14. WIRING DEVICES

The catalog numbers listed for wiring devices are generally for 20A rated devices. Where 15A rated devices are indicated on the drawings or required for circuit rating limitations, provide wiring devices equivalent to those specified for 20A, but rated for 15A.

All receptacles located outdoors or in damp or wet locations: Listed as 'weather Resistant', designated by a 'WR' on the faceplate.

Minor changes relative to the location of electrical equipment may be made to comply with structural and building requirements as determined in the course of construction. Provide all wiring devices of the same manufacturer and not mixed on the project, to the maximum extent possible. Provide color of toggles and receptacles as requested by the Architect.

Wiring Devices: Unless noted otherwise, devices shall be commercial grade and rated for 20A. Wiring device manufacturers: Cooper, Hubbell, Legrand, or Leviton.

Floor Boxes: UL 514A listed for scrub water exclusion. For slab on grade - Watertight, Class 1, and fully adjustable cast iron box. For slab above grade - Concrete-tight, fully adjustable, stamped galvanized steel box. Floor box shape, quantity of gangs, type and quantity of devices, finish, and flange type per drawings. Floor box manufacturers: Hubbell, Legrand, Thomas and Betts, or Walker.

Fire-Rated or Pedestal Poke-Thru Devices: NRTL listed and NRTL fire classified with one- to four-hour fire rating as required by floor rating and type. Cover must be UL 514A listed for scrub water exclusion. Poke-Thru shape, quantity of gangs, type, and quantity of devices, finish, and flange type per drawings. Poke-thru device manufacturers: Hubbell or Legrand.

Switch Installations in Door/Side Light Frames: Despard type ivory switch, Pass and Seymour ACD201-i or approved equal.

Switch and Pilot Installations: One Despard type ivory switch and one Despard type flush 1/25 Watt neon pilot light, both installed in a single-gang box with cover plate. Pass and Seymour ACD201-IV switch and 1475 pilot light, or approved equals.

Type of Device	Hubbell	Pass & Seymour	Leviton	Cooper Wiring Devices
Duplex Receptacles – Commercial Grade				
Duplex Receptacle	BR20	CR20	CR20	CR20
Duplex Receptacle – Weather resistant	BR20WR	WR20TRW	WBR20	WRBR20
Isolated Ground (IG) Receptacle	IG20CR	IG5362	5362–IG	IG5362
Other Receptacles				
GFCI Receptacle	GF20LA	2095	7899–H	VGF20
GFCI Receptacle – Weather resistant	GFTR20	2095TRWR	W7899	WRVGF20

15. SWITCH AND OUTLET COVER PLATES

Switch and Outlet Plates: Colored, smooth nylon as directed by Architect; by the same manufacturer as the wiring devices, wherever possible. Verify desired materials and colors with Architect before installation. Switch plates in unfinished rooms and spaces: Stamped steel, cadmium plated. Install groups of switches under one ganged-plate, usually horizontally; or, where required by details, vertically. Set all cover plates plumb, parallel, and finished flush with the wall.

16. WEATHERPROOF COVER PLATES

Provide GFCI receptacles for designated weatherproof receptacles, unless indicated otherwise on the drawings.

Unattended Exterior, Wet Locations or Other Locations as Indicated: In-use, NEMA 3R, recessed or flush mount, NRTL labeled plates molded from a clear high impact ultraviolet stabilized polycarbonate material for easy verification that cords are plugged in and that the GFCI is functioning. Back box must be suitable for conduit connecting. Coordinate back box with wall depth. Intermatic WP1000RC/HRC or equal.

Cover Plates: By the same manufacturer as the wiring devices; complying with NFPA 70 ARTICLES 406.9 (A) or (B) requirements for attended or unattended use as applicable.

17. ELECTRICAL SERVICE AND GROUNDING

A. ELECTRICAL SERVICE

See drawings for type, size, voltage, phase, and other requirements.

Provide, or arrange with the serving utility for installation to provide, a recording voltmeter at the service point, on the first day the facility is open for business, for a 24-hour voltage test. If voltage and regulation are not within acceptable limits, arrange with the utility for proper voltage. Submit to the Owner a report of maximum and minimum voltage and a copy of the recording voltmeter chart.

