# GENERAL

### The requirements of the Contract, Division 1, and Division 16 apply to work in this Section.

## SECTION INCLUDES

### Low voltage, front/rear-accessible, ANSI/IEEE rated metal enclosed switchgear line-up with drawout ANSI/IEEE rated low voltage power circuit breakers in an integrated system as specified below and shown on the contract drawings.

### This specification and associated drawings describe for 600VAC Entellisys Low Voltage Draw-out Switchgear assemblies constructed to ANSI/IEEE C37.20.1 standards.

## RELATED SECTIONS

### [26 24 13 Surge Protective Devices]

## REFERENCES

### The Entellisys equipment lineup and low voltage power circuit breakers in this specification shall be designed, tested and manufactured according to latest revision of the following standards, unless otherwise noted.

### ANSI/IEEE C37.16 , Low Voltage Power Circuit Breakers and AC Power Circuit Protectors- Preferred Ratings, Related Requirements, and Application Recommendations

### ANSI/IEEE C37.17, American National Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers

### ANSI C37.50, Switchgear - Low Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures

### ANSI/IEEE C37.51, American National Standard for Switchgear - Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies - Conformance Test Procedures

### ANSI C39.1, Requirements for Electrical Analog Indicating Instruments

### ANSI/IEEE C37.13, Low - Voltage AC Power Circuit Breakers Used in Enclosures

### ANSI/IEEE C37.20.1, IEEE Standard for Metal-Enclosed Low Voltage (1000 VAC and below, 3200VDC and below) Power Circuit Breaker Switchgear

### ANSI/IEEE C37.27, IEEE Standard Application Guide for Low-Voltage AC Non-Integrally Fused Power Circuit Breakers (Using Separately Mounted Current Limiting Fuses)

### ANSI/IEEE C57.13, IEEE Standard Requirements for Instrument Transformers

### ANSI/IEEE C37.90.2, IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

### UL 1066, Standard for Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

### UL 1558, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

## SYSTEM DESCRIPTION

### The switchgear shall be rated at [208] [240] [480] [600] volts, three phase, [3] [4] wire, [60] [50] Hertz power system having a short circuit availability [65] [85] [100] [150] kilo-Amperes RMS symmetrical.

## SUBMITTALS

### The contractor/installer shall provide the following documents as APPROVAL drawings to the engineer/owner for review and evaluation. The equipment manufacturer shall provide the factory shop drawings as detailed below. Manufacturing of the equipment will not begin until the submitted documents are acknowledged “APPROVED” or “APPROVED AS NOTED” by the engineer/owner and officially released for manufacture by the contractor/installer/distributor/owner.

#### Shop drawings of the designed equipment including:

##### Breaker Options Summary Sheets

##### Detailed Bill of Material for Installed Component Devices

##### Nameplate Engraving Sheets

##### Equipment ratings (short circuit, voltage, continuous current)

##### [Key Interlock ordering Sheets – If required]

##### Summary of Equipment Options Sheets

##### [Special Requirements Sheets – If required]

##### Equipment One Line Bussing Diagram

##### Front View (Elevation View)

##### Floor Plan

##### Top View

##### Electrical Schematic drawings

##### Plan View showing Power Cable Conduit Areas and Control/Signal Conduit Areas

##### Typical Section Side View showing breaker compartment and bus/cable compartment details

##### Panel Layouts for each section and cubicle showing component device location

##### Drawing Legend Sheet

##### 3 Line Power Elementary Diagrams

##### Control Circuit Wiring Diagrams

##### [Control Power Throwover Diagram – If applicable]

##### [HMI Circuit Diagram – if applicable]

##### Device Communication Diagrams

##### [Zone Definition Diagrams -if applicable]

##### [Product data sheets – if required]

##### [Heater Circuit and Auxiliary Circuit Diagrams – If applicable]

##### [Busway connection – if applicable]

### The contractor/installer shall provide the following documents as Record Drawings to the engineer/owner after the equipment has shipped. These drawings will reflect the “AS BUILT” condition of the specified equipment.

#### Shop drawings of the manufactured equipment shall include all the same information as the APPROVAL drawings plus the following:

#### Point-to-Point Wiring Diagrams for each section cubicle

#### Equipment & breaker instruction books.

#### Instruction books for major component devices installed by the manufacturing factory.

#### Installation publications and drawings.

### The manufacturer shall provide drawings in the following format. Refer to the SUBMITTALS section for the specific documentation requirements.

#### Approval and Record documentation shall be supplied in an all [electronic][and][or][paper] format as detailed below:

##### Electronic equipment mechanical and electrical drawings shall be provided in [Adobe PDF formats] [AutoCAD dwg] [ dxf].

##### [Electronic general information details (nameplate schedules, material lists, etc.) shall be provided in Adobe PDF format.]

##### [Other information (data sheets, standard typical diagrams, etc.) shall be provided in Adobe PDF format.]

##### [Paper documentation shall be provided on size “A” (8.5” x 11”) or size “B” (11” x 17”) paper to facilitate easy copying.]

##### Submittal and record documents shall include a list of potential spare parts to include all trip devices, protective relays, meters, instrument transformers for meters and relays, communicating devices and control devices.

##### [Insert quantity of paper copies] copies shall be provided.

### Factory certified test reports [are not required as normal factory testing procedures are acceptable.][shall be issued at the conclusion of the factory testing. The format of the information shall be the same as described in the “Approval and Record documentation” section above.]

### Manufacturer shall provide [3] [digital] copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division [1] [01] and Division [16] [26].

## QUALITY ASSURANCE (QUALIFICATIONS)

### The manufacturer shall have specialized in the manufacture and assembly of low voltage switchgear for at least 20 years and shall have at least 5 years’ experience incorporating intelligent electronic devices (PLCs, Multifunction Meters, Communicating Trip Units, etc.) as functioning systems into the equipment lineup. If requested to do so, the manufacturer shall provide a listing of projects demonstrating their compliance to the engineer/owner.

### The manufacturer shall be ISO 9001 certified.

### The equipment shall be manufactured in accordance with standards listed in the REFERENCES Section of this specification.

### The switchgear lineup shall be constructed [to regular design parameters, the project has no building code seismic requirements] [to meet seismic qualifications of IBC-2018 and IEEE-693].

## DELIVERY, STORAGE, AND HANDLING

### Ambient temperature of the area where the equipment will be installed must be between minus 30 degree C (minus 22-degree F) and plus 40 degrees C (104-degree F) and shall be protected to prevent moisture from entering enclosure [see circuit breaker temperature de-rating factors above 40 degree C per manufacture’s requirements].

### The equipment shall be shipped FCA Sellers facility or FCA Buyers/FF Warehouse. It is the responsibility of the contractor/installer to inspect and report any damage to a manufacturer’s representative who shall handle any freight damage claim.

### Within 24 hours of receiving the equipment, the contractor/installer shall heat the equipment enclosures with a temporary heat source to prevent condensation per the storage instructions of the equipment manufacturer.

