



TELLUS WAREHOUSE EXPANSION PROJECT

ELECTRICAL, INSTRUMENTATION & CONTROLS INSTALLATION - DETAILED SCOPE OF WORK

SUMMARY

Work to be performed under this Contract is shown on the drawings and specifications listed in this document and as described herein. In general, the Work includes, but is not limited to, Project Management, Supervision, shop and field labor, fabrication, materials, equipment, safety management, transportation, tools, consumables, insurances, and other services required to provide Installation services plus all other work described herein for the Tellus Warehouse Expansion Project in Belle Glade, Florida. The following is not intended to be a comprehensive listing of the work, nor is it intended to indicate or limit the methods or resources necessary to satisfy the requirements of the work, but is further defined as follows.

WORK INCLUDED BY CONTRACTOR:

Note: The scope description herein shall take precedence over any other scope descriptions on drawings or specifications.

I. Electrical Demolition

In general, the Work includes, but is not limited to, Project Management, Supervision, safety management, transportation, tools, equipment, consumables, insurances, and other services required to provide demolition services and disposal of equipment and materials off-site for the Tellus Warehouse Expansion Project in Belle Glade, Florida. The following is not intended to be a comprehensive listing of the work, nor is it intended to indicate or limit the methods or resources necessary to satisfy the requirements of the work, but is further defined as follows.

A. Existing gate, controls, and light pole

- Existing swing gate (location referenced in TEL2305-CV-DWG-0100) to be relocated by others to new location indicated in TEL2305-CV-DWG-0200. Existing cables are routed underground from the west side of the road to the equipment. Gate pivot will change from east to west side of road. Keypad will move from entering vehicle passenger side to driver side on west side of road.

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2. Existing wires will be coiled and stored cleanly and safely until gate and keypad are relocated and ready to be reconnected by Others during Early Civil Works. Contractor will be responsible for reconnecting gate prior to completion of construction.

II. Electrical, Instrumentation & Controls Installation

Furnish all materials, labor, supervision and tools necessary to install complete electrical systems in good operating order and in accordance with the specifications, the drawings, and the other contract documents. Items not specifically shown on the drawings or mentioned in the specifications, but essential to the proper completion of the work, shall be furnished and installed.

General Scope of Work is as follows:

- A. Contractor to supply and install all wiring and raceway referenced on Cable Schedule, Elementaries, and Sketches. Refer to cable schedule TEL2305-EL-SCH-0002.
- B. Contractor to coordinate all activities with Mechanical/Piping trades prior to starting work to ensure proper sequencing and avoid clashes with new installation.
- C. New Warehouse Grounding Plan (TEL2305-EL-PLN-003)
 - a. Provide and Install copper ground wire around perimeter of warehouse.
 - b. Tie new ground wire into existing building grounding ring.
 - c. Tie new ground ring into rebar.
- D. Modify Existing Substation MB-USS4 in Molding Building electrical room on second floor electrical equipment platform A 1-201.

- a. Existing 400A spare breaker to be utilized to feed power to new warehouse panel WH-PP1 per single line diagram 500-1606-004 revision 4.
- b. Run of 3/C #500 IAC to be terminated at breaker during cold outage and routed from electrical room in existing cable tray and left until new warehouse is dried-in. Temporarily support beyond existing tray. Contractor to include 600 linear feet of 3/C #500 IAC to be confirmed upon finalization of existing tray routing. Cable to remain locked out by owner until terminated in new panel WH-PP1.
- c. Provide and install 4" channel beyond existing cable tray and route to new warehouse above panel WH-PP1. Maintain same height as existing cable tray. Contractor to include 150 linear feet of 4" channel to be confirmed upon finalization of new tray routing.
- d. Substation is to be de-energized during cold outage during plant outage tentatively scheduled from December 23rd, 2023 to January 2nd, 2024.
- E. New Warehouse Power Plan (TEL2305-EL-PLN-0001)
 - a. Provide and install 480V / 600A panel board (WH-PP1) including breakers detailed in panel schedule (TEL2305-EL-SCH-0001).
 - b. Provide and install 480V-208/120V transformer (WHX-0001).
 - c. Provide and install 208/120V / 125A panel board (WH-PP2) including breakers detailed in panel schedule (TEL2305-EL-SCH-0001).
 - d. Provide and Install lighting controller (WHLC-0001).
 - e. Provide and install two 60A welding receptacles.
 - f. Install owner furnished forklift charging receptacles.
 - g. Supply and install six (6) starters with disconnects at each supply fan. Terminate fan motors.
 - h. Provide cable and terminate office split air conditioning unit.
 - i. Provide and Install disconnect at each rollup door (two total).
 - j. Provide cable and terminate two (2) rollup door motors and two (2) air curtains.
 - k. Provide cable and terminate owner furnished dock equipment (levelers, locks, doors, etc.)
- F. New Warehouse Lighting and Receptacle Plan (TEL2305-EL-PLN-0002)
 - a. Provide and install all lights and receptables shown.
- G. New Warehouse Lightning Protection Plan (TEL2305-EL-PLN-0004)
 - a. Provide and install all air terminals and aluminum cable shown.
- H. Approximate cable lengths have not been included in the Cable Schedule. Cable and raceway will be field routed in accordance with standard industry practices. Care shall be taken to avoid interfering with existing personnel/equipment access, obstructions, etc. All routings to be confirmed with Owner's Representative prior to installation.