B. CONNECTION TO SERVING UTILITIES

Provide raceways, terminations, metering provisions, and miscellaneous equipment as required for electrical and telephone services for connection by the serving utility, in strict compliance with the requirements of all applicable codes and of the serving utility involved. Verify all service terminations and connection points in the field and work in conjunction with the utility involved in the installation of all services. Provide all materials and equipment required for complete utility connection but not furnished by the serving utility. Notify the utility companies involved within two weeks after notice to proceed of all required information necessary for the utility to supply the project without delay. Pay all charges of the serving utility for the electrical service(s).

C. GROUNDING

Permanently and effectively ground and bond the electrical installation in a thorough and efficient manner, and in conformance, at a minimum, with NFPA 70, or these documents, where they exceed code requirements. Use bare or insulated conductors as specified herein, and other materials indicated on the Drawings.

18. DISTRIBUTION AND CONTROL EQUIPMENT

D. LIGHTING AND APPLIANCE PANELBOARDS

Panelboards: Complete with bolt-on thermal magnetic, molded case circuit breakers assembled in a dead-front finished cabinet containing a typewritten card directory indicating exactly what each circuit breaker controls; fully- [or] [series-] rated and with the integrated short circuit current ratings indicated on the drawings. Plug-in type breakers will not be acceptable. All two- and three-pole breakers: Common trip type.

1. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip). Use as indicated on drawings.
2. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip). Use as indicated on drawings.
3. Handle Clamp: Loose attachment for holding circuit breaker handle in "on" position. Use for all circuits containing emergency lighting loads, fire alarm loads, and as indicated on drawings. Breakers serving fire alarm loads must have a permanently-affixed red label stating "FA" in white letters adjacent to the circuit breaker.
4. Handle padlocking device: fixed attachment for locking circuit breaker handle in "on" or "off" position. Use as indicated on drawings.

Manufacturers: Square D Type NQ or NF (as applicable, based on voltage and ampere ratings and required short circuit interrupting ratings as scheduled on the drawings) or approved equal by Eaton, G.E., or Siemens.

[illegible] DISCONNECT (SAFETY) SWITCHES

Disconnect (Safety) Switches: Heavy-duty, fused or non-fused (as indicated on drawings or required) NEMA [illegible], externally operated, visible-blade safety switches; NEMA enclosure type indicated on the drawings suitable for the environment in which installed. based on fusible switch and fuse sizes indicated. Include Class R, J, or L fuse provisions as applicable.

Where indicated, provide fusible switches permanently labeled as suitable for use as service entrance equipment, with integral and separate neutral and ground assemblies, suitable for the sizes of conductors indicated. Do not double-lug any terminations not specifically listed as suitable for more than one conductor.

Provide switches where not furnished with the starting equipment, at all other points required by NFPA 70, and where indicated on the drawings.

Manufacturers: Eaton, G.E., Siemens, or Square D.

M. FUSES

Provide each circuit and set of fuse clips throughout the work with sizes and types as required or indicated. All fuses larger than 600A: UL Class L, similar to type KRP-C Bussmann Low Peak or equal. Fuses used to protect motors: UL Class RK5, Bussmann Fusetron or equal. Fuses used to protect all other electrical equipment: UL Class RK1, dual element, Bussmann LPS/LPN or equal. All fused devices shall be labeled as to type and size of fuse required.

Furnish three spare fuses of each size and type used on the project (except for main switch fuses, furnish one spare), neatly contained in a properly labeled cabinet.

Manufacturers: Bussmann, Edison Fuse, Mersen/Ferraz Shawmut, or Littlefuse.

N. FRACTIONAL HORSEPOWER MANUAL CONTROLLER

Manual motor starters for fractional horsepower single-phase motors shall consist of a manually operated toggle switch equipped with melting alloy type overload relay. Thermal unit shall be of one piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed. Provide flush mounted units in finished areas and surface mounted units in unfinished areas. Starters shall have NEMA I general purpose enclosure, unless otherwise indicated, and be rated for the motor horsepower required. Provide with handle guard with locking provisions and an integral pilot light.

Manufacturers: Square D Class 2510 Type F, Eaton 9101 series, G.E. CR101 series, Siemens MSF series, or Westinghouse MST series.

19. LIGHT FIXTURES, LAMPS AND BALLASTS

A. LIGHT FIXTURE LOCATIONS

Light fixtures shown on the drawings represent general arrangements only. Refer to architectural drawings for more exact locations. Coordinate location with all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.