### The contractor/installer shall handle the equipment in accordance with all appropriate NEMA, ANSI/IEEE, UL, and manufacturer's written instructions to avoid damaging the equipment, installed devices and finish.

### The contractor/installer shall protect and handle the equipment in accordance with recommended practices listed in manufacturer's installation publications and/or maintenance manuals. When stored, the equipment shall be located in a clean, dry space and shall maintain factory protection or cover the equipment with heavy canvas to keep out dirt, water, construction debris, and traffic.

### The contractor/installer shall follow all appropriate standards and service conditions before, during and after the equipment installation.

### The final location of the equipment shall be in a well-ventilated area, free from excess humidity, dust and dirt and away from hazardous materials.

## WARRANTY

### The manufacturer warrants the low voltage metal-enclosed switchgear to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of shipment, whichever occurs first. The equipment must be received, stored and installed in accordance with the manufacturer’s installation publications and/or maintenance manuals to avoid nullifying this warranty.

### In the event that any warranty work needs to be performed, a representative of the manufacturer shall be notified in writing of the problem. The manufacturer’s factory will then issue instructions and any materials to correct the problem. All warranty work must be performed by the manufacturer at the manufacturer’s discretion in order to maintain the manufacturer’s warranty.

1. [An extra one year warranty shall be provided when the manufactures’ field service organization performs start-up and commissioning services detailed in Part 3.]

## FIELD MEASUREMENTS

### The contractor/installer shall make all necessary field measurements to verify that the low voltage switchgear lineup shall fit in allocated space in full compliance with minimum required clearances recommended by the manufacturer, specified in National Electrical Code and required by any applicable local/facility requirements.

# PRODUCTS

## MANUFACTURER

### The ABB Entellisys low voltage metal enclosed integrated switchgear system has been selected as the basis of design given its flexibility, modularity and overall functionality. The Entellisys system parameters are detailed below along with a brief description of the parameter functionality. Should the Entellisys system not be provided, the described parameter functionality must be provided to be considered as an acceptable equal. Failure to provide the Entellisys system or all of the specific parameter functionalities is unacceptable and will result in the proposal being rejected by the owner/engineer.

### Any and all exceptions to the requirements detailed below shall be included in the contractor’s proposal so that the engineer or owner’s representative can easily make a comparison to this base-line specification document. The contractor shall document in their proposal that the manufacturer provided detailed information to support exceptions or substituted products.

### If no exceptions or qualifications are contained in the alternate contractor’s and manufacturer’s proposal, the alternate manufacturer shall provide exactly what is detailed in both this specification and the project contract documents. Failure to meet this requirement will result in the rejection of the proposal based on non-compliance with the technical performance requirements of this specification.

### The first source of general information shall be these general specifications; however, detailed and specific information contained in the drawings will take precedence over these general specifications as the drawings contain project specific information. In the event of a conflict between the plans and specifications, the owner/engineer will determine which is correct.

## EQUIPMENT

### Furnish ABB Entellisys Low Voltage Switchgear with ABB EntelliGuard E type circuit breakers as indicated in drawings.

### To assure maximum uptime and operational reliability the system shall be provided with two central processing units (CPUs). Use of dual/redundant programmable logic controllers (PLCs) that provide the same parameter functionality will be considered equal.

### The physical placement of the redundant devices (two CPUs and two UPSs) shall be together. In this arrangement space is minimized as both CPU – UPS groups will be located together.

### Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; and other required details.

### Switchgear shall include all protective devices and equipment listed on drawings with necessary interconnections, instrumentation and control wiring.

### Switchgear shall be furnished with an indoor NEMA 1 enclosure. [Outdoor applications shall be NEMA 1 enclosures installed in an equipment power center. See section 16410 for equipment power center requirements.]

### A UL 1558 label shall be provided on the equipment verifying that the lineup meets all requirements of UL for metal-enclosed low voltage power circuit breaker switchgear.

### All live components shall be contained in a grounded metal enclosure. Individual vertical sections shall be constructed of bolted 11-gauge modular steel frames with removable plates. Each breaker compartment shall be completely isolated from other breaker compartments by grounded metal barriers. Barriers shall isolate the breaker compartments from the busbar system.

### The switchgear front doors shall [shall have ¼ turn latches to easily secure the front doors in the fully closed position] [shall have ¼ turn latches with padlocking provisions to prevent unauthorized entry into the front compartment][shall have ¼ turn latches with key locking provisions to prevent unauthorized entry into the front compartment].

### Auxiliary / transition section(s) shall be supplied and equipped with [devices as herein described] [all necessary devices requested to perform the specified breaker and equipment functions] including [auxiliary relays, ] [primary and control circuit fuse blocks, ] [potential transformers] and [control power transformer]. The section(s) shall have hinged doors over each compartment.

### [Switchgear shall be provided with UL service entrance label, and incoming line isolation.]

### [Switchgear shall be provided with side barriers in the bus and cable compartments and consisting of metal and polyester-glass vertical barriers [between the main and feeder sections.] [between all sections.]]

### [Provide metal plates in the bottom of the power cable compartment along the floor to seal off the compartment. The installer/contractor shall be responsible for punching the plates to provide access for the conduits.]

### [Pull boxes shall be supplied where indicated on drawings for the width and depth of the cable compartment and shall be [15] [22] [29] inches high and include screw cover plates.]

### Service Entrance shall comply with UL Service Entrance requirements, which include service entrance label, incoming line isolation barriers, and neutral connection to switchgear ground.

## BUS BARS

### Horizontal main bus bars shall be full-sized as indicated in drawings.

### Bus bar material shall be copper, [tin -plated] [silver-plated], bolted at vertical-to-horizontal bus connections and at points where the vertical bus connects to bus bars supplying power to circuit breaker compartments.

### All bolted joints for bus interconnections and connection to equipment shall be [tin-plated] [silver-plated] copper.

### Main and riser busses shall be fully isolated from breaker, instrument and auxiliary compartments.

### Bus arrangement shall be designed to permit future additions.

### Vertical busses shall be held rigid in a support structure of non-hygroscopic and flame retardant molded, glass reinforced polyester.

### Continuous current rating will be based on temperature rise as limited by ANSI/IEEE standards and will be demonstrated by design tests. If a main circuit breaker, bus tie circuit breaker, incoming bus duct or cable is provided, the continuous rating of the bus will be equivalent to the frame size rating of the main breaker, bus tie breaker, incoming bus duct or cable. All line and load side bussing shall be rated to carry full frame size continuous current rating of breaker to which they are connected. Breaker load side bars shall be insulated.

### Breaker primary disconnects (moveable and fixed) shall be silver-plated copper-to-copper.

### Main bus bars shall be braced to withstand short circuit mechanical forces exerted during a short circuit of [65kA] [100kA] [150kA] [200kA] RMS symmetrical. Other buswork shall be braced to withstand mechanical forces exerted during a short circuit equivalent to the maximum interrupting capacity of the associated circuit breakers.