III. Materials of Construction

- A. Conduit
 - a. Rigid steel conduit shall be of mild steel piping with a uniform protective coating of hot-dipped galvanizing inside and outside, including all threads. The conduit shall be furnished in nominal 10 foot lengths, with both ends threaded and one coupling (galvanized inside and out) applied to each stick. The threads opposite the coupling end shall be protected by a plastic cap.

- b. Intermediate metal conduit shall not be used without permission from Owner. Provide pricing basis in bid submittal.
- c. Plastic coated flexible conduit shall be constructed with a flexible core of galvanized steel and an overall PVC jacket to form a liquid-tight raceway. The overall jacket shall be wrinkle-free and suitable for use in temperatures from -40°C to +100°C. Flexible conduit shall be "Sealtite" type UA or a product of equal construction.
- d. Plastic conduit shall be heavy wall Schedule 40 tubing of polyvinyl chloride, furnished in 10 or 20-foot lengths, with one coupling applied to each stick.
- e. Conduit Fittings
 - i. Bushings. Insulated bushings for conduit sizes 1½ inches and larger shall have metal bodies and threads with molded-on high impact phenolic thermosetting insulation to prevent conductor insulation damage. The metal body shall be of the same material as the conduit to which it is attached. Insulated bushings for conduit sizes 1 inch and smaller may be of plastic.
 - ii. Insulated grounding bushings shall be similar to the insulated bushings described above, except they shall have set screws to lock the bushings on the conduits and shall have mechanical type lugs attached. Lugs shall be sized to accept the ground wire sizes as set forth in the latest edition of the National Electrical Code, but in no case smaller than No. 8 AWG wire.
 - iii. Male bushings shall be insulated throat chase nipples. Bushings used only to pass conductors through metal partitions shall have an insulated throat chase nipple and an insulated bushing.
- f. Condulets
 - i. Condulets for use with steel conduit may be of galvanized or cadmium-plated cast iron. All conduit fittings shall be provided with neoprene gaskets and sheet metal covers. Cover screws shall be captive. All conduit fittings shall be Crouse Hinds Form 8 or Mark 9, or a product of equal construction. Condulets installed in hazardous areas shall be rated for the area classification of the area.
- g. Hubs
 - i. Watertight conduit connections are required on all electrical equipment located outside or in process areas. Where hubs or watertight threaded connections are not provided as a part of the enclosure and are required, watertight hubs shall be installed. Watertight hubs shall be Myers "Scru tite," or a product of equal construction.
- h. Junction Boxes
 - i. Junction boxes shall be of code gage metal with continuously welded joints or of cast metal as called for on the drawings. All junction boxes shall have gasketed screw covers. Sheet steel boxes shall be galvanized after fabrication. Screws for galvanized steel box covers shall be made of stainless steel or brass.
- i. Pull Fittings
 - i. Type "LB," "C" and "TB" conduit fittings may be used as pull fittings on individual conduits, where the conductor size does not exceed No. 2 AWG for

600-volt insulation. Pull boxes shall be sized in accordance with the requirements of the latest edition of the National Electrical Code.

j. Expansion Joint Fittings

- i. All expansion joint fittings shall be of the same metal as the conduit involved. All expansion joint fittings shall be furnished complete with bonding jumpers.

k. Conduit Unions

- i. Where conduit unions are required in a run, Thomas and Betts Corporation, Erickson couplings may be used, or a product of equal construction, except that unions in outdoor conduits or in conduits in wet areas shall be watertight.