B. LIGHT FIXTURES

Provide light fixtures as scheduled on drawings, including all lamps, all necessary accessories, material and labor to securely hang, clean, and make light fixtures completely ready for use. Light fixture model numbers scheduled on the drawings show only the manufacturer, grade, and style of light fixtures required. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures, proper trim to fit each ceiling condition actually encountered, and additional tie wires connected to structure to conform to seismic requirements where required by the applicable building code.

Packaging of light fixtures will not be allowed. Only those luminaires listed in the Light Fixture Schedule or approved in accordance with substitutions of these specifications will be accepted. Where the Light Fixture Schedule indicates an allowance for a specific light fixture, the price is a Contractor price. Include all additional costs for freight, lamps, and installation of light fixture and lamps.

Install fluorescent light fixtures hung in continuous rows on channel struts specifically designed for this purpose.

Surface-mount all fluorescent light fixtures located in areas with a ceiling but without suspended ceilings unless otherwise indicated on the drawings. Provide rigid metal spacers finished in white enamel between the top of each light fixture and the ceiling above to maintain a 1-1/2 inch space. Spacers shall be approved before installation.

Install all fluorescent light fixtures located in areas without ceilings immediately below the roof-framing members, or suspended from chain hangers suitable in length to provide the indicated mounting height. Hangers: "Hydee" hanger type for outlet box mounting, complete with grounding receptacle, plug, 3-wire cord, and necessary chain.

Through-wiring of recessed light fixtures in suspended ceilings is not permitted. Connect each light fixture by a whip to a junction box. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.

C. EMERGENCY LIGHTING UNITS AND EXIT SIGNS

Description: Self-contained units complying with UL 924.

Battery: Sealed, maintenance-free, lead-acid type. The batteries shall be of suitable rating and capacity to supply and maintain at not less than 87-1/2 percent of the nominal battery voltage for the total lamp load associated with the unit for a period of at least 1-1/2 hours, or the unit equipment shall supply and maintain not less than 60 percent of the initial emergency illumination for a period of at least 1-1/2 hours.

Charger: Fully automatic, solid-state type with sealed transfer relay.

Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power, and demonstrates unit operability.

LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge, and bright glow indicates charging at end of discharge cycle.

Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

Integral Time-Delay Relay: Holds unit on for fixed interval of [15] <Insert period> minutes when power is restored after an outage.

Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

D. LAMPS

Refer to lighting consultant specifications and light fixture schedule for all lamp requirements.

Provide lamps and color temperatures as indicated on the drawings for all light fixtures; or, if not indicated, per the Architect and/or lighting designer. Lamps shall be by the same manufacturer for color consistency. Lamps shall be compatible with the specified light fixture. Fluorescent, metal halide, and incandescent lamp manufacturers: Eiko, G.E., Osram/Sylvania, Philips, Soraa, or Venture.

Fluorescent Lamps: Low-mercury type in compliance with NEMA LL 1; minimum color-rendering index (CRI) of 82 unless noted otherwise; minimum average rated life of 24,000 hours.

Incandescent Lamps: Type and wattage as shown on the drawings; rated 130V unless otherwise scheduled or specified.

LED Lamps and Luminaires: Comply with ANSI C78.377 for white light LED color ranges; minimum CRI of 80 unless noted otherwise; LED binning specification tolerance to be within 3 macadam ellipses of rated values; all LEDs used for same fixture type throughout the project must originate from the same production bin; minimum average rated life of 20,000 hours for LED lamps and 50,000 hours for LED luminaires; Rohs compliant. LED lamp manufacturers: Bridgelux, Cree, Nichia, Osram or Xicato.

E. BALLASTS

Fluorescent Ballasts (General Requirements): Comply with [illegible] and ANSI C82.11; designed for type and quantity of lamps served; high-efficiency electronic type; NEMA premium label for linear lamps; electronic; sound levels not exceeding Class A ambient noise levels; line transient withstand ratings as defined in ANSI/IEEE C62.41, Category A; lamp current crest factor of 1.7 or less; 95-percent power factor or greater; low [illegible]; thermally protected against overheating. Ballasts in indoor locations shall have disconnecting means, either internal or external to the luminaire. Fluorescent ballast manufacturers: Philips Advance, [illegible], Fulham, G.E., Osram/Sylvania, Robertson, Lutron, or Universal.

