## 1 General

### 1.1 DIVISION 16 - ELECTRICAL

.1 Winnipeg Fire Station
Winnipeg, ON

.2 Sub-Contractors

.1 Each bidder for the work of Division 16: Electrical shall submit this Supplementary Bid Form completed in full with Bid closing to the Prime Consultant.

.2 This document, on acceptance by the Consultant, will be included in the Contract Documents, and shall govern the work of Division 16.

| TRADE | SUB-CONTRACTOR |
|---|---|
| Excavating & Backfilling | _____ |
| Fire alarm System Verification | _____ |

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**LABOUR RATES**

Indicate on the appropriate space below the unit labour rate required for additional work and work to be deleted in changes to the contract under "Part 6" for 1994 version of the General Conditions of the Stipulated Price Contract. Rates indicated shall include all allowances for foremen etc. but shall not include Contractor's overhead and profit margins, and shall be based on regular working hours. The Owner reserves the right to negotiate labour rates prior to award of Contract.

| **TRADE** | **HOURLY RATE** |
|---|---|
| Labourer | $_____/hr |
| Electrician | $_____/hr |
| Fire Alarm System Verifier | $_____/hr |

## 1.2 PRODUCTS

**PRODUCTS**

Indicate in the appropriate space below the manufacturer of equipment items included in the Bid Price, and the name of any manufacturer whose equipment is proposed as an alternative to that specified (refer to Section 16010, paragraph 2.3). The failure to indicate a specific manufacturer shall be taken to mean that product of the manufacturer first indicated in the specification are included in the Bid Price. This list is intended to cover only major equipment items and shall in no way limit the extent of the Contract.

| | PRODUCT | SPECIFIED MANUFACTURER INCLUDED IN BASE BID | CONTRACTOR'S PROPOSED ALTERNATIVE |
|---|---|---|---|
| 16141 | CABLETRAYS AND J-HOOKS | | |
| 16131 | SPLITTERS, JUNCTION, PULL BOXES AND CABINETS | | |
| 16132 | OUTLET BOXES, CONDUIT BOXES AND FITTINGS | | |
| 16141 | WIRING DEVICES | | |
| 16191 | FASTENINGS AND SUPPORTS | | |
| 16195 | ACCESS PANELS, SERVICE PENETRATIONS | | |
| 16199 | SEISMIC RESTRAINTS | | |
| 16421 | SERVICE ENTRANCE SWITCHBOARD | | |
| 16428 | DIGITAL METERING SYSTEM | | |
| 16440 | DISCONNECT SWITCHES | | |
| 16471 | PANELBOARDS-BREAKER TYPE | | |
| 16477 | MOULDED CASE CIRCUIT BREAKERS | | |
| 16478 | FUSES-LOW VOLTAGE | | |
| 16485 | CONTACTORS | | |
| 16505 | LIGHTING EQUIPMENT | | |
| | FIXTURE TYPE AA | | |
| | FIXTURE TYPE BA | | |
| | FIXTURE TYPE CA | | |
| | FIXTURE TYPE CB | | |
| | FIXTURE TYPE DA | | |
| | FIXTURE TYPE DB | | |
| | FIXTURE TYPE EA | | |
| | FIXTURE TYPE FA | | |
| | FIXTURE TYPE FB | | |
| | FIXTURE TYPE GA | | |
| | FIXTURE TYPE GB | | |
| | FIXTURE TYPE HA | | |
| | FIXTURE TYPE JA | | |
| | FIXTURE TYPE JB | | |
| | FIXTURE TYPE KA | | |
| | FIXTURE TYPE KB | | |
| | FIXTURE TYPE MA | | |
| | FIXTURE TYPE NA | | |
| | FIXTURE TYPE PA | | |
| | FIXTURE TYPE QA | | |
| | FIXTURE TYPE QB | | |
| | FXTURE TYPE RA | | |
| | BALLASTS FOR EACH FIXTURE | | |
| | LAMPS FOR EACH FIXTURE | | |
| 16519 | EXIT LIGHTS | | |
| 16536 | UNIT EQUIPMENT FOR EMERGENCY LIGHTING | | |
| 16721 | FIRE ALARM | | |
| 16770 | PUBLIC ADDRESS SYSTEM | | |
| 16811 | MOTOR STARTERS TO 600V | | |
| 16882 | ELECTRIC HAND DRYERS | | |