B. Wire and Cable

- a. Standards. All wire and cable shall be designed, constructed, and tested in accordance with the current standards of the American National Standards Institute (ANSI); the Institute of Electrical and Electronics Engineers (IEEE); the Insulated Cable Engineers Association (ICEA); and Underwriters' Laboratories, Inc. (UL), as applicable.
- b. General. All wire and cable furnished by the Contractor shall comply with the Cable List and Specifications. All cables shall be marked and listed for cable tray installation.
 - i. The conductors of all control and signal cables shall have ICEA Class B stranding and shall be protected by a tin or alloy coating. Tinned or coated cables shall comply with ASTM Specification No. B 33.
 - ii. All grounding conductors shall be stranded copper, and when insulated, shall have GREEN-colored insulation.
 - iii. Each cable and conductor shall be plainly marked to indicate the manufacturer's name and trade name, the maximum rated voltage, the NEC insulation type, the conductor size, and the name or label of an independent testing laboratory or agency which has identified the cable as being suitable for its intended use.
 - iv. All cable shall be new and of recent manufacture. In no case shall cable be more than six (6) months old.

C. Cable Fittings

- a. All armored cable fittings used in outdoor or process areas shall be watertight types and shall be completely sealed with heavy-wall cable sleeves after installation.

IV. Installation

A. Raceway Installation

- a. General. Conduit shall be installed so that they are mechanically secure, electrically continuous, and neat in appearance. The interiors of conduit shall be clean, smooth raceways through which conductors may be drawn without damage to the insulation. All threaded connections shall be wrench-tight.
- b. The minimum size raceway shall be ¾ inch trade size, except that ½ inch conduit may be used for lighting fixture stems.
- c. Conduit shall not be stored directly on the ground or in any other place where dirt is likely to enter it. After conduit is installed and before the wires are drawn in, its ends

shall be plugged, capped or protected in some other way against the intrusion of foreign matter.

- d. Conduit shall be cut off square with a power saw or a rotary-type conduit cutter designed to leave a flat conduit face. Pipe cutters shall not be used for cutting conduit. The cut ends of conduit shall be reamed with a reamer designed for the purpose to eliminate all rough edges. Threads shall be cut with standard conduit dies providing $\frac{1}{4}$ inch taper per foot and shall be of the proper length so that joints and terminals may be made up tight and the ends of the conduit not deformed. Dies shall be kept sharp and a good quality threading oil used continuously during the threading operation. Metal cuttings and oil shall be removed from the conduit ends after the threads are cut and threads shall be painted before connections are made. Zinc-rich epoxy primer shall be used on the threads of steel conduit. A lubricant recommended by the conduit manufacturer shall be applied to aluminum conduit threads.
- e. Strap wrenches only shall be used to tighten joints in plastic-coated rigid steel conduit. All damage to the plastic coating, such as cuts, nicks and threader chuck jaw marks shall be carefully repaired using the conduit manufacturer's recommended patching material. A solvent, or the same patching material, shall be used to seal around the edges of conduit fitting covers.
- f. All bends in conduit 2 inches and smaller may be made in the field using manual or power tools designed for the purpose, except PVC coated conduit systems shall utilize manufactured elbows. Changes in direction of conduit shall be made in elbows or fittings, if the conductors are smaller than No. 1 AWG.
- g. Trapped runs of conduit shall be avoided, if possible. When they are necessary, they shall be drained using a "tee" conduit equipped with a drain. Conduit passing through areas where there is likely to be a temperature differential of 20°F or more shall be sealed with a proper seal fitting at the wall or barrier between such areas.
- h. All conduit crossing building or structure expansion joints shall be fitted with approved expansion fittings, except that fittings will not be required when conduit crossing an expansion joint is supported on trapeze hangers in such a way that at no time will the conduit be under stress due to building expansion or contraction. Bonding jumpers shall be installed around all expansion joint fittings.
- i. All conduit terminating in sheet metal boxes where no threaded hubs are provided shall be fitted with double locknuts and bushings. Flexible metallic conduit shall be provided where called for on the drawings; where necessary to allow for movement; or to localize sound or vibration, at transformers, at motors and any other rotating equipment.
- j. Conduit routing, where not detailed and/or dimensioned on the drawings, shall be determined by the Contractor. Final and exact routing of conduit even when dimensioned on the drawings shall be determined by a field check of the proposed conduit routing before installation of the run is started. Exposed conduit shall be run perpendicular or parallel to the main structural components of the building. Concealed conduit shall follow the most direct practical route from outlet to outlet, unless specifically indicated otherwise on the drawings.