Indoor Fluorescent Ballasts: 10 percent or less total harmonic distortion; operating frequency of 42 kHz or greater with no visible flicker.

Compact Fluorescent Ballasts: 20 percent or less total harmonic distortion; operating frequency of 20 kHz or greater with no visible flicker.

LED Drivers: Comply with NRTL requirements and ANSI C82.77; designed for type and quantity of lamps served; sound levels not exceeding Class A ambient noise levels; lamp current crest factor of [illegible] or less; 9[illegible]-percent power factor or greater; line transient withstand ratings as defined in ANSI/IEEE C62.41, Category A.; total harmonic distortion less than 20 percent; shall tolerate sustained open circuit and short circuit output conditions without damage; shall not over-drive LEDs at a current or voltage above LED rated values; ROHS compliant; meets EN610000 requirements for input harmonics.

20. MISCELLANEOUS ELECTRICAL

A. WIRING OF MECHANICAL EQUIPMENT

Provide all raceways and power wiring for all Division 23 equipment requiring electrical connections, including but not limited to pumps, water heaters, and HVAC equipment, and all line-voltage control and interlock wiring not provided under Division 23. Connect per manufacturers' wiring diagrams. Coordinate with Division 23 for disconnects and variable frequency drives (VFD) furnished with equipment, and provide all disconnect switches and final connections as required. If VFD is separate or does not have an integral disconnect feature, provide disconnect switch with auxiliary contact such that motor will be turned off if switch is off. provide VFD cable, Belden or approved equivalent, for connection of VFD to motor when required. After installing wiring, verify that each motor load has the correct phase rotation.

Verify the actual "Maximum Overcurrent Protection" (MOCP) device ratings and "Minimum Circuit Ampacity" (MCA) conductor sizing for mechanical equipment from the equipment nameplate. Base electrical installations on actual required amperages, which may vary somewhat from the conductor and equipment sizes shown on the drawings; however, in no case, reduce the size of conductors indicated on the drawings without authorization from the Engineer. Provide properly sized electrical wiring and equipment without extra cost to the Owner. Notify the Engineer of all changes required in the electrical installation due to equipment variances so that the effects on feeders, branch circuits, panelboards, fuses and circuit breakers can be checked prior to purchasing and installation. Be responsible for coordinating with Division 23 to verify the actual ampacities and correct sizes of all conductors and overcurrent protective devices for all equipment, and correct overload heaters for all motors, when starters are provided under Division 26.

B. WIRING OF THERMOSTATS, TIME AND TEMPERATURE CONTROLS

Provide all raceways, power wiring, and line-voltage control and interlock wiring not provided under Division 23, for all thermostats, temperature control devices, and controls, including, but not limited to, night-stats, water heater interlocks, time switches and override timers. See mechanical drawings for locations and temperature control diagrams. Low-voltage conductors for thermostats and temperature control system may be run exposed above finished accessible ceilings, if approved and listed for this purpose, but shall be installed in conduit within walls and where exposed in the work areas.

C. TELEPHONE SYSTEM PROVISIONS

Provide incoming telephone service raceways as indicated on drawings or as required by the serving telephone company. Provide 3/4-inch thick plywood board, fire-retardant-treated and stamped FRT, securely anchored to the wall, at the location and of the size as indicated on the drawings. Provide flush mounted telephone outlet boxes with 1 inch conduit stub-up with pull-string concealed to accessible ceiling space at locations as indicated on the drawings.

D. DATA SYSTEM PROVISIONS

Provide flush mounted data outlet boxes with 1 inch conduit stub-up with pull-string concealed to accessible ceiling space at locations as indicated on the drawings.

E. TIME SWITCHES

Manufacturers: Intermatic, Paragon, or Tork.

Time switches: Electronic digital [Mechanical] astronomical, type as indicated, with manual bypass switch, NEMA enclosure suitable for the environment installed; number and types of contacts, sequence, and voltage as indicated on the drawings, or as required, based on the time switch function and the number of branch circuits or contactors controlled. Provide wiring to photocells, contactors, relays or other control points as required.