### Where a bus-sectionalizing breaker is present, busses on both sides of the breaker shall be isolated from each other. Where an incoming line or main breaker is present, incoming line conductors shall be isolated from main bus.

### [Furnish an insulated / isolated bus system which fully insulates the horizontal main bus with a fluidized epoxy coating and isolates each phase of the vertical riser bus with molded polyester glass barriers. Main bus joints shall be accessible through removable / replaceable covers. No live connections shall be accessible from the rear except the breaker load side terminals or incoming service conductors.]

### ***NOTE TO SPECIFIER: The paragraph above applies for main bus ratings of 4000A and below. 5000A main bus is available in bare bus or bus compartment barrier configurations (optional paragraph below) – no insulated / isolated bus at 5000A.***

### [Vertical and horizontal busses shall be isolated from cable compartment by glass reinforced polyester barriers. No live connections shall be accessible from the rear except the breaker load side terminals or incoming service conductors.]

### A [tin-plated] [silver-plated] copper, ground bus [(1)-0.25” x 3.00”] [(2)-0.25” x 3.00”] shall be secured to each vertical section structure. Ground bus shall extend entire length of switchgear and shall be equipped with a 4/0 terminal for connection to purchaser's ground system. Furnish a lug strap for each vertical feeder section for feeder breaker ground lugs.

## ***NOTE TO SPECIFIER: 2-0.25” x 3.00” ground bus is supplied when the main bus is 5000A or greater. For main bus ratings of 4000A and below, the ground bus is 1-0.25” x 3.00”***

## SERVICE ENTRANCE

### Service Entrance shall comply with UL Service Entrance requirements, which include service entrance label, incoming line isolation barriers, and neutral connection to switchgear ground.

## INCOMING LINE SECTION

### Incoming line section shall be [3- wire] [4-wire], [1600A] [2000A] [3200A] [4000A] [5000A]

### Incoming line shall be [main cable connection with mechanical lugs.] [Main cable connection with compression lugs.] [Transition to a ABB transformer.] [Spectra busway connection which will include cutout in the switchgear top plate.]

## UTILITY METERING COMPARTMENT

### Furnish a utility metering compartment to meet requirements of <utility name.>

#### Metering compartment shall have removable links in bus work for utility supplied current transformers. Comply with all utility company requirements for service entrances and provide mounting in the compartment for utility supplied metering devices as required.

## BREAKER COMPARTMENTS

### Each low voltage power circuit breaker shall be mounted in a separate compartment. Each compartment shall have grounded metal barriers at top, bottom, front and side and a flame retardant, track resistant glass reinforced polyester base barrier at the rear.

### Furnish each compartment with draw-out rails, stationary breaker contacts, mechanical interlocks and required control and indicating devices.

### Furnish a system of floating primary and secondary disconnect assemblies that shall ensure accurate alignment of breaker primary and secondary contacts during drawout operation.

### Draw out mechanism shall retain removable element in connected position and shall overcome mechanical resistance of making and breaking the contacts of the self-coupling primary and secondary disconnects.

### Positive mechanical interlocks shall prevent breaker from being racked in or out unless breaker is open. The interlock shall prevent breaker from being closed while it is being racked in or out. Circuit breaker can be closed only in CONNECT or TEST positions. Limit stop shall be provided in CONNECT, DISCONNECT and WITHDRAWN positions.

### A true closed-door drawout mechanism shall permit circuit breaker to be moved from the CONNECT to DISCONNECT position without opening the circuit breaker cubicle door. Draw out mechanism shall provide four distinct positions for circuit breaker: CONNECT, TEST, DISCONNECT, and WITHDRAWN. Mechanism shall be able to be operated without opening the door over circuit breaker. An indicator shall be provided on the front of the breaker or cubicle to show position of circuit breaker.

### Breaker frame shall be grounded to the switchgear throughout travel of draw out mechanism.

### Breaker doors shall be provided without ventilation slots and shall be able to be closed when the breaker is in the CONNECT, TEST, or DISCONNECT positions

### Padlocking provision shall permit locking the breaker in TEST and DISCONNECT positions. Drawout rails shall accept up to three padlocks to prevent the unauthorized installation of a breaker into an empty cubicle.

### Furnish each breaker compartment with a steel auxiliary panel for mounting breaker LED pilot lights. The panel shall contain:

#### Engraved circuit breaker nameplate

#### LED pilot lights for breaker open / closed indication

#### Control power status indication

### Each breaker cubicle shall contain a rugged, positive rejection system so that only the breaker frame for which the cubicle was designed can be inserted. Breakers of the same physical size with higher continuous current and / or interrupting ratings may be safely inserted into lower rated cubicles thus minimizing the number of spare breakers required for a switchgear line-up.

### [Each [main] [and tie] breaker cubicle shall [be equipped with a position switch with the necessary form “a” and form “b” contacts to communicate if the breaker is in the racked-in or disconnected position] [be equipped with a position switch with the necessary form “a” and form “b” contacts to signal to the automatic throwover system if the breaker is in the racked-in or disconnected position].]

### [Furnish shutters for main [and ] [tie ] [and ] [feeder ] [breaker compartment(s)] [and the fuse rollout] [in double ended substations]. Shutters shall cover breaker primary line and load disconnects with the breaker removed from compartment.]

### [When specified for a future breaker, the compartment shall be completely equipped for the future addition of a power circuit breaker element including all mechanical and electrical features, such as current transformers, secondary disconnects, indicating lights, position switches, shutters, neutral sensor, and all other items specified for active circuit breaker cubicles. Provide a reusable metal barrier for the opening in the breaker compartment door.]

## POWER CABLE TERMINATION COMPARTMENTS

### Switchgear shall have a rear cable and terminal compartment for cable termination and installation. Cable bending space shall meet National Electrical Code requirements.

### Furnish [bolted covers] [split hinged covers which can be bolted closed] [full height hinged covers] for each cable compartment.

### Full height hinged covers, when specified, shall be secured by a [two captive bolts] [T-handle mechanism] [lockable T-handle mechanism] [three point catch to secure the door at the top, bottom and center].

### Conductors shall terminate into [compression lugs – two-hole long barrel type shall be provided for every cable connection] [clamp lugs (mechanical type) shall be provided for every cable connection]. Refer to the project drawings for quantity and size information.]

### [Rear doors shall have padlock provisions to provide secured access to the cable section of the equipment lineup].

### [Furnish cable supports for each vertical section.]

## CIRCUIT BREAKERS

### Provide ANSI rated low voltage power circuit breakers listed per UL1066. Use of, or substitution by, UL489 insulated case circuit breakers or molded case circuit breakers is unacceptable and will be rejected by the owner/engineer.

### Provide circuit breakers with frame and trip current ratings as indicated on the drawings.

### Each breaker shall be a 3-pole, electrically and mechanically trip free unit with self-aligning primary and secondary disconnecting contacts, arc quenchers, position indicator and the necessary hardware to mount on a drawout mechanism in the compartment.