Affix Corporate Seal

Name and Address of Division 16
Electrical Sub-Contractor:

End of Section

# 1 General

## 1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.
- .3 Refer to Instructions to Bidders and/or Supplementary Conditions for instructions regarding taxes, including the Manitoba Provincial Retail Sales Tax (RST) and the Federal Goods and Services Tax (GST).

.3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work.

.3 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.

.4 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

## 1.2 GENERAL REQUIREMENTS

.1 The General Requirements of Section 16010 apply to and governs all work of Division 16.

## 1.3 DESCRIPTION

.1 Work Included:
- .1 Provide all labour, materials, plant, equipment, and incidentals necessary to completely supply, install, wire, connect, test, and put into operation all electrical work indicated under this Division.
- .2 Provide all power wiring, conduit and connections for motorized equipment supplied under Division 15. For controls wiring responsibility, see Mechanical-Electrical Schedule, Section 16845.
- .3 Provide motor starters and disconnect switches for all motors supplied under Division 15, unless otherwise indicated.
- .4 Take such measures and make necessary allowances in Bid Price for proper protection of building and its finishes at all times during construction. Coordinate protective work with all Trades.
- .5 Cutting and patching of new and/or existing work: Comply with Section 16010, Paragraph 3.7.
- .6 Excavating and backfilling: comply with Section 16010, Paragraph 3.8.
- .7 Arrange, pay for, and carry out the following work in accordance with stipulations of respective Specification Divisions noted.
  - .1 Removal of obsolete materials and equipment for work of this Division.
  - .2 Provision of plaster frames and rings in plaster ceilings for work of this Division.
  - .3 Excavation and backfilling for hydro and telephone services, wiring to outdoor lighting standards and all miscellaneous services as shown.
  - .4 Concrete encasement or concrete covering of hydro and telephone service ducts and other raceways as indicated, concrete pads for indoor and outdoor transformers, concrete bases for lighting standards, and all miscellaneous services as shown.

.2 Related Work:
- .1 Division 15 to provide complete composite wiring diagrams of each specific mechanical system for review showing all electrical components and wiring both internal and external.
- .2 The Controls Sub Contractor under Section 15900 will require 120 volt power for certain components of his system. As part of his work he will obtain power from the nearest

branch panel as site directed by the Consultant and supply and install his own properly sized breaker. His work will be done to the same standards as specified in Division 16. Coordinate with Division 15.

.3 All cutting and patching of roofs: refer to paragraph 16010/3.7/6.

.4 Flashings for electrical equipment and services located on or passing through roof will be provided under Division 7. Provide counter flashings, integral flashings, and integral flashing collars on equipment and raceways.

.5 Painting of electrical equipment, conduit and mounting accessories will be provided under Division 9. For painting under this Division, refer to Item 16010/3.9.

.6 Disconnect switches, to be installed at each item of outdoor - mounted equipment supplied under Division 15, shall be provided by this Division unless noted otherwise.

## 1.4 INTENT

.1 Provide all products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.

.2 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is properly required.

.3 Wherever differences occur in the tender documents, the maximum condition governs and the bid shall be based on the greatest amount.

## 1.5 SUBMITTALS

.1 Prepare and submit drawings necessary for approvals to any authority having jurisdiction, and obtain two (2) copies of approved drawings and/or comments for retention by Consultant prior to commencement of work under this Division.

.2 Submit electronic copies of shop drawings for major equipment items (including those items specifically indicated under Part 1: General of each Section), to Consultant for review.

.1 Clearly indicate project name and number, manufacturer's and supplier's names, catalogue model number, details of construction, accurate dimensions, capacities and performance approval agencies (CSA, ULC), electrical characteristics. Prior to submission, check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of shop drawings, reviewed by Consultant, has been returned to Contractor. Include a checklist confirming compliance with each item of the specifications. All specified items must be clearly idenified.