F. LIGHTING CONTACTORS

Industrial duty type; silver alloy, double break contacts, convertible with N.O. and N.C. indicators; capable of adding poles in the field; number and rating of poles as indicated on the drawings or required by the load controlled; typed directory affixed to the inside of the enclosure door listing all branch circuits switched and the control power branch circuit; complying with NEMA ICS 2 and UL 508.

Short Circuit Current Rating: 22,000A at 240V maximum and 14,000A at 480V maximum 100,000a.

Fusing: Provide fuse blocks and fuses in the contactor enclosures, of the ampacity and Class recommended by the manufacturer to obtain a contactor minimum RMS symmetrical short circuit current rating of 100,000A. Mount fuse blocks ahead of the input to each contact, both used and spare (if any). Also provide a fuse puller and spare fuses (25-percent of total fuses or a minimum of 2 of each rating, whichever is greater) affixed to the inside of the enclosure.

Enclosures: NEMA as indicated on the drawings.

Coil Voltage: as indicated on the drawings.

Mechanically-held type, control interface shall be as indicated on the drawings; Square D Class 8903 LX or equivalent of G.E., Siemens, Cutler Hammer, or ASCO.

Electrically-held type, control interface shall be as indicated on the drawings; Square D Class 8903 L or equivalent of G.E., Cutler Hammer, Siemens, or ASCO.

G. SIGNALING SYSTEM

Provide a complete and functioning 24V signaling system for loading door signals, and others as indicated on the drawings. Low-voltage conductors for signaling system may be run exposed above finished ceilings, but shall be installed in conduit within walls and where exposed in the work areas.

Signal bell units shall be 4-inch, single-stroke type, Edwards Signaling and Security Systems (Edwards) No. 332-4G5 or equal, for 24Vac operation, installed on a standard single-gang box. Transformers shall be Edwards 590 Series or equal, having adequate capacity for the connected load plus 10-percent at 24Vac, and mounted in a standard two-gang box. Exterior push button shall be Edwards No. 1786-C with solid brass cap.

Customer signal units shall consist of an Edwards No. 620-B pushbutton in a 5/8-inch ID chrome plated pipe or conduit with an Edwards No. C-75 "Cadet" two-note chime and transformer contained in a weatherproof enclosure as required, as located on the drawings.

H. EXISTING FIRE ALARM SYSTEM MODIFICATIONS

Provide new equipment compatible with and connected to the existing fire alarm control system. Modify in accordance with NFPA 72 as applicable and with the AHJ.

1. Provide all required initiating devices, notification appliances, auxiliary devices, and interconnecting circuits.
2. Provide additional auxiliary panels as required to power new equipment for scope of work.
3. Sequence of operations shall match that of the existing system.
4. All wiring and cable shall match that of the existing system and be in accordance with applicable codes.
5. Contractor shall install, program, and test all new/existing equipment to ensure system functionality per NFPA 72 requirements for the scope of work.

END OF SECTION 26

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - General

1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices.
   1. Also include coordination of series-rated devices where series rating is specified in other sections and where indicated on Drawings.
   2. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the fault current study. Device ratings for furnished equipment shall be as required by the results of the fault current study at no additional cost.

B. Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project.

1.2 SUBMITTALS

A. Product Data: For computer software program to be used for studies.
B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
C. Qualification Data: For coordination-study specialist.
D. Other Action Submittals:
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Coordination-study report.
   3. Equipment evaluation report.
   4. Arc-Flash Hazard Analysis.
   5. Setting report.
E. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
   1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.

1.3 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
C. Comply with IEEE 399 for general study procedures.
D. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
E. Comply with IEEE 1584 and NFPA 70E for arc-flash [illegible] calculations.

PART 2 - Products and Materials

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:
   1. CYME International, Inc.
   2. EDSA [illegible] Corporation.
   3. Electrical Systems Analysis, Inc.
   4. SKM Systems Analysis, Inc.
   5. Operation Technology, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.
B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.
C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.
   1. Zero sequence current [illegible]
   2. Arcing faults.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.
C. Fault current study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.
D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project's utility company confirms the available fault current. A final coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity. For the components of emergency and legally required standby system components, full selectivity must be maintained.

