-B. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

14. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.

15. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.

16. The ultimate breaking strength of the completed cable, measured in accordance with ASTM D 4565 (Ref B135), shall be 90 lbs minimum. The maximum pulling tension shall not exceed 40 lbs to avoid stretching the conductors.

3.9 HORIZONTAL CROSS CONNECT INSTALLATION

The voice cross connect shall be a passive connection between the horizontal termination blocks and the backbone termination blocks. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designation strips. Management rings shall be mounted between vertical columns of blocks to provide management of cross-connect wire. Backbone and horizontal blocks shall use 4-pair connecting blocks. Blocks shall be oriented so that backbone terminations are located on the left and horizontal frames are located on the right of the termination field when facing the frame assembly.

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA -568latest standard, manufacturer's recommendations and best industry practices.

B. Pair untwist at the termination shall not exceed 12 mm (0.5 inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. The cable jacket shall be maintained as close as possible to the termination point.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.10 OPTICAL FIBER TERMINATION HARDWARE

A. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

C. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

D. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

E. A maximum of 12 strands of fiber shall be spliced in each tray

F. All spare strands shall be terminated

G. Unused terminated connectors shall be capped

3.11 BACKBONE CABLE INSTALLATION

A. Backbone cables shall be installed separately from horizontal distribution cables

B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

C. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.

D. Where backbone cables are installed in an air return plenum, riser rated cable shall be installed in metallic conduit.

E. Where backbone cables and distribution cables are installed in a cable tray or wire way, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

F. All backbone cables shall be securely fastened to the sidewall of the IDF on each floor.

G. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.

H. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.

I. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

3.12 COPPER TERMINATION HARDWARE

A. Cables shall be dressed and terminated in accordance with the recommendations made in the most current ANSI/TIA -568 standard, manufacturer's recommendations and best industry practice.

B. Pair untwist at the termination shall be kept to a minimum but not exceed 12 mm (one-half inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.13 RACKS / CABINETS

A. Racks shall be securely attached to the floor using minimum 3/8” hardware and/or as required by local codes.

B. Racks shall be placed with a minimum of 36inch clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.

C. All racks shall be grounded to the communications ground bus bar in accordance with Section 3.15 of this document.

D. Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

E. Wall mounted termination block fields shall be mounted on 4’ x 8’ x .75” void free plywood. The plywood shall be mounted vertically 12” above the finished floor. The plywood shall be painted with two coats of white fire retardant paint.

F. Wall mounted termination block fields shall be installed with the lowest edge of the mounting frame 18” from the finished floor.

3.14 FIRESTOP SYSTEM

A. All fire stop systems shall be installed in accordance with the manufacturer’s recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

B. A fire stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Fire stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.

C. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped.

D. Fire stop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed. A drawing showing the proposed fire stop system, stamped/embossed by the PE shall be provided to the Owner's Technical Representative prior to installing the fire stop system(s).

3.15 BONDING SYSTEM

A. The TBB shall be designed and/or approved by a qualified PE, licensed in the state that the work is to be performed. The TBB shall adhere to the recommendations of the ANSI/TIA -607-C standard, and shall be installed in accordance with best industry practice.

B. Installation and termination of the main bonding conductor to the building service entrance ground shall be performed by a licensed electrical contractor.

C. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all communications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA -607-C Communications Bonding and Grounding Standard.

D. The main entrance facility/equipment room in each building shall be equipped with aPrimary Bonding Busbar (PBB). Each communications room shall be provided with aSecondary Bonding Busbar (SBB). The PBBshall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between communications equipment and the electrical system to which it is attached.

E. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the MDF/IDF shall be bondedto the respective SBB or PBB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

F. All wires used for communications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.

3.16 IDENTIFICATION AND LABELING

A. The contractor shall develop and submit for approval a labeling system for the cable installation if the required labeling scheme is not detailed in the design drawings or appendices, the Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. Labeling shall follow the guidelines of ANSI/TIA-606-B.