.2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.

.3 Consultant will only review shop drawings bearing Contractor's stamp of approval or certification.

.4 Shop drawings shall include complete project component identification (i.e. fixture type, starter wiring schematic including all components listed in ME schedule and/or shown on drawings).

.5 It is understood that the following is to be read in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawing or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all subtrades."

.6 Submit initial short circuit/coordination study with shop drawings.

.3 Prepare and submit 4 copies of detailed sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Division 16. Obtain Consultant's approval in writing prior to sleeving, forming or cutting

such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

.4 Division 15 will submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. All electrical equipment and wiring, both internal and external, will be indicated therein for review and coordination of all trades.

.5 Submit Contractor's Material and Test Certificates for each system installed. Certificates shall include:

.1 description of the system (designation and type),
.2 description of the tests conducted and results observed, including re-testing where necessary,
.3 description of any corrective measures undertaken,
.4 description of materials used,
.5 list of witnesses for each test conducted,
.6 date system left ready for service,
.7 signature of installing Contractor.

Where certificates are prescribed by regulations, codes or standards, they shall conform to the requirements of those documents (eg. NFPA Standards, Electrical Safety Authority (ESA) Standards). A copy of each certificate shall be included in the Operating and Maintenance manuals.

.6 Maintenance Data and Operating Instructions:

.1 Submit three (3) copies of Operation and Maintenance Manual individually bound in black hard-backed three-ring binders.

.2 Spine of each binder shall have typewritten lettering as follows:
ELECTRICAL
OPERATION
AND
MAINTENANCE
MANUAL
FOR
[PROJECT TITLE]
[DATE OF SUBMISSION]

.3 Provide master index at beginning of each binder indicating all items included. Use plastic tab indices for all sections of the manual with separate sections for each different type of equipment item.

.4 Provide list of names, addresses and telephone numbers of Equipment Suppliers, Installing Contractors, General Contractors, and Consultants. Include special telephone numbers for service departments on normal and emergency call basis.

.5 Provide descriptive literature (shop drawings, wiring diagrams and schematics) of each item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item. Provide full parts list and drawings, literature, etc. show all Owner's equipment numbers.

.6 Where fuses with maximum let-through current are indicated, provide manufacturer's fuse curve data in Maintenance & Operating manual showing fuse coordination with system interrupting capacity at that location in the system.

.7 Include copies of startup reports and checklists and all certificates issued with respect to this Contract.

.8 Operating instructions shall include:

.1 General description of each electrical system.
.2 Step by step procedure to follow in putting each piece of equipment into service.
.3 Schematic control diagrams for each separate system. Diagram shall indicate locations of switches. Mark correct operating settings for each device on these diagrams.
.4 Diagram of the electrical system indicating the wiring of all related electrical components such as fuses, interlocks, electrical switches and relays.
.5 Drawings of each control panel completely identifying all components on the panels and their function.

.9 Maintenance instructions shall include:

.1 Manufacturer's maintenance instructions for each item of equipment installed under

this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.

.2 Summary list of each item of electrical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.

.3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.

.4 Balancing and testing reports.

.7 Submit record drawings in accordance with 16010/3.6 to Consultant along with applying for Substantial Performance of the Work.

.8 Submit record drawings in accordance with 16010/3.6 to Consultant prior to applying for substantial Performance of the Work. Submit in autocad format on disk to Owner. (CAD version to match drawings).

.9 Submit final commissioning report with record drawings.

.10 Submit five (5) copies of system control schematics for each electrical system indicating relative locations of equipment and control devices.

.11 Submit draft copy of all manuals 60 days prior to expected date of completion of work for review by Owner. Prepare copies of all schematics for training purposes and submit to Owner for review 30 days prior to demonstration and training schedule.

.12 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruptions from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available.

.13 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down.