- k. A polypropylene pull cord shall be left in each empty conduit to facilitate the future installation of conductors by others.
 - l. Seal all openings or holes where conduits pass through walls or floors. When passing through a fire wall or floor, the seal shall be fire-rated per the drawing details.
 - m. Only hot dipped galvanized rigid steel or PVC conduits may be installed in concrete or underground. Conduits installed in slabs shall occupy the middle third of the slab and shall have a space not less than 3 times the nominal diameter of the larger conduit between parallel runs of conduit.
 - n. Conduits turning up from a concrete slab shall terminate in couplings, with their top ends set flush with the concrete. Where they turn up into permanent walls or partitions, the couplings may be omitted and the conduit runs need not be interrupted at floor level. A stick of conduit shall be screwed into each coupling and maintained in the vertical position until the concrete has hardened. After the concrete has set, they shall be removed and the couplings plugged with screw type pipe plugs.
 - o. Raceway Supports. Parallel runs of conduit may be supported by structural steel racks or prefabricated structural systems. When two or more racks are arranged one above the other, vertical separation of not less than 12 inches shall be provided between racks unless otherwise indicated on the drawings.
 - p. All miscellaneous iron used for conduit racks, all hanger rods, conduit clamps, beam clamps, nuts, bolts, etc. shall be hot-dip galvanized. Where it is necessary to cut or drill galvanized metal, it shall be given one zinc rich epoxy primer coat before installation.
 - q. Use prefabricated structural systems such as Kindorf, Powerstrut, Unistrut, or a product of equal construction, for support of raceways. Welding is not permitted.
 - r. The Contractor shall be fully responsible for the proper sizing and assembling of support systems to adequately and rigidly support raceways and/or equipment mounted thereon with a safety factor of at least three.
 - s. Conduit sizes two inches and larger shall be supported at spacings not exceeding 10 feet and conduit sizes 1½ inches and smaller shall be supported at spacings not exceeding 8 feet.
 - t. Pliers, channel lock or otherwise, shall not be used to tighten nuts, bolts or screws. All nuts bearing on metal shall be locknuts or have lock-washers.
- B. Cable Tray Installation
- a. In general, all cable tray will be made of aluminum.
 - b. Furnish and install all cable tray supports and miscellaneous fittings required. Cable trays and their fittings shall be constructed, installed and supported in accordance with NEMA Standards Publications VE 2 for metal cable trays or FG-1 for fiberglass trays. When cable trays are installed one above the other, the bend radius of all trays so installed shall be the same.
 - c. When it is necessary to cut out a rung to facilitate cable dropouts, all edges shall be filed smooth and rounded. Make miter joints in tray when manufactured fittings will not satisfy field requirements. Ventilated channels in 4 inch widths or conduit shall

be used for supporting cables dropping out of trays to connect to individual pieces of equipment.