### All circuit breakers shall be drawout type and the primary connections shall be fully silver-plated copper-to-copper.

### [Circuit breaker control shall be electrically operated type via a motor to charge the closing springs. Closing shall be accomplished by pressing a close push button icon on the equipment HMI. Opening shall be accomplished by pressing an open / trip push button icon on the equipment HMI. Manual charging of the closing springs may still be accomplished via the front mounted handle. The spring charging motor shall have a nominal control voltage rating of 120VAC @ 60Hz.]

### Manual or electrical closing mechanisms shall use an energy storage spring between the operator and the breaker contacts. This spring shall provide a constant closing speed not influenced by operator speed or control power voltage level.

### Circuit Breaker Protective Functions

#### Long-time protection shall be provided with adjustable pickup and delay.

#### Ground fault protection shall be provided with adjustable pickup and delay [where indicated on drawings].

#### Short-time protection shall be provided with adjustable pickup and delay.

#### Instantaneous protection shall be provided with adjustable pickup. This function shall be a true adjustable with low range settings (not with only high range or fixed high range). A selective discrimination instantaneous function that recognizes the overcurrent waveform profile shall be included for selective tripping with downstream current limiting breakers or fuses. The selective instantaneous shall allow the instantaneous pick-up of a feeder breaker to be set below the peak let-thru of the downstream current limiting device while maintaining selectivity.

#### To provide field coordination flexibility, either the short-time or instantaneous functions must be capable of being switched /turned off via the HMI.

#### [As indicated on drawings, provide breakers with a frequency and reverse power relay package.

##### This relay package shall be capable of providing an alarm signal and/or tripping the breaker in the event that the power system experiences an over frequency situation, an under-frequency situation or opposite flow of power.

##### Under-frequency relay shall have a pickup adjustment range from 50 to 60Hz in 0.1Hz increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds.

##### Over frequency relay shall have a pickup adjustment range from 60 to 70Hz in 0.1Hz increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds.

##### Reverse power relay shall have a pickup adjustment range from 10 to 990kW in 10kW increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds.]

#### [As indicated on drawings, provide breakers with voltage relay protection.

##### This relay package shall be capable of providing an alarm signal and/or tripping the breaker in the event that the power system experiences an over voltage situation, an under-voltage situation or a phase loss.

##### Undervoltage relay shall have a pickup adjustment range from 50 to 95% of nominal in 1% increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds. Delay curves shall be user selectable fixed and inverse time curves.

##### Overvoltage relay shall have a pickup adjustment range from 105 to 125% of nominal in 1% increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds.

##### Phase loss relay shall have a pickup adjustment range from 8 to 50% of nominal in 1% increments, with a delay setting range of 0.5 to 600 seconds in increments of 0.5 seconds.]

### [Circuit breakers shall be provided with a high current alarm to provide a preemptive alert of a critical breaker tripping (abnormal loading / above nominal ampere draw). The user adjustable pickup point may be used to provide an alarm or initiate a control sequence when the breaker exceeds the established value.]

***NOTE TO SPECIFIER: THE FOLLOWING TWO FEATURES ARE MUTUALLY EXCLUSIVE – SELECT NEITHER OR ONE BUT NOT BOTH. LOGIC OPERATED INTERLOCK PROVIDES A MEANS TO MECHANICALLY LOCK OUT A BREAKER FOR CONTROL PURPOSES SUCH BLOCKING A BREAKER CLOSING OPERATION IN AN AUTO TRANSFER DUE TO OVERCURRENT OR SOURCES OUT OF SYNC THE BELL ALARM OPTION PROVIDES A MECHANICAL LOCKOUT DUE TO OVERCURRENT ONLY THE LOGIC OPERATED INTERLOCK IS AVAILABLE ON ELECTRICALLY OPERATED BREAKERS ONLY. THE BELL ALARM IS AVAILABLE FOR USE ON MANUALLY- OR ELECTRICALLY OPERATED BREAKERS.***

### [Electrically operated [main and tie] breakers shall be provided with logic-operated mechanical interlocks that will establish the breaker’s ability to be closed. A “SET” condition shall place the breaker mechanism in a trip-free status and a “RESET” condition shall allow the breaker to be closed via a command over the communications network.] [The interlocks shall be used to prevent simultaneous closing of both mains and ties and shall prevent closing immediately after a trip.]

### [The breaker shall be provided with a bell alarm. This bell alarm shall be provided with a lockout function such that the breaker cannot be closed until the lockout has been manually reset.]

### When equipment is furnished as a double ended substation, main and tie circuit breakers shall be provided with a limited access manual close button to prevent inadvertent manual closing of these breakers when not permitted by the control logic.]

## ADVANCED PROTECTION

### [Zone Interlocking

#### Dynamic Zone selective interlocking (ZSI) shall be provided. The ZSI system shall assure that all circuit breakers will trip for a fault within their respective zone of protection at the set short time and ground fault band. Dynamic zone selective interlocking shall allow all breakers to be set to minimum time delay and the system will automatically adjust time delays for breakers upstream of the faulted zone for selective back-up tripping. The breaker closest to the fault will trip at the preset minimum time delay. Zone selective interlocking shall be provided for both short time and ground fault if either is used in the system.

2. [Feeder breakers shall be capable of accepting a zone selective interlock signal from downstream circuit breakers with EntelliGuard TU or MicroEntelliGuard trip units to provide restrained tripping for faults in downstream switchboards or motor control centers.]

3 [The low voltage switchgear shall be able to provide line-side zone protection by utilizing IEC 61850 GOOSE communication. Switchgear shall be capable of IEC 61850 GOOSE bi-directional communication (publisher and subscriber) to IEC 61850-compliant relays and devices.]

#### 4. Refer to the project drawings for details of the zone(s).

#### 5 The trip time and clearing time of the circuit breakers while operating in the interlocked mode shall be documented in the coordination study and shall be reflected in the Arc Flash Analysis.]

### [Bus Differential Protection

#### Bus differential protection shall be provided via Entellisys zone-based overcurrent protection to provide fast fault clearing to reduce potential incident energy. The minimum adjustable pickup setting shall be 20% of the CT rating of the largest breaker in the zone and the maximum pickup setting shall be 22,000 amperes. Any circuit breaker feeding into a protected zone may be initiated to trip in as little as 25ms.

#### Refer to the project drawings for details of the zone(s).

#### If the Entellisys system is not supplied then separate bus differential relays (ANSI 87B device), current transformers for every breaker, lockout relays (ANSI 86 device) and all associated breaker trip wiring shall be provided.

#### Acceptable switchgear-type bus differential relays are as manufactured by Multilin, Basler BE1,- and ABB. Industrial-class or DIN-rail mounted bus differential relays are not acceptable.]