## 1.6 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Materials supplied to conform to minimum published requirements and recommendations, or better, of applicable standards of:

| | | |
|---|---|---|
| CSA | - | Canadian Standards Association |
| EEMAC | - | Electrical and Electronic Manufacturers' Association of Canada |
| NEMA | - | National Electrical Manufacturers' Association |
| ULC | - | Underwriters Laboratories of Canada Ltd. |
| MESC | - | Manitoba Electrical Safety Code |
| ESA | - | Electrical Safety Authority |
| CEC | - | Canadian Electrical Code |
| MBC | - | Manitoba Building Code |
| NBC | - | National Building Code |

.3 Use latest edition or revision of codes and standards and their supplements in effect on date of Bid call.

.4 Arrange and pay for all permits and inspections by authorities having jurisdiction, required in undertaking of work under this Division. Modifications required by the above stated authorities shall be made without any additional charge to the Owner.

.5 Voltage Ratings:

.1 Operating voltages: to CAN3-C235-83 (R2000).

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

## 1.7 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.

.2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

## 1.8 JOB CONDITIONS

.1 Visit site during Bid period and examine all existing conditions which may affect work of this Division.

.2 Examine all Contract Documents to ensure work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of Contract for any expenses incurred through failure to do so.

.4 Submission of a Bid confirms that Contract Documents and site conditions are accepted without qualifications unless exceptions are specifically noted in Bid.

## 1.9 WARRANTY

.1 Refer to General Conditions. Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.

.2 Make submissions necessary to register product warranties to the benefit of the Owner.

.3 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

## 1.10 DEFINITIONS

.1 Following are definitions of words found in this Specification and on associated drawings of Division 16:

| | | | |
|---|---|---|---|
| 1. | "Concealed" | - | hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, underground, and partitions. |
| 2 | "Exposed" | - | all electrical work visible to building occupants. |
| 3 | "Provide" | - | (and all tenses of "provide") - supply, install, wire and connect complete. |
| 4 | "Install" | - | (and all tenses of "install") -install, wire and connect complete, products and services specified. |
| 5 | "Supply" | - | supply only. |
| 6 | "Owner" | - | Building Owner as defined in the Contract or the Owner's designated representative. |
| 7 | "High | - | (and "Premium Efficiency" and "Energy efficiency") - a motor that, under 75% or 100% Motors" of the rated load, meets or exceeds efficiency levels set by the Manitoba Energy Efficiency Act. |
| 8 | "Wet" | - | wet areas requiring special materials. Where indicated on drawings and/or specified herein. Include pool, whirlpool, shower areas, etc. |
| 9 | "Consultant" | - | the Consultant as defined in the Contract and/or Sub-Consultants retained by the Consultant. |

Note: Refer to Mechanical-Electrical Schedule Section 16845 for specific definitions applicable thereto.

### 1.11 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations and to minimize effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service, notify Owner and Consultant in writing at least 48 hours in advance and obtain written authorization. Do not interrupt any existing service without Owner's specific authorization.

.3 Arrange time and duration of interruption through Owner. Include in Bid Price, for all overtime or premium time hours necessary to minimize duration of service interruption.

.4 Existing equipment and systems that are shut down due to work of this project, shall be tested and proper operation verified when returned to service.

.5 All existing dead wiring and conduit in renovated areas shall be removed in its entirety where accessible. Where not accessible, wiring only shall be removed and conduit shall remain.

.6 Rework all existing wiring, conduit, etc. remaining in use and falling within existing walls which are being removed, to nearest existing walls remaining. All reworked wiring shall be concealed.

.8 Disconnect and remove any electrical equipment in ceiling space or walls that causes interferences during renovation work. All equipment shall be reinstalled and reconnected upon completion of renovation work.

.8 Electrical equipment being removed and not being reused shall be stored on site and remain the property of the Owner. Any such equipment the Owner does not wish to retain shall be removed from site and disposed of by this Trade.

## 2 Products

### 2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new, free from all defects and bear labels of approval as required by the codes referred to in this Division and/or by inspection authorities.

.2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, and other pertinent information. Nameplates shall be easily read and clearly visible, with openings provided where equipment is insulated.

.3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products shall be suitably labelled and supplied with Material Safety Data Sheets.