- d. Unless otherwise noted, all cable trays shall be supported by rigid-steel brackets, trapeze-type hangers or fittings made by the tray manufacturer. All hanger materials, including threaded hanger rods, all brackets and other structural support items shall be of hot-dipped galvanized steel and shall have sufficient strength to support the load with a safety factor of at least three when all trays are filled to design capacity. All field cuts shall be thoroughly cleaned; given two primer coats, each of a different color, and a finish coat of aluminum paint. In fabricating or installing cable tray supports, all holes shall be drilled and all cuts made with a saw. All hanger rods shall be of 2 inches or larger diameter; shall be double nutted at the lowest cable tray support; and shall not be spliced. Except with specific approval, or where otherwise noted on the drawings, cable tray support spacing for horizontal runs shall not exceed 8 feet for ladder and channel type trays. For vertical runs, supports shall be not more than 8 feet apart for either tray or channel.
- e. Use prefabricated structural systems such as Kindorf, Unistrut, or a product of equal construction, for support of cable tray and channels. Welding is not permitted.
- f. Aluminum cable tray shall have expansion joint splice plates installed at intervals not exceeding 72 feet. The gap set between cable tray lengths at expansion joint fittings shall relate to the maximum and minimum gap possible as the temperature at the time of installation relates to the temperature extremes for that area. All expansion joints shall incorporate an approved bonding jumper to maintain electrical continuity. An approved lubricant shall be used on the sliding surfaces of expansion joint.
- g. Seal all openings where tray passes through walls or floors. When passing through a fire wall or floor, the seal shall be fire-rated per the drawing details.

C. Wire and Cable Installation

- a. Cable Installation, General. Splices are allowed only with Owner's permission. Connectors and terminal lugs for all sizes of conductors shall be of the crimp on type. Hydraulic and ratchet-type tools for compressing lugs or connectors shall be built to require full closure of the dies before the tool can be reopened. Crimp on connectors and terminators for cables larger than No. 3/0 AWG shall be long-barrel with two-hole tongues. For conductor sizes No. 14, No. 12, and No. 10 AWG in lighting service, splices and taps may be made with MMM "Hyflex" connectors or a product of equal construction. Other splices and taps in 600 volt conductor sizes through No. 2/0 AWG may be made with "Split Bolt" connectors and insulated as required. With 600 volt conductors larger than No. 2/0 AWG, splices and taps may be made with Burndy type KVS connectors or a product of equal construction. Control conductors shall be connected directly to terminal strips. All power cable ends shall be sealed to exclude moisture from the strands.
- b. Connections in motor terminal boxes, where the motor leads are furnished with crimped on lugs, shall be made by installing lugs on the motor branch circuit ends and then bolting the proper pairs of lugs together. Motor connection kits as manufactured by Raychem, Sigmaform, 3M, or equal shall be used to insulate the connections.

- c. Connections to high voltage switches, high and low voltage switchgears and MCCs, and buswork are to be made using silicon bronze bolts, springwashers and / or flatwashers, and / or Belleville washers and shall be torqued as shown below. The torque has to be verified by the Contractor in written form on related documents and signed by Contractor's electrician and his supervisor. The supervisor shall mark the bolts for MCCs, Switchgear and any terminations 400A and above. The table gives an indication - the torque values have to be verified with the manuals of the supplier of the related equipment. In every case the manuals are the binding documents.

Bolt Size	Torque
¼ in. – 20	5 ft-lb
5/8 in. – 18	10 ft-lb
3/8 in. – 16	15 ft-lb
7/16 in. – 14	30 ft-lb
½ in. – 13	40 ft-lb
5/8 in. – 11	55 ft-lb

- d. Multiconductor Cable Installation. Most power and control cables will be installed in cable trays unless otherwise shown on the drawings. When cables leave trays, they shall be protected between the trays and the cable terminus points by drawing them through conduits or by installing them in ventilated channels.
- e. Generally, cables shall enter and leave trays to prevent liquids from collecting inside the conduit dropouts. Care shall be exercised with cables entering or leaving cable trays, that all cable bend radii exceed the recommended minimums and that cables are not left to rest unprotected on any sharp edge or corner.
- f. When spacing is to be maintained between cables in trays, they shall be fastened to the trays with suitable bands or straps at intervals not greater than 7½ feet on horizontal runs and 4½ feet on vertical runs. All cable in trays where spacing is not maintained shall be attached at points 6 inches from the end of the fitting to each elbow or tee and at intervals not exceeding 4½ feet in all tray runs in other than a horizontal plane. Bands or strips shall be plastic and of a type not adversely affected by sunlight.
- g. Cables connecting stationary pieces of electrical equipment shall be rigidly supported over their entire length. Cable connecting to equipment subject to vibration, such as transformers, motors, etc., shall have not less than 18 inches or more than 36 inches of cable left free at each such termination, unless additional length is required because of the minimum bending radius of the cable.
- h. PVC insulated or jacketed cables shall not be installed or worked in any way at temperatures below 14°F.
- i. Each cable entering an enclosure shall have its conductors bundled together and identified with the cable number. All groups of conductors within an enclosure shall be shaped and formed to provide a neat appearance and to facilitate future additions or rework. All control conductors shall be numbered and labeled at each termination with this number, using plastic sleeve-type markers designed for the wire size. Metal tags and tags with metal rims will not be permitted in any enclosure.
- j. Shielded signal cable shall, unless specifically noted otherwise, be installed in cable tray or aluminum conduit. They shall be terminated with compression-type locking