3.2 system components to be included in studies

A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths on both sides of any transfer switch, contactor or circuit breaker.
B. Components include, but are not limited to:
   1. Switchgear
   2. Switchboards
   3. Distribution Panelboards
   4. Panelboards
   5. Air Handling Equipment
   6. Roof Top HVAC equipment

3.3 Power system data for studies

A. Gather and tabulate the following input data to support studies:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical distribution system diagram showing the following:
      a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
      b. Circuit-breaker and fuse-current ratings and types.
      c. Relays and associated power and current transformer ratings and ratios.
      d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      e. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Magnetic inrush current overload capabilities of transformers.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      d. Ratings, types, and settings of utility company's overcurrent protective devices.
      e. Special overcurrent protective device settings or types stipulated by utility company.
      f. Time-current-characteristic curves of devices indicated to be coordinated.
      g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
      h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
      i. Panelboards, switchboards, motor-control center ampacity, and interrupting ratings in amperes rms symmetrical.

3.4 FAULT-CURRENT STUDY

A. Source Impedance: Utility company's fault-current contribution as indicated
B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
D. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.
E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
   1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
   2. Low-Voltage Fuses: IEEE C37.46.
   3. Circuit Breakers: IEEE C37.13.
F. Study Report:
   1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
   2. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.
G. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.5 COORDINATION STUDY

A. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.
B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.
C. Comply with IEEE 241 recommendations for fault currents and time intervals.
D. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.
E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.
F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
      c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
      d. Fuse-current rating and type.
      e. Ground-fault relay-pickup and time-delay settings.
   2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve the level of selective coordination required in the contract documents or by the edition of the National Electrical Code (including any local jurisdiction amendments) the project must comply with. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
      a. Device tag.
      b. Voltage and current ratio for curves.
      c. Three-phase and single-phase damage points for each transformer.
      d. No damage, melting, and clearing curves for fuses.
      e. Cable damage curves.
      f. Transformer inrush points.
      g. Maximum fault-current cutoff point.
   3. Completed data sheets for setting of overcurrent protective devices.

3.6 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.
   1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
      a. Verify that overcurrent protective devices meet parameters used in studies.
      b. Adjust devices to values listed in study results.
      c. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.7 Arc-Flash hazard analysis

A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies. Perform the analysis under worst-case arc-flash conditions for all modes of operation.
B. Indentify all locations and equipment to be included in the arc-flash hazard analysis:
   1. Include a copy of the facility one-line in the report.
   2. Indentify the possible system operating modes including tie-breaker positions and parallel generation.
   3. Calculate the arcing fault current flowing through each branch for each fault location.
   4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.
   5. Select the working distances based on system voltage and equipment class.
   6. Calculate the incident energy at each fault location at the prescribed working distance.
   7. Determine the hazard/risk category (HRC) for the estimated incident energy.
   8. Calculate the flash protection boundary at each fault location.
   9. Document the assessment in reports and one-line diagrams.
   10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.
C. Results of the arc-flash study shall be summarized in a final report containing the following:
   1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
   2. Tabulation of the data used to model the system components and a corresponding one-line diagram.
   3. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment ratings.
   4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.
   5. Required arc-flash labeling and placement of labels.
   6. Conclusions and recommendations.

RGLA

rgla solutions, inc.
5100 River Road, Ste 125
Schiller Park, IL 60176
p: 847.671.7452
f: 847.671.4200
www.rgla.com

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ISSUE FOR BID, CLIENT, LANDLORD AND PERMIT	11/01/2017
ISSUE FOR PERMIT	11/17/2017

robert g. lyon + associates, inc.
retail architecture
5100 River Road, Ste 125
Schiller Park, IL 60176
p: 847.671.7452
f: 847.671.4200
www.rgla.com

WRITTEN DIMENSIONS ON THESE DRAWINGS SHALL HAVE PRECEDENCE OVER SCALED DIMENSIONS: CONTRACTORS SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS AND CONDITIONS ON THE JOB AND THIS OFFICE MUST BE NOTIFIED OF ANY VARIATIONS FROM THE DIMENSIONS AND CONDITIONS SHOWN BY THESE DRAWINGS. SHOP DETAILS MUST BE SUBMITTED TO THIS OFFICE FOR APPROVAL BEFORE PROCEEDING WITH FABRICATION.

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8345 LENEXA DRIVE, SUITE 300
LENEXA, KS 66214
TEL (913) 742-5000 FAX (913) 742-5001
WWW.HENDERSONENGINEERS.COM
1750003858
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DAVID D. HAKE