.4 When utilizing/removing any products that are hazardous, including PCB contaminated products, keep Material Safety Data Sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide suitable Workplace Labels on such containers.

.5 All products, instruments, devices, controls and equipment that incorporate computer chip(s) and use dates in their operation shall be "Year 2000 Compliant" and shall operate in the intended manner through the change in the millennia. Items that require reprogramming or changes in internal components will not be accepted. Provide written, project specific confirmation for submission to Owner and include a copy in maintenance manuals.

### 2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications regarding performance, quality of all material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship, are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

## 2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of General Contract Bid Submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in the alternative proposals. Prior approval by Consultant is not required for unsolicited alternative proposals.

.3 Where Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

## 2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 If during progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.

.2 Apply, in writing, to Consultant for substitution of any products indicating:

- .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
- .2 Reason for substitution.
- .3 Any revisions to Contract Price made necessary by substitution.
- .4 Any revisions to Contract time made necessary by substitution.
- .5 Any revisions to layout, arrangement or services made necessary by substitution.

.3 No substitution will be permitted without written authorization from Consultant.

## 2.5 CONSULTANT'S REVIEW

.1 The Consultant will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.

.2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

# 3 Execution

## 3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.

.2 Verify that work of this Division may be executed in accordance with pertinent codes and

regulations, specifications, drawings, and referenced standards.

.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

## 3.2 INSTALLATION, APPLICATION AND PERFORMANCE

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.

.3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

.4 Provide 19 mm (3/4"), G1S painted plywood backboards for all equipment to be surface mounted to wall by this Division as required by current code. Comply with Manitoba Electrical Code, Equipment Over Combustible Surfaces and Panelboards.

## 3.3 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.

.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.

.3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.

.4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.

.5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.

.6 Provide suitable shielding and physical protection for devices.

.7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.

.8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.

.9 Do not use power activated tools without written permission of the Consultant. Use them in accordance with the Owner's Health and Safety policies.

.10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

.11 All tradesmen shall hold valid trade certificates and licenses as applicable.

.12 All welding shall be executed by certified welders and a copy of all electrical and welding trade certificates for each employee shall be provided to the Owner prior to commencement of work.

## 3.4 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.

.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.

.3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.

.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 3 m (10 feet) in any direction without a change to the contract price.

.5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the electrical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on

the documents of this Division.

.6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the electrical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

.7 Prepare installation (construction) drawings to reflect the latest architectural ceiling layout.

## 3.5 CONSTRUCTION DRAWINGS

.1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.

.2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other Divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.

.3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.

.4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.

.5 Submit construction drawings prior to commencement of work.

## 3.6 RECORD DRAWINGS

.1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".

.2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.

.3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.

.4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.

.5 Transfer records from the "Project Record Copy" to a computer file on CD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.

.6 Submit the "Project Record Copy" on computer CD with a plot of each drawing and two sets of white prints to the Consultant at the time of Substantial Performance.

## 3.7 CUTTING AND PATCHING

.1 Include cutting and patching as required in execution of work under respective Sections of this Division.

.2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.

.3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.

.4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.

.5 Reinforcing shall not be cut or modified without prior approval of the Structural Consultant. Should reinforcement be cut without such prior approval, the cost of any additional reinforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.

.6 Alternative imaging techniques are subject to the approval of the Structural Consultant.

.7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.
.8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.
.9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant. Finish painting, where required, will be provided under Division 9.
.10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