B. All label printing will be machine generated by an approved label equipment manufacturer.

C. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

D. Labeling schema shall follow:

1. MDF name should include floor number, for example MDF01 (MDF_{floor})

2. IDF name should include floor number and unit number, for example IDF01-01 ($IDF_{floor\ -\ unit}$)

3. MDF/IDF To End Station (aka Horizontal Cabling)

    a. MDF/IDF Jack Labels (A-Side) A001-999 / (B Side) B001-999

    b. Station Jack Labels (1^{st} Jack) IDF01-01-A001 - 999 / (2^{nd} Jack) IDF01-01-B001 - 999

4. MDF To IDF(s) (aka Vertical Cabling)

    a. MDF Jack Labels IDF01-01-001

    b. IDF Jack Labels MDF01-001

3.17 TESTING AND ACCEPTANCE

A. General Procedures

1. All testing shall be performed to the satisfaction of ORTRONICS and Superior Essex so the required nCompass Limited Lifetime Warranty can be extended to American Water.

2. All testing shall be performed in accordance with Ortronics recommended testing guidelines and procedures.

3. Cable testing shall be performed on 100% of all installed cable infrastructure.

4. Test results of (pass*) are not acceptable.

5. The results of all test and analyses shall be kept on file and provided to Owner at completion of the project.

B. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of the most current revision of ANSI/TIA -568 series standard. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

C. All cables shall be tested in accordance with this document, the ANSI/TIA standards, the Ortronics Certified Technician Installation Field Guide and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

3.18 APPROVED TESTING EQUIPMENT

A. UTP Testing Equipment

a. Fluke DSX5000, DSX8000 or DTX1800 certified tester approved by Ortronics for Category 6 Link and Channel Testing using the tester's manufacturer approved patch cords and connectors only.

B. Fiber Optic Testing Equipment

b. Fluke Versiv Certifiber Pro or DSX5000 certified tester approved by Ortronics for Fiber Optic Cable Testing.

C. Copper Channel Testing

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level

III test unit for Category 6 performance compliance as specified in the most current revision of ANSI/TIA -568 standards.

2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the most current ANSI/TIA -568 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

4. Category 6 Performance Test

    a. Follow the Standards requirements established in ANSI/TIA/EIA-568.1-D

    b. A Level IV test unit is required to verify category 6 performances.

    c. The basic tests required are:

        i. Wire Map

        ii. Length

        iii. Attenuation

        iv. NEXT (Near end crosstalk)

        v. Return Loss

        vi. ELFEXT Loss

        vii. Propagation Delay

        viii. Delay skew

        ix. PSNEXT (Power sum near-end crosstalk loss)

        x. PSELFEXT (Power sum equal level far-end crosstalk loss)

d. Attenuation

i. All cable pairs to be tested for signal attenuation must pass the tests

ii. Attenuation shall be measured in dB/100 m

iii. Record the Worst Pair Attenuation of a cable

iv. Near End Cross Talk (NEXT), Equal Level Far End Cross Talk (ELFEXT), Power Sum NEXT and Power Sum ELFEXT

v. All cable pairs to be tested for NEXT and ELFEXT must pass the tests

vi. NEXT, ELFEXT, power sum NEXT and power sum ELFEXT shall be measured in dB

vii. Record the readings for each measurement between

- Pair 1 and Pair 2
- Pair 1 and Pair 3
- Pair 1 and Pair 4
- Pair 2 and Pair 3
- Pair 2 and Pair 4
- Pair 3 and Pair 4

viii. Record the Worst pair of every measurement for each cable

e. Return Loss

a) All cable pairs to be tested for Return Loss must pass the tests

b) Values shall be measured in dB

c) Record the Return Loss of a cable

d) The Worst Pair ACR and Return Loss shall not exceed the values specified by the cable manufacturer and TIA/EIA-568-C Standard

f. Propagation Delay and Delay Skew

a) All cable pairs to be tested for Delay must pass the tests

b) Delay shall be measured in ns/100 m.

c) The Propagation Delay and Delay Skew shall not exceed the values specified by the cable manufacturer

D. Fiber Testing

1. All fiber testing shall be performed on all fibers in the completed end to end system. There shall be no splices unless clearly defined in an RFP. Testing shall consist of an end to end power meter test performed per EIA/TIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers. These tests also include continuity checking of each fiber.

2. Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for single mode) in both directions.

3. Test set-up and performance shall be conducted in accordance with ANSI /TIA-526-14 Standard, Method B. A one jumper test method is preferred.

4. Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. Only link test is required. The contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA Standard.

3.19 POST-INSTALLATION TESTING

A. The Communication Contractor shall be responsible for testing and troubleshooting every fiber optic strand of every installed and terminated fiber optic cable.

B. Testing Procedures

1. Perform and end-to-end, bi-directional power loss tests at 850 nm and 1300 wavelengths for MulitiMode Fiber with an optical loss test set.

2. The cable runs should meet the optical transmission performance for both cables and connectors, specified by the cable manufacturer for cables and connectors respectively.

3. For those fiber strands of a cable run that exceed the specified maximum power loss, re-test by using an OTDR. By reading the OTDR trace, determine whether it is the fiber strand or the connector that exceeds the power loss margin.

4. If the fiber strands exceed the specified loss budget, then re-pull the fiber optic cable containing the fiber strand at fault and repeat the testing procedures above.

5. Record and document all power loss readings in relative decibels (dB). Indicate as part of the testing documentation those runs that exceeded the power loss margins and the action taken.

3.20 SYSTEM DOCUMENTATION

A. Upon completion of the installation, the communications contractor shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.

B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor). This is inclusive of all test result and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. Communications contractor shall provide copies of the original test results.

C. The Engineer may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the communications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.21 TEST RESULTS

A. Test documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation”, the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

B. The field test equipment shall meet the requirements of the most current ANSI/TIA - 568 series including applicable TSB’s and amendments. The appropriate Level IV tester shall be used to verify Category 6 cabling systems.

C. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. The communications contractor must furnish this information in electronic form on a CD-ROM.

D. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.22 AS-BUILT DRAWINGS

A. The drawings are to include outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD) formats on which as-built construction information can be added. These documents will be modified accordingly by the communications contractor to denote as-built information as defined above and returned to the American Water.

B. The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD)

PART 4 WARRANTY AND SERVICES

4.1 WARRANTY

A. The nCompass Warranty provides the warranty directly to American Water.

B. A Limited Lifetime Premium Warranty shall be provided to include the backbone and the entire channel provided that Ortronics patch cords are utilized. The warranty shall cover the system to perform to the specifications listed in the nCompass data sheets in effect at the start of the installation. The Limited Lifetime Warranty will be in effect for the expected usable life of the building which shall not exceed forty (40) years. The contractor shall provide a 1-year warranty on the physical installation.

4.2 CONTINUING MAINTENANCE

A. Moves-Adds-Changes (MACs) shall be performed by an Ortronics CIP-ESP Contractor and shall be added to the nCompass warranty when registered with Ortronics.

4.3 FINAL ACCEPTANCE & SYSTEM CERTIFICATION

Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two-week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate, from Ortronics, registering the installation.

APPENDIX A – CIP-ESP Protocols

CIP-ESP National Network Protocols for Providing Replicated Support and Value:

The CIP-ESP program is designed to offer end-users seamless installation coverage on a national basis. End-users with multiple locations have traditionally had the burden of managing each and every location as unique, one-time projects. This is largely because channel partners have often placed the burden on the customer. There are very few national contractors; distributors operate as individual locations; and manufacturers pay their sales people on point of sale, which has the unwanted effect of making the local sales person unresponsive to the national needs of a customer.

The Ortronics ESP program addresses every one of these issues by offering solutions created to enhance the value of all three components of the channel. For national installation coverage, the CIP-ESP network addresses national opportunities by coordinating a team of the best contractors in the industry, dedicated to the replication of the customer's standard design and product choice. The network offers the customer value by reducing project management responsibilities, improving on-time completion of installations, simultaneously providing multiple installations to multiple regions, and providing the value that comes from having all locations standardized and protected by the nCompass warranty. In order for the CIP-ESP network to be able to meet these goals, certain protocols must be followed and supported. These protocols have been created with one thing in mind: the members of the network understand that these protocols are in place to provide better support for the end-users' needs, and by working as team, are able to follow the customer's standards and specifications and operate as one entity, in a coordinated fashion.