fork tongue terminals. The shields and drain wires of shielded signal cables shall be grounded only at one point, as indicated on the drawings. At the time of installation, shields shall be checked for accidental grounds.

- k. Furnish and install a suitable permanent plastic marker on each end of every multiconductor cable or conduit if single conductor wires are installed. This marker shall indicate the cable/conduit number as indicated on the drawings.

V. **Inspection, Testing and Start-up**

- A. The intent of the inspection, testing, and checkout work specified herein, or required, is to ensure that all electrical workmanship and equipment is installed and performs in accordance with the design specifications, drawings, manufacturer's instructions and all applicable codes and requirements. Also, it is intended to provide, ensure, or determine the following:
 - a. If the equipment or installation has been subjected to damage during shipment or installation,
 - b. If the equipment is in accordance with the Purchase Orders and specifications,
 - c. Provide initial acceptance tests and recorded data that can be used as a benchmark for future routine maintenance and troubleshooting by Owner's operating forces,
 - d. Ensure a successful start up with a minimum of last-minute interruptions and problems,
 - e. Determine the suitability of the equipment and systems for energization and placing into operating service,
 - f. Provide assurance that each system component is not only installed satisfactorily but performs, and will continue to perform, its function in the system with reasonable reliability throughout the life of the plant,
 - g. Provide all necessary supervision, labor, materials, tools, test instruments or other equipment or services and expenses required to inspect, test, adjust, set, calibrate, functionally and operationally check all work and components of the various electrical systems and circuitry throughout the installation. Also furnish sufficient personnel to assist operating forces in any additional checks they may require for acceptance, start up of the electrical equipment, run in and placing the equipment and systems into continuous service,
 - h. Listings and Descriptions of Work. The listings and descriptions of the inspections, tests and checks described herein shall not be considered as complete and all inclusive. Additional normal standard construction (and sometimes repetitive) checks and tests will be necessary throughout the job prior to final acceptance by the Owner.
- B. INSPECTION AND OTHER TESTS
 - a. Equipment purchased by the Contractor or purchased by the Owner for the Contractor's installation shall be inspected and tested to determine its condition. At any stage of construction and when observed, any electrical equipment or system determined to be damaged, faulty, or requiring repairs shall be reported to the Owner's representative. Corrective action may require prior approval.

- b. Provide all equipment and instruments required to conduct the tests. This test equipment shall have calibrations traceable to the National Bureau of Standards. All testing instruments shall be checked to insure satisfactory operation prior to proceeding with the tests. Serial and model numbers of the instruments used shall be recorded on the test forms.
 - c. All testing and checkout work shall be performed with fully qualified personnel skilled in the particular tests being conducted. This is essential for obtaining and properly evaluating data while the tests are in progress and for insuring that important facts and questionable data are reported.
 - d. Ensure that all testing and checkout work is conducted in a safe manner. Special safety precautions such as the following shall be utilized where appropriate: (1) locking and tagging procedures; (2) barricades; (3) de-energization and/or isolation of equipment prior to testing; (4) review of procedures with the Owner's safety personnel; (5) erection of warning signs; (6) stationing of guards and watchmen; (7) maintenance of voice communications; and (8) personnel orientation.
 - i. The checks and tests to be made shall include, but not be limited to, the following:
 - ii. Check continuity of all conductors and shields on shielded cables. Check for shield grounds,
 - iii. Visually check all wire and cable connections, including terminal wiring of switchgear, transformers and motor control centers,
 - iv. Make continuity checks of all power and control cables, including each conductor of multiconductor power and control cables,
 - v. Check polarity of all bushing current transformers and instrument type current and potential transformers,
 - vi. Check all AC and DC control circuits for short circuits and extraneous grounds,
 - vii. Check all equipment for proper mechanical adjustment and freedom of operation, and remove all shipping blocks.
 - viii. Visually check all insulators for cracks or checking,
 - ix. Programming and parametrization of electronic relays will be performed by others,
 - x. Operate all electrically operated breakers, motor starters, contactors, etc., from their control devices.
 - xi. Check all closing, tripping, supervision and alarm functions of the control equipment.
 - xii. Trip each circuit breaker by operation of its associated protective relays.
 - xiii. Check operation of all alarm circuits,
 - xiv. Check drive motors for proper rotation during pre-shutdown checkout in the drive aisle.
 - e. Furnish assistance, as required, to equipment vendor's representatives in the testing and adjustment of equipment furnished by their companies.
- C. INSULATION TESTS
- a. Furnish the necessary test equipment and labor to test the insulation of electrical equipment and circuits before they are energized. The insulation tests will be