## 3.8 EXCAVATING AND BACKFILLING

.1 Be responsible for excavation and backfilling necessary for installation of underground work under this Division.
.2 Excavate with suitable machinery or by hand as may be necessary and as follows:
  .1 Excavate to the depth and dimensions shown on drawings.
  .2 Keep excavation free of water by bailing, pumping or a system of drainage as required.
  .3 Cut and trim banks of excavation evenly, as nearly vertical as possible, and shore if required to prevent caving-in.
  .4 Keep bottom of excavation clean and clear of loose material. Slope or grade as required.
  .5 Provide shoring in accordance with The Occupational Health and Safety Act, 1980 and Regulations for Construction Projects.
  .6 Notify Consultant immediately in case of encountering any unstable ground, unsuitable for bearing of pipes. Consultant will decide the method of installation of pipes in unstable ground.
  .7 Inform Consultant immediately if the excavation reveals seepage zones, springs or other unexpected sub-surface conditions which may necessitate revisions to drainage or water supply systems.
.3 Obtain Consultant's approval prior to commencement of backfilling of trenches. Backfill the trenches carefully to prevent injury to the work and subsequent settlement and execute backfilling generally as follows:
  .1 provide minimum 150 mm (6") fine gravel or coarse sand bedding (Class B) or as indicated for the bottom of trenches.
  .2 backfill above services bedding with granular material specified, hand tamp in layers of 150 mm (6") thickness. Extend backfill 300 mm (12") above services.
  .3 backfill and consolidate remainder of trench depth below paved or graveled areas with granular Class "B" aggregate in 150 mm (6") layers to an elevation to allow for thickness of Class "A" aggregate and asphalt pavement.
  .4 backfill and consolidate remainder of trench depth below sodded or seeded areas with specified granular material or material obtained from site excavation where approved by Consultant, in 225 mm (9") layers to an elevation 150 mm (6") below of proposed grades in sodded/seeded areas.
  .5 compact each layer thoroughly at optimum moisture content with approved hand or mechanical tampers to a density equal to;
    95% of Maximum Standard Proctor Density
    - Behind foundation and retaining walls on grades
    - Below sodded or seeded areas
    100% of Maximum Standard Proctor Density
    - Below slabs on grade within building areas up to the underside of the crushed stone underlay
    - Below paved or graveled areas
  .6 Do not puddle or flood with water for consolidating backfill. Add Water during the compaction to optimum moisture content of backfilling material.
  .7 Establish locations of existing underground services. Give notice to Civic Department, Public Utilities and Owners of intention to excavate adjacent to their services. Arrange and pay for all necessary repairs to services damaged in connection with this work.

## 3.9 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this Division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.

.2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

.3 Paint both sides of plywood backboards prior to installation with fire retardant (intumescent type) paint conforming to ULC ASA #61 light grey. Paint to be as manufactured by Pittsburgh Paints "Speedhide" #42-7 or equivalent as manufactured by P.P.G., Glidden or Olympic. Comply with OESC-26-004, Equipment Over Combustible Surfaces and 26-402, Panelboards.

.4 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish primer.

.1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1-1955.

.2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1-1958.

.5 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting. Paint all galvanized materials that have been field cut, with cold galvanizing paint.

## 3.10 IDENTIFICATION OF EQUIPMENT

.1 Identify electrical equipment with nameplates as follows:

.1 Nameplates:

.1 Lamacoid 3 mm (1/8") thick plastic engraving sheet, white face with black lettering for normal power and red face with white lettering for emergency power, mechanically attached with self tapping screws.

NAMEPLATE SIZES

| | | | |
|---|---|---|---|
| Size 1 | 10 x 50 mm | 1 line | 3 mm high letters |
| Size 2 | 12 x 70 mm | 1 line | 5 mm high letters |
| Size 3 | 12 x 70 mm | 2 lines | 3 mm high letters |
| Size 4 | 20 x 90 mm | 1 line | 8 mm high letters |
| Size 5 | 20 x 90 mm | 2 lines | 5 mm high letters |
| Size 6 | 25 x 100 mm | 1 line | 12 mm high letters |
| Size 7 | 25 x 100 mm | 2 lines | 6 mm high letters |

.2 Labels:

.1 Laminated adhesive labels with 6 mm (1/4") high letters produced on an electronic labelling system equal to P-Touch by Brother.

.2 Wording on nameplates and labels to be approved by Consultant prior to manufacture.

.3 Allow for average of twenty-five (25) letters per nameplate and label.

.4 Identification to be in English language.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics. Coordinate names of equipment and systems with Division 15 to ensure that identical names are used.

.6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY No. ". Number as directed by Consultant. Comply with 3.10.10 and 3.10.11.