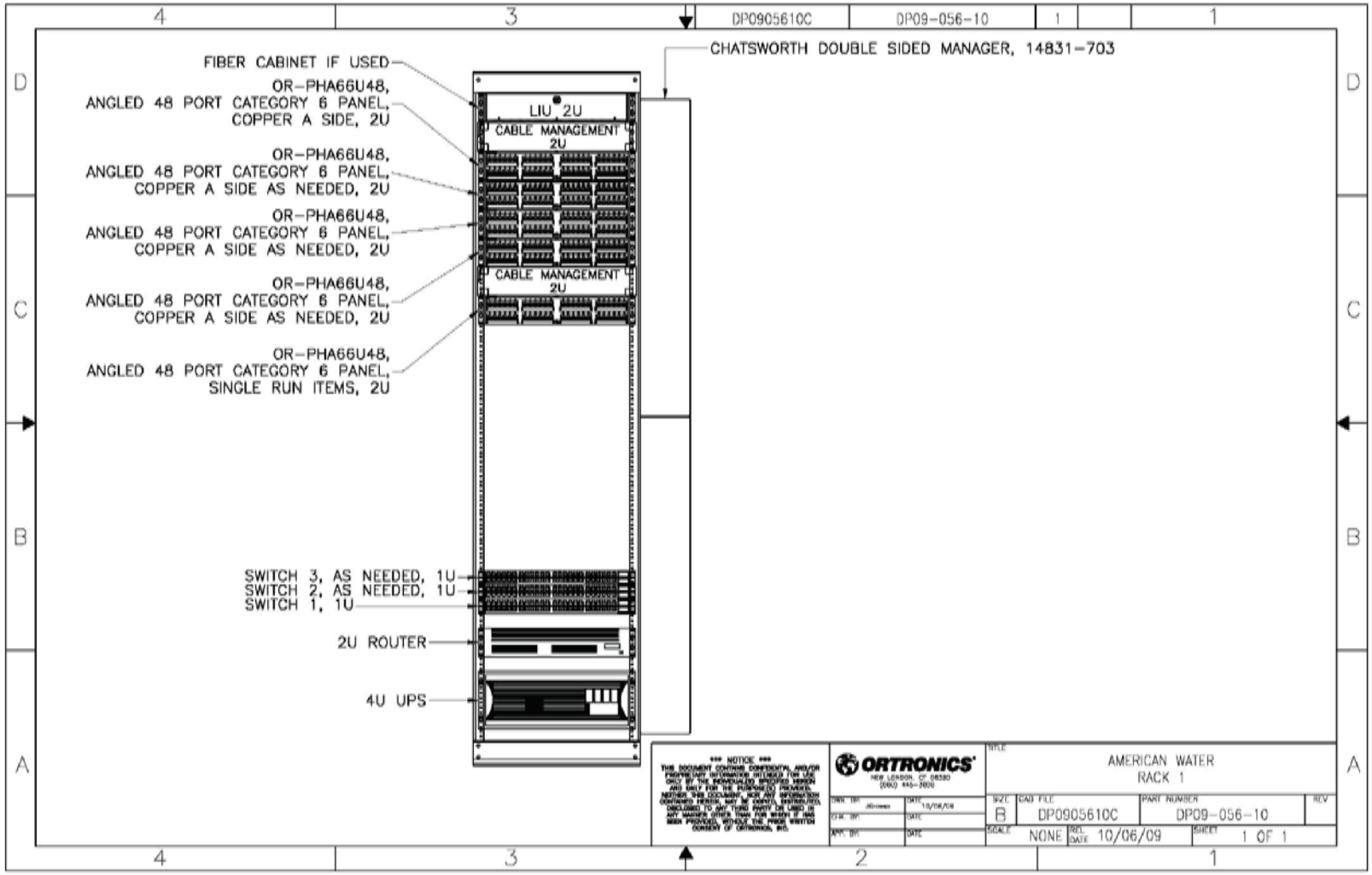
Every member of the CIP-ESP network must commit to the following list of protocols:

- ✓ Precisely replicate the customer's standard design, product choices and communication protocols
- ✓ Work closely with the distributor of choice in order to minimize lead time issues and to work seamlessly with the customer's logistics partner
- ✓ Handle all channel disputes internally and never put the end-user in the middle of channel conflict
- ✓ Constantly search for improved process opportunities Fully understand the value of the ESP program in order to serve as an extension of the Ortronics sales team.