### [Multi-Source Ground Fault Protection

#### When equipment is furnished as a double ended substation, multi-source ground fault (MSGF) protection shall be provided to provide selectivity within the ground fault protection zone of the lineup. The MSGF shall identify the location of any fault within a specific zone by summing all the outgoing and incoming currents and tripping all source circuit breakers feeding into that zone at the time delay set for the zone. In a multiple-grounded system, the time-delay bands are set for the MSGF zone, not for the individual circuit breakers.]

### [Sync Check Relaying

#### [Provide sync check relay package, to allow for any source or bus voltage to be used to compare sync status Sync Check is an optional control element that checks for synchronism between two voltage sources (adjustable voltage, angle, and frequency) and can serve as a permissive element in the control logic to allow a circuit breaker to close only when two voltage sources are synchronized. The Sync Check function includes Live/Dead Bus–Live/ Dead Line sensing for bypassing the Sync Check requirement if one or both of the sources are de-energized.]

#### Refer to the project drawings for details of the power sources supplying the lineup.

#### If the Entellisys system is not supplied, then separate and discrete sync check relays (ANSI 25 device), potential transformers and all associated permissive/non-permissive breaker control wiring shall be provided. Acceptable switchgear-type synch check relays are as manufactured by Multilin, Basler BE1, or Beckwith M-0388. Industrial–class or DIN-rail mounted sync check relays are not acceptable.]

### [High Resistance Ground Detection

#### Provide a system that will detect and alarm on ground faults occurring on this high resistance grounded distribution system. Ground fault detection shall use harmonic filtering to detect ground currents of only the fundamental frequency and eliminate false indication for harmonic currents in the power system. The system shall permit acknowledging and re-alarming if the fault is not cleared within a preset time period.]

#### [Provide a pulsing system that will automatically begin pulsing when a ground fault is detected and identify the faulted circuit by way of the system event log. The fault data from the event log shall also identify the faulted phase. Pulsing system shall be able to be manually initiated to aid in locating the ground fault in any downstream equipment.

#### [Provide a tripping system that will automatically trip a breaker if a second ground fault occurs before the initial ground fault is cleared. All breakers shall be assigned a priority such that the faulted breaker of lowest priority will trip to return the power system to a single ground fault condition.]

### [Low Energy Let-Thru Mode

#### Provide a low energy let-thru mode where the owner/operator shall be able to select a setting which temporarily establishes all breaker protective functions to minimum during maintenance operations. Initiating the low energy let-thru mode shall be through a one-line representation on the touchscreen. Only individuals with proper password privileges will be allowed to put individual breakers or the entire system into low energy let-thru mode. The user shall be able to select whether the low energy let-thru mode should apply to a downstream load (load protection) or for the switchgear (breaker protection). All users who initiate the low energy let-thru mode for an individual breaker, multiple breakers, or the entire system are required to also de-activate the low energy let-thru mode via their password. This would be analogous to a lockout-tagout (LOTO) procedure.]

## CONTROL POWER AND WIRING

### System control power shall be derived from the line side of all sources feeding the switchgear. Control power for the equipment lineup shall be 120 VAC. The CPT circuit shall contain an ANSI 83 function for CPT automatic transfer. At least two control power sources shall be used with an automatic control power throw over to supply power to a dual redundant UPS system that shall in turn provide control power to all electronic devices and breaker controls (with the exception of circuit breaker closing spring charging motors) contained in the switchgear.. The control power system (UPS) shall provide a minimum of 30 minutes of control power to all electronic devices should black out conditions occur.

### Minimum wire size for breaker control wiring within the equipment lineup shall be No. 14 AWG, extra flexible, stranded, tinned-copper, type SIS cross-linked polyethylene, rated 600 volts, except for specific circuits requiring larger wire]. CT wire size for Entelisys CTs shall be No. 14 AWG and may be preinstalled with connectors on compartment CTs. Minimum wire size for the C/Ts (current transformers) with 5 ampere secondary used for external relays, meters, or other non-Entellisys devices, within the equipment lineup, shall be [No. 14 AWG] [No. 12AWG] [No. 10 AWG], extra flexible, stranded, tinned-copper, type SIS cross-linked polyethylene, rated 600 volts.

### Wire terminals for the control wiring within the equipment lineup shall be [standard spring spade insulated terminals, except where ring terminals are used to connect C/T circuits] [special ring insulated terminals, and where ring terminals are used to connect C/T circuits]. Wire terminals for the C/Ts (current transformers) within the equipment lineup shall be crimp-type, insulated ring terminals. If 3-phase current transformers are used, the CT assembly may be equipped with a color-coded secondary harness that terminates in a polarized plug connector.

### Control wiring shall have wire marking sleeves with the wire origin and destination information stamped on the sleeve.

### Furnish fuse holders in switchgear when required.

## LOCAL SYSTEM INTERFACE (HMI)

### Each low voltage switchgear lineup shall be supplied with a means to view the status of the overall equipment, breakers, electronic devices and other important components as detailed below. The preferred interface is the ABB Entellisys HMI. Other touch screen displays containing the parameter functionality listed below will be considered equal.

#### The HMI color view screen will be a backlit liquid crystal display (LCD) and have a minimum diagonal viewing area of at least 15 inches.

#### The HMI cubicle shall also contain: a keyboard and pointing device mounted in a slide-out tray for the direct input of alphanumeric data. A USB port located in the HMI cubicle shall be provided for connection of USB-based devices.

#### The HMI shall also be provided with an operating system and software to display the following screens. These screens shall be originally configured in the factory and shall be finalized by a start-up service engineer during the factory startup/commissioning process (see INSTALLATION Section below in Part III). As a minimum the following screens shall be incorporated into the HMI for end customer use:

##### Main Menu Screen – Displaying choices of “ONE-LINE”, “ELEVATION”, “SEQUENCE OF EVENTS”, “SYSTEM HEALTH” , “USER SETTINGS” , “USER ADMINISTRATION”], MAINTENANCE”

##### Active One-Line Diagram – Displaying all the circuit breakers contained in the lineup and their active status as OPEN, CLOSED or TRIPPED. Active metering values for bus voltage for each phase and breaker current for each phase shall also be displayed. Touching a breaker symbol on the one-line diagram shall take the user to a screen containing metering data and status information for the particular breaker.

##### Physical Front Elevation Diagram – Displaying the general appearance and mechanical layout of the lineup. This display will be particularly useful when the HMI is being viewed remotely. Touching a breaker cubicle on the elevation shall take the user to a screen containing metering data and status information for the particular breaker.

##### Sequence of Events Menu – This display will contain all the recorded events pertinent to the line-up (breaker events, alarm events, system events, etc.). These events will all be time stamped and all system events for the entire lineup shall be fully synchronized. The user shall be able to configure the preferences of events (FIFO, Auto Cleanup, etc.) and shall be able to filter the information shown.