performed at the voltage levels as prescribed by NETA ATS (Standard for acceptance testing) for the tested equipment. Provide adequate, recently-calibrated 1000 V “Megger,” or other approved instrument, which shall be used to test the insulation resistance of circuits insulated for 600 volts, 460 volt motors and transformers, low voltage motor control centers under consideration of special requirements of the motor protection device Simocode Pro V and low voltage switchgear. The acceptable Megged values shall be in accordance to NETA ATS (Table 100.1).

- b. The insulation resistance of lighting and receptacle circuits and of control circuits will be “Megged” and the circuits must be shown to be free of short circuits and unintentional grounds. Megged values shall be in accordance to NETA ATS (Table 100.1).
- c. The insulation resistance, in megohms, of motors shall be at least as great as the values given in the following table before they may be energized.

Insulation Resistance in Megohms						
Winding Temperature	Motor Terminal Voltage					
	230	460	500	575	2300	4000
0°C	18.9	22.5	23.1	24.2	50.8	76.9
5°C	13.7	16.2	16.7	17.5	36.7	55.6
10°C	10.7	12.7	13.0	13.7	28.7	43.5
15°C	6.8	8.1	8.3	8.8	18.3	27.8
20°C	4.7	5.6	5.8	6.1	12.7	19.2
25°C	3.3	3.9	4.1	4.3	8.9	13.5
30°C	2.4	2.9	2.9	3.1	6.5	9.8
35°C	1.7	2.0	2.1	2.2	4.6	6.9
40°C	1.23	1.46	1.5	1.58	3.3	5.0

- d. Low voltage feeder insulation resistance may be tested with the connections to low voltage switchgear and/or motor control centers made, in which case the resistance to ground and the resistance phase to phase must be at least 1 megohm. The resistance to ground of low voltage motor branch circuits may be tested at the motor control centers with the motors connected, in which case the combined resistance to ground must be at least as high as the higher of the requirements for the separate parts.
- e. Control power transformers, potential transformers and other devices connected phase to phase or phase to ground and any devices not designed to withstand the test voltages must be disconnected when testing insulation resistance in switchgear, motor control centers and other apparatus.
- f. Test duration for shielded cables shall be 15 minutes maximum. Test duration for non shielded cables shall be 5 minutes. The test voltage should be applied from phase to ground on each conductor with the other conductors, shields, and metallic jackets connected to ground.

- g. A written record of all insulation tests shall be kept by the contractor on forms approved for the purpose and turned over to the engineer upon request, or at the termination of the work. These forms shall show the number or other suitable identification of each circuit or piece of apparatus tested, the date of the test, the temperature at the time the test was made, the instrument used, the test voltage applied, the resistance values found and the name of the person in charge of and witnessing the test.

D. Start-up

- a. Prior to checkout by the Owner, check all work and correct any faults discovered. Have competent personnel available at all times to assist and to correct any faults found during the Owner's checkout and start-up periods.
- b. Wire used for temporary jumpers and test connections during checkout shall have insulation of a color obviously different from all other wire. All temporary jumpers shall be removed after the checkout is completed.

END OF DOCUMENT