AMERICAN WATER

APPENDIX B – RACK ELEVATION DRAWINGS

Sample Rack Elevation – 1 rack space



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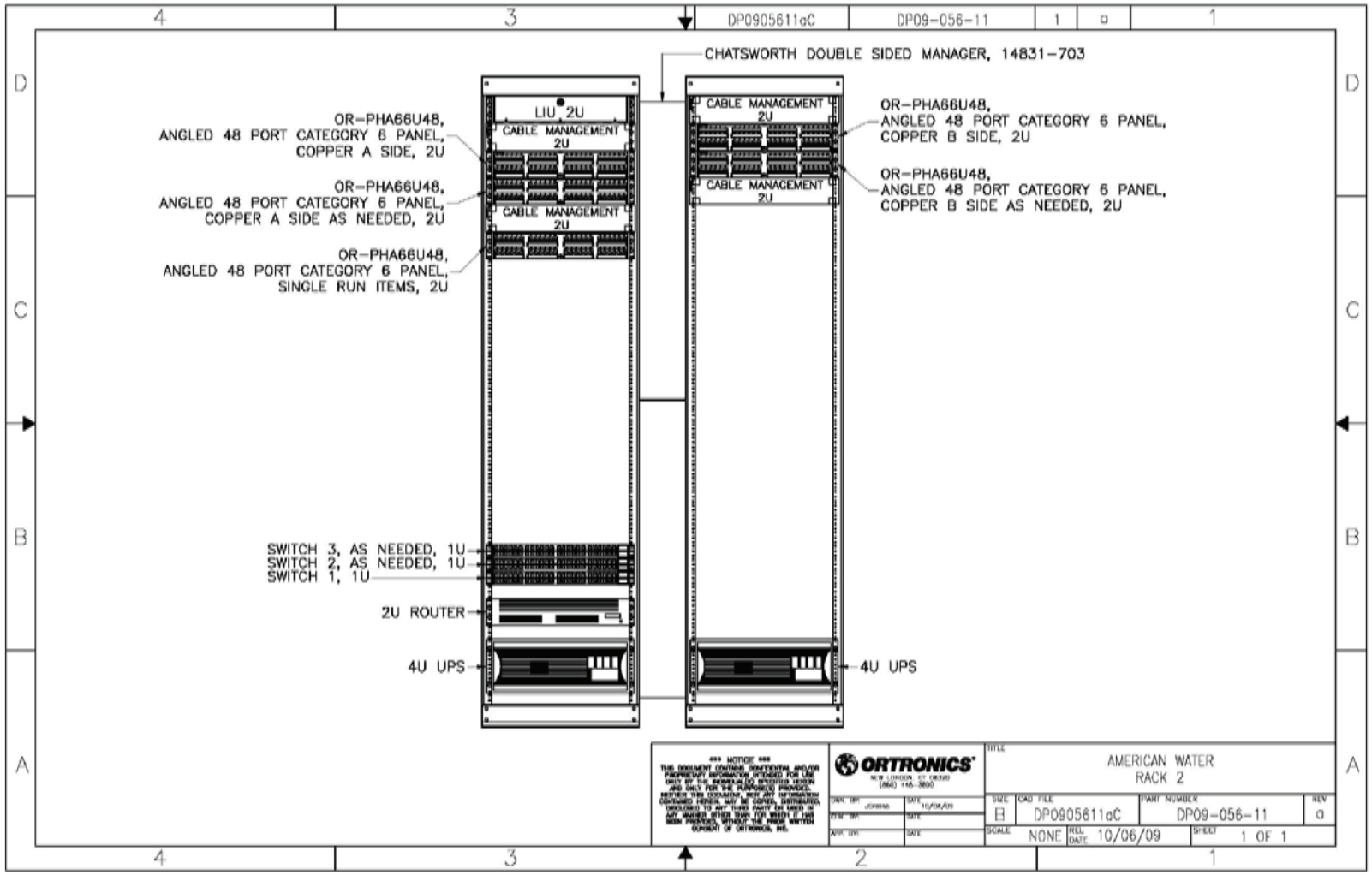
Sample Rack Elevation – 2 rack space