##### System Heath Menu – This display will provide status indication of the central processors and individual circuit breaker electronics. For ease of information assessment, a status signal shall be displayed (green for OK, yellow for a loss of redundancy, red for hardware error)

##### User Settings Menu – This display will allow the operator to view the configuration of the system and the individual settings associated with each breaker.

##### In addition to the General Menus and Diagrams listed above, the following screens shall be available for each individual breaker in the lineup. Breaker Status showing breaker contact position, closing spring status [and breaker position] as well as protection settings showing enabled, disabled, etc. Detailed Metering showing all the configured parameters (see the metering parameters section below).

##### If the waveform enhancement option is required, then the HMI shall display the one second duration capture for all current and voltage channels (see the metering parameters section below). The waveform data shall be stored in the industry standard COMTRADE format allowing the user compatibility with many existing analysis packages.

##### If the Demand metering option is required, the HMI shall display the logged demand information in a line graph with time as the horizontal axis and the demand values as the vertical axis.

##### If the Harmonics metering package is required, the HMI shall display the K Factor value by phase, the current total harmonic distortion by phase and the voltage total harmonic distortion by phase. Additionally, by selecting the “Harmonic Analysis” button, the user shall view the frequency spectra for the voltages and currents captured on the system. This information shall be displayed in a bar graph with the harmonic number as the horizontal axis and the ampere value on the vertical axis. A table shall also be displayed showing the individual magnitude value under each harmonic number for each phase.

### ***NOTE TO SPECIFIER: SELECT OPTIONS BELOW FOR HMI LOCATION. MULTIPLE HMI LOCATIONS ARE PERMITTED.***

### [Provide [one] HMI device and all necessary CPU’s or PLCs, and UPSs located in a stand-alone equipment stack, which would allow for remote user interface with the equipment lineup and maintenance of Entellisys components outside the OSHA limited approach boundary. The Ethernet cable connection from the switchgear to this stack shall be no longer than 300 feet. Each switchgear line up shall be provided with a separate stack when these are required.]

### [Provide one HMI device located on the front cover of an auxiliary compartment in the equipment line-up.]

### Provide [[one] HMI device located in a wall mounted unit] which would allow for remote user interface with the equipment lineup outside the OSHA limited approach boundary. Ethernet cable connection from the equipment to this HMI shall be no longer than 300 feet. Each switchgear line up shall be provided with a separate HMI when these are required.

## SYSTEM DIAGNOSTICS

### Standard sequence of event recording shall be provided. This feature will enable the user to view via the equipment HMI, any trip, alarm, logged event, etc. The system will have unified time synchronization so that all recorded occurrences will be time stamped.

## [AUTOMATIC TRANSFER [AND LOAD SHED] CONTROL

### Provide a three circuit breaker automatic throwover scheme. The Main / Tie / Main scheme shall contain all the necessary voltage sensing instrumentation, all the necessary status and position sensing devices, all the necessary control power requirements, etc. The interface for the status indication of the appropriate circuit breakers and the control of these devices (Automatic Transfer, Manual Mode, Testing, etc.) shall be accomplished via the equipment lineup touch screen HMI.

### Voltage sensing on each source shall be three phase with loss of phase and over/under voltage protection. All transfer scheme logic shall be incorporated into and executed by the switchgear control or a comparable Programmable Logic Controller (PLC). The system shall receive the following inputs: source voltage status, breaker status (open, closed, tripped on fault, closing springs charged, racked in or out) for main and bus tie breakers. PLC systems shall use interposing relays for interfacing the PLC outputs with the circuit breaker close and trip circuits. The HMI shall show local indication of the following: transfer scheme status (auto / manual), breaker status, source availability, transfer control status, and control fault. PLC systems shall be powered from the redundant UPSs supplied within the switchgear to ride through any momentary switching of control power sources.

### Basic automatic throwover control logic features shall include: interlocking of the main and bus tie breakers to prevent paralleling sources; time delay for initiating a transfer upon an over/undervoltage or loss of phase condition; time delay for return to normal after the over/undervoltage or loss of phase has been corrected; and blocking transfer, if the main or bus tie breaker trips due to a fault.

### The HMI shall provide the following touchscreen operable system selector switches.

#### Select between auto and manual operation

#### Select automatic re-transfer to normal or manual re-transfer to normal.

#### Select between open transition and closed transition in manual or auto mode.

#### Test mode selector to which simulates a loss of voltage on the selected main and force opening of that main and closure of the tie. Touching the same button again shall initiate a re-transfer back to the normal source.

#### Auto Acquire selector, to allow for system to seek an operable source and reconnect bus to this source (good line seeking).

### The control screen shall include the following indicators.

#### Auto Mode. The Auto indicator shall be off if the system cannot execute an auto transfer, if the system is in the Manual mode or there is a fault or other problem with the transfer system.

#### Breaker status. Indicates if the breaker is open, closed, or tripped and status of the logic operated interlock.

#### Main 1 Source Available.

#### Main 2 Source Available.

#### Transfer mode switch (Auto ON / OFF).

#### System test switches to simulate loss of a source and initiate a transfer

#### Return to normal mode selector (auto or manual, open or closed transition).

#### Semi-auto (Maintenance mode) transfer selector

#### Sync Check status indicator

#### Parallel Selector Switch and indication (trip Main 1, trip Tie, trip Main 2)

### Description of operation - three breaker transfer (main-tie-main), delayed transfer / delayed return. Under normal conditions both main breakers are closed and the bus tie breaker is open. System operation is in the auto position. When an over/undervoltage or loss of phase condition is detected, the program executes, tripping the affected main breaker after the programmed time delay. The control senses the open main breaker status and closes the bus tie breaker. With the return of the affected source, the control trips the bus tie breaker after the programmed time delay. The control senses the open tie breaker and recloses the open main breaker. Simultaneous loss of both sources shall not cause any change in breaker status. Upon return of one source, the control shall immediately trip the main breaker without voltage and close the bus tie breaker.

### Manual operation—Manual operation of a breaker from the touchscreen or the manual pushbuttons on the breaker will cause the auto transfer system to enter the manual mode. Interlocking remains in effect to prevent both main breakers and the tie breaker from being closed at the same time.

## USER METERING

### All breakers shall be monitored for the following parameters. Breaker trip devices are acceptable if they provide all the indicated data as a minimum. Otherwise, provide separate electronic power meters. The values listed below shall be displayed on the equipment lineup HMI.

#### Amperes phase A, amperes phase B, amperes phase C, amperes of the neutral (on a 4 wire system)

#### Volts phase A-B, volts phase B-C, volts phase C-A, Volts phase A-N, volts phase B-N, volts phase C-N. (Line-to-neutral voltage applies to 4-wire systems)

***NOTE TO SPECIFIER: INSERT QUANTITY OF METERING PACKAGES REQUIRED IN PARAGRAPHS BELOW. DELETE THOSE THAT ARE NOT APPLICABLE.***

### [The switchgear shall be capable of monitoring the following metering parameters on [quantity] circuit breakers simultaneously and displaying the values on the equipment lineup HMI. These Expanded metering functions shall have the ability to move from breaker to breaker at the user’s discretion via the lineup HMI interface. If the proposed switchgear does not have the ability to move the metering functions from breaker to breaker, then an acceptable alternative is to supply all breakers with the metering functions listed.

#### Amperes phase A, amperes phase B, amperes phase C, amperes of the neutral (on a 4 wire system)

#### Volts phase A-B, volts phase B-C, volts phase C-A, Volts phase A-N, volts phase B-N, volts phase C-N.

#### Positive Real Energy (+ watt-hours) – 3 phase total and per phase (on wye connected systems)

#### Negative Real Energy (- watt-hours) – 3 phase total and per phase (on wye connected systems)

#### Positive Reactive Energy (+ var-hours) – 3 phase total and per phase (on wye connected systems)

#### Negative Reactive Energy (- var-hours) – 3 phase total and per phase (on wye connected systems)

#### Apparent Energy (volt-ampere-hours) – 3 phase total and per phase (on wye connected systems)

#### Real Power (watts) – 3 phase total and per phase (on wye connected systems)

#### Reactive Power (vars) – 3 phase total and per phase (on wye connected systems)

#### Apparent Power (volt-amperes) – 3 phase total and per phase (on wye connected systems)

#### Power Factor (PF) – 3 phase total and per phase (on wye connected systems). Measurement shall be real power factor, not just fundamental.

#### Minimum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time

#### Maximum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time]

### [The switchgear shall be capable of monitoring the following metering parameters on [quantity] circuit breakers simultaneously and displaying the values on the equipment lineup HMI. These Demand metering functions shall have the ability to move from breaker to breaker at the users discretion via the lineup HMI interface. If the proposed switchgear does not have the ability to move the metering functions from breaker to breaker, than an acceptable alternative is to supply all breakers with the metering functions listed.

#### Amperes phase A, amperes phase B, amperes phase C, amperes of the neutral (on a 4 wire system)

#### Volts phase A-B, volts phase B-C, volts phase C-A, Volts phase A-N, volts phase B-N, volts phase C-N.

#### Positive Real Energy (+ watt-hours) – 3 phase total and per phase (on wye connected systems)

#### Negative Real Energy (- watt-hours) – 3 phase total and per phase (on wye connected systems)

#### Positive Reactive Energy (+ var-hours) – 3 phase total and per phase (on wye connected systems)

#### Negative Reactive Energy (- var-hours) – 3 phase total and per phase (on wye connected systems)

#### Apparent Energy (volt-ampere-hours) – 3 phase total and per phase (on wye connected systems)

#### Real Power (watts) – 3 phase total and per phase (on wye connected systems)

#### Reactive Power (vars) – 3 phase total and per phase (on wye connected systems)

#### Apparent Power (volt-amperes) – 3 phase total and per phase (on wye connected systems)

#### Power Factor (PF) – 3 phase total and per phase (on wye connected systems). Measurement shall be real power factor, not just fundamental.

#### Minimum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time

#### Maximum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time]

#### Previous interval kilowatt (kW) demand.

#### Maximum kW demand.

#### Previous interval kilovar (kvar) demand.

#### Maximum kvar demand.

#### Previous interval kVA demand.

#### Maximum kVA demand.

#### Demand logging for kWh, kvarh, kW demand, kvar demand, power factor.

### [The switchgear shall be capable of monitoring the following metering parameters on [quantity] circuit breakers simultaneously and displaying the values on the equipment lineup HMI. These Harmonics metering functions shall have the ability to move from breaker to breaker at the users discretion via the lineup HMI interface. If the proposed switchgear does not have the ability to move the metering functions from breaker to breaker, than an acceptable alternative is to supply all breakers with the metering functions listed.

#### Amperes phase A, amperes phase B, amperes phase C, amperes of the neutral (on a 4 wire system)

#### Volts phase A-B, volts phase B-C, volts phase C-A, Volts phase A-N, volts phase B-N, volts phase C-N.

#### Positive Real Energy (+ watt-hours) – 3 phase total and per phase (on wye connected systems)

#### Negative Real Energy (- watt-hours) – 3 phase total and per phase (on wye connected systems)

#### Positive Reactive Energy (+ var-hours) – 3 phase total and per phase (on wye connected systems)

#### Negative Reactive Energy (- var-hours) – 3 phase total and per phase (on wye connected systems)

#### Apparent Energy (volt-ampere-hours) – 3 phase total and per phase (on wye connected systems)

#### Real Power (watts) – 3 phase total and per phase (on wye connected systems)

#### Reactive Power (vars) – 3 phase total and per phase (on wye connected systems)

#### Apparent Power (volt-amperes) – 3 phase total and per phase (on wye connected systems)

#### Power Factor (PF) – 3 phase total and per phase (on wye connected systems). Measurement shall be real power factor, not just fundamental.

#### Minimum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time

#### Maximum Power Factor (PF) – 3 phase total and per phase (on wye connected systems) with date and time]

#### Previous interval kilowatt (kW) demand.

#### Maximum kW demand.

#### Previous interval kilovar (kvar) demand.

#### Maximum kvar demand.

#### Previous interval kVA demand.

#### Maximum kVA demand.

#### Demand logging for kWh, kvarh, kW demand, kvar demand, power factor.

#### K factor for each phase.

#### Voltage Total Harmonic Distortion (VTHD) for each phase.

#### Current Total Harmonic Distortion (ITHD) for each phase.

#### Frequency spectrum (magnitude only) for each voltage and current phase up to the 31st harmonic. These values shall be graphically displayed as a bar graph on the equipment HMI interface.

### [Waveform capture of all phase and neutral currents and voltage, phase-to-phase or phase-to-neutral, at all circuit breakers shall be triggered from a trip, an alarm or a manual initiation. These waveforms shall be viewed on the system HMI. The same waveform capture capability detailed above can also be provided by using a dedicated waveform capture meter on all circuit breakers and connecting these meters to the HMI interface. Provide any required software so that the user can view and manipulate the voltage and current waveforms from the HMI.]

### Addition of more metering capability in the future shall not require additional instrument transformers or wiring within the switchgear assembly. All required wiring for present and potential future metering shall be included in the package provided as part of this project.

## METERING TRANSFORMERS

### All instrument transformers shall be UL listed and classified as indicated in drawings.

### Current Transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].

### Potential transformers shall be provided where indicated on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].

## DISCRETE I/O INTERFACE

### All system information shall be available via Modbus TCP/IP. This includes system status and health, breaker status, overcurrent and protective relay status and settings, and alarms. For external systems interface requiring the use of dry contact inputs and outputs, provide an I/O (discrete Input / discrete Output) device incorporated into the lineup with a capacity of [up to 64] [up to 128] points.

### The total number of digital input points shall equal [Insert the number of digital input points in multiples of sixteen].