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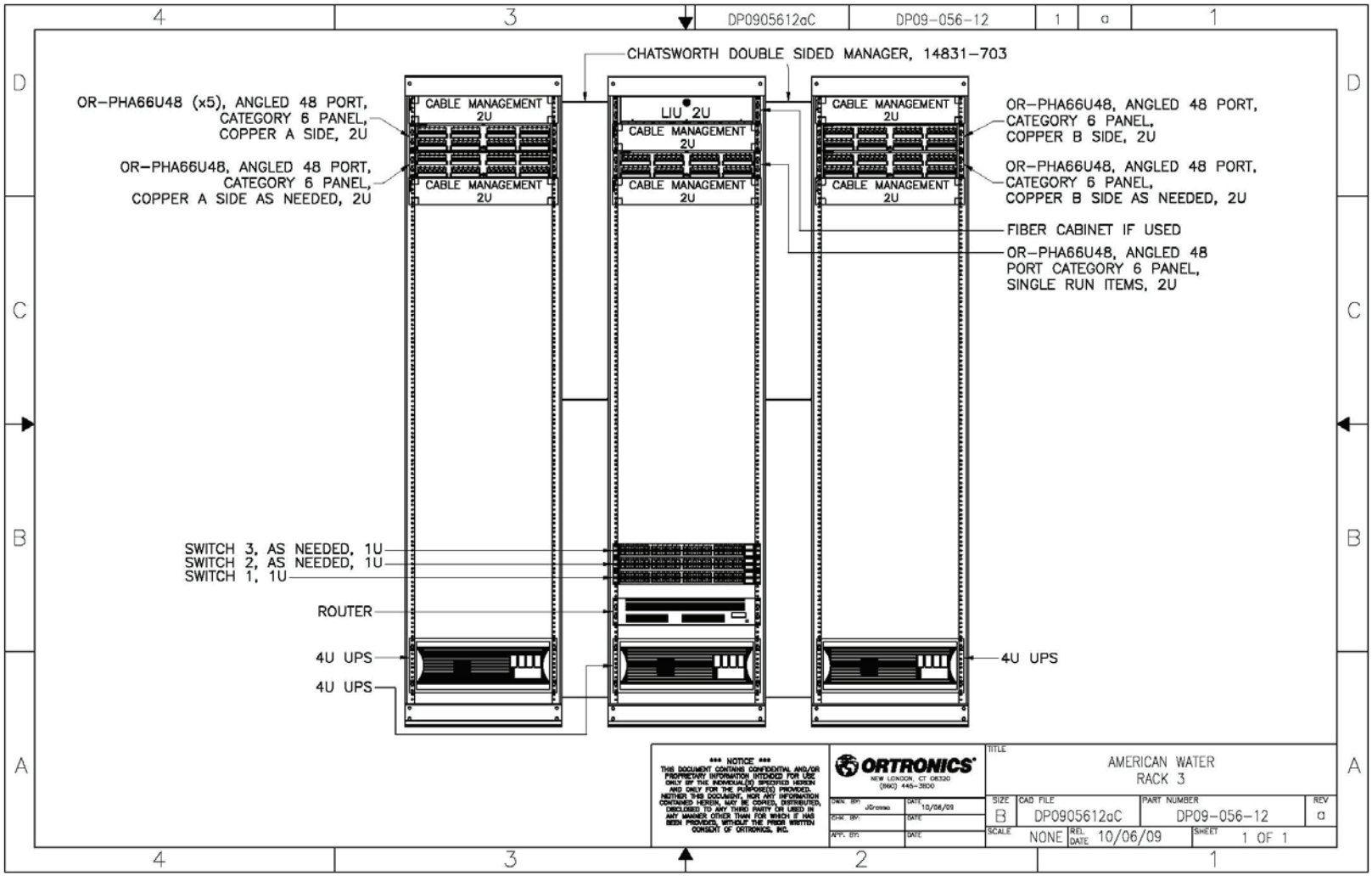
Sample Rack Elevation – 3 rack space



Sample Rack Elevation – Wall Mount Cabinet

APPENDIX C – COLOR CODING

Copper Patch Cords

Red	SCADA
Yellow	IT Workstation / IP Phone / Printer
Blue	IT Servers
Grey	Special
White	IT Network Infrastructure
Black	Security
Orange	Audio/Video

Fiber Patch Boot

Red	SCADA
White	IT
Black	Security