### The total number of digital output points shall equal [Insert the number of digital output points in multiples of sixteen].

### For I/O details refer to project drawing – interface details.

### Provide redundant control of I/O points.

## SCADA INTERFACE

### The system will be provided with 3 (three) copper 10/100 Base T user ports (RJ-45 female receptacle) as standard. The communications protocol for the system will be an open architecture Modbus TCP-IP.

### [In addition to the standard copper connection ports, a fiber optic external communication port shall be provided.]

### Provide a firewall device to restrict access into this communications environment.

## ACCESSORIES

### Provide circuit breaker spreader-lifting unit for lifting every circuit breaker frame size contained in the lineup.

### [Integral breaker lifting device shall be rail mounted on top of equipment, hand operated and movable. The rail system shall be affixed to every vertical section that contains a circuit breaker cubicle.]

### [Furnish a portable breaker lifting device. The device shall be capable of rolling on the floor and shall be hand operated. ] [Additionally, a transfer truck shall also be supplied to provide a convenient method to transport the removed circuit breakers].

### [A test kit shall be provided to independently test breaker overcurrent tripping functions and operational readiness].

### [A remote racking mechanism shall be provided to minimize risk from an arc flash, allowing the operator to remotely rack a breaker in/out up to 30 feet away from the front of the equipment.]

### [A separate test cabinet for the circuit breakers shall be provided to test the breaker charging, tripping and closing functions external to the lineup.]

### [A mimic bus shall be provided on the front of the equipment to diagrammatically show the internal bus structure of the lineup. Mimic bus material shall be [adhesive vinyl] [laminated plastic strips mounted to the equipment using[standard screws][stainless steel screws]].

#### The mimic bus size shall be [3/8 inch wide][1/2 inch wide].

#### The mimic bus color shall be [red] [orange] [brown] [green] [blue] [black] [yellow] [white] [Insert special mimic bus color].]

## TESTING

### Manufacturer shall perform the following production tests on the assembled switchboard:

#### Device check – visual inspection of device catalog number to verify compliance to specification.

#### Control lead check – continuity test to ensure correctness of all wiring.

#### Instrument transformer ground test – verify that instrument transformer frame is grounded.

#### Meter and relay check - induce current on the secondary side of current and voltage transformers to verify device functionality.

#### Control power check – apply power to control circuits.

#### Bus check – visual check of phase, neutral, and ground buses in accordance with switchboard one-line diagram.

#### Clearance check – inspect buses and devices for proper electrical clearances.

#### Connection test – check tightness of all bolted connections.

#### Nameplate check – verify nameplate engraving and location are per drawings.

#### Current and voltage transformer polarity check – visually inspect transformer polarities are in accordance with drawings.

#### Secondary high potential test – 1500vAC for 1 minute on control wiring.

#### Primary high potential test – 2200vAC for 1 minute on bus system.

#### Power management communication test – verify all devices are able to communicate on the switchboard communication bus.

### [Factory certified test reports shall be issued at the conclusion of the factory testing. The format of the information shall be the same as described in the “Approval and Record documentation” section above.]

### [Factory witness testing shall be provided. The manufacturer shall notify the owner/engineer at least 2 weeks in advance of the test date. The test shall demonstrate the successful operation of the equipment as it will operated in the owner’s facility.]

### [Customer inspection shall be provided so that the owner/engineer/owner’s representative can visit the factory and view the assembled equipment prior to it’s shipment to visually confirm the correctness of the final product prior to shipment. The manufacturer shall notify the owner/engineer at least 2 weeks in advance of the final assembly date.]

## FINISH

### The switchgear shall be painted using a polyester powder coat process. Prior to powder coating, the steel parts shall go through a 10-stage cleaning process and a dry-off oven. Steel parts shall pass through a series of sensors at the start of the automatic spray booth to set the position of the spray guns. Parts shall be coated with 2-3 mils of ANSI 61 light gray polyester powder, applied by 16 automatic spray guns in 4 zones. Powder coated parts shall be routed through a curing oven and cooling area prior to being assembled in the switchgear. Paint qualification test shall be per UL-1558 and ANSI/IEEE C37.20.1.

# EXECUTION

## EXAMINATION

### The contractor/installer shall verify that the ABB Entellisys low voltage metal enclosed integrated switchgear system lineup is ready to install before installing

### The contractor/installer shall examine the installation area to assure there is enough clearance to install the low voltage switchgear such that it will fit in the allocated space in full compliance with the minimum required clearances recommended by the manufacturer, specified in National Electrical Code and required by any applicable local/facility constraints.

### The contractor/installer shall check concrete pads for uniformity and level surface.

### The contractor/installer shall verify that the field measurements are as shown on drawings.

### The Contractor/Installer shall verify that required utilities are available, in proper location and ready for use.

### Beginning of installation means installer accepts conditions.

## LOCATION

### Refer to the site drawings for details.

## INSTALLATION

### The contractor/installer shall furnish and completely install Entellisys low voltage metal enclosed integrated switchgear system lineup as shown on the drawings and per manufacturer's installation instructions.

### After the lineup has been completely assembled, a ABB start-up service engineer shall provide factory startup/commissioning.

### The contractor/installer shall provide and install any required safety labels.

## FIELD QUALITY CONTROL

### The contractor/installer shall inspect the installed low voltage switchgear lineup for proper anchoring, alignment and grounding as well as inspecting for any internal and external physical damage.

### The contractor/installer shall check tightness of all accessible mechanical and electrical connections with a calibrated torque wrench. Minimum acceptable values are specified in the manufacturer's instructions.

### The contractor/installer shall refer to manufacturer's instruction books for any other equipment requirements.

### The contractor/installer shall test the main-tie-main automatic breaker transfer system for proper functioning and accurate sequence of operation if such a system is provided.

### The contractor/installer shall test each key interlock system for proper functioning if keyed interlocks are provided.

## ADJUSTING

### The contractor/installer shall adjust all access doors and operating handles for free mechanical and electrical operation as described in the manufacturer's instructions.

### The contractor/installer shall refer to the manufacturer's instruction book to make adjustments to mechanisms, doors, handles, interlocks, etc. as required.

### The contractor/installer shall return "odd/extra-startup" key interlock keys to the engineer before energizing equipment.

### As part of the manufacturer-provided start-up services, the manufacturer’s service engineer shall set all adjustable protective devices to the values recommend in the coordination study - refer to the separate “Short Circuit and Coordination Study” specification contained in this project specification document for additional information.

## CLEANING

### The contractor/installer shall clean the interior and exterior of the switchgear to remove construction debris, dirt, and shipping materials.

### The contractor/installer shall repaint scratched or marred exterior surfaces to match original finish.

## TRAINING

### Provide the services of a factory trained field engineer for training at owner's job site. Training shall include instructions on adjusting, servicing and maintaining the low voltage metal enclosed integrated switchgear system switchgear assemblies. The field engineer shall be at the site for a single eight hour shift.

# END OF SECTION