.7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.8 Terminal cabinets and pull boxes: indicate system and voltage.

.9 Transformers: indicate capacity, primary and secondary voltages.

.10 Manufacturer's Nameplates:

.1 Provide nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Include registration plates, Underwriters' Laboratories and CSA approval, as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors, all factory supplied.

.3 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

.11 System Nameplates:

.1 Fasten nameplates securely in conspicuous place. Where nameplates cannot be moutned on cool surface, provide standoffs.

.2 Identify equipment type and number and service for area or zone of building served.

.3 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate 60 x 230 mm (2-1/2" x 9"), reading:
"WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME."

.4 Provide system nameplates on all electrical equipment including but not limited to panels, disconnect switches, starters, etc. Obtain Consultant's approval of markings before production and installation.

.5 Identify source panel and circuit no. of all receptacles and light switches with 6.4 mm (1/4") high lettering using laminated adhesive labels produced on an electronic labelling system equal to P-Touch by Brother. Identification label to be applied on wall above the device coverplate and inside on wall at device outlet box. Panel directories identification shall also be by the laminated adhesive labels by Brother.

.6 Panel identification: first letter indicates Fire Zone/Block Identification.

| | |
|---|---|
| Second letter ===== | floor # |
| Third ====== ==== | Normal/emergency |
| Fourth ====== ==== | Panel A to Z |
| Fifth ====== ==== | Breaker # from which fed |

## 3.11 IDENTIFICATION OF WIRING, RACEWAYS, JUNCTIONS BOXES AND TERMINAL STRIPS

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: comply with Manitoba Electrical Safety Code.

.4 Use colour coded wires in communication cables, matched throughout system

.5 All terminal strips shall be indexed and wires tagged.

.6 All junction boxes to be labelled as to nature of services.

.7 All main feeders to be tagged at both ends.

## 3.12 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m (45') intervals.

.3 Colours: 25 mm (1") wide prime colour and 20 mm (3/4") wide auxiliary colour.

| | Prime | Auxiliary |
|---|---|---|
| up to 250V | yellow | |
| up to 600V | yellow | green |
| up to 5kV | yellow | blue |
| up to 15kV | yellow | red |
| up to 28kV | yellow | black |
| Telephone | green | |
| Other communications systems | green | blue |
| Fire alarm | red | |
| Emergency voice | red | blue |
| Other security systems | red | yellow |

## 3.13 PROTECTION

.1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.

.2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.

## 3.14 SUPPORT AND ATTACHEMENT

.1 Support and attach conduits, cabletrays, fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes. Roof mounted electrical equipment and services shall be anchored to the roof structure to resist both lateral and uplift wind forces in accordance with requirements of the Manitoba Building Code.

## 3.15 EQUIPMENT BASES AND CURBS

.1 Supply and erect structural work required for installation of electrical equipment.

.2 Build concrete bases 150 mm (6") high, providing all necessary inserts, anchor bolts and other fasteners required, for floor mounted electrical equipment. Make concrete bases 50 mm (2") larger all around than the base of the supported equipment and trowel finish to a neat smooth finish. Anchor equipment to pads using 200 mm (8") cast-in-place anchor bolts. Ensure concrete supplied under this Division is 17 MPa (2500 psi) compressive strength after 28 days.

.3 Build 100 mm (4") high concrete curbs around all openings through floors for eletrical and system risers. Ensure joint between curb and floor is watertight and maintains integrity of floor membrane where applicable.

## 3.16 SERVICE CONNECTIONS

.1 Include in Bid Price all amounts required by municipality and/or utilities for service connections and /or modifications to service connections. Ensure Amounts include fees, assessments, charges, etc., required in relation to service connection.

## 3.17 WARNING SIGNS

.1 As specified and/or to meet requirements of Safety Authority and Consultant.

.2 Porcelain enamel signs, minimum size 175 x 250 mm (7" x 10" ).

## 3.18 SINGLE LINE ELECTRICAL DIAGRAMS

.1 Provide single line electrical diagrams under plexiglass as follows:
- .1 Electrical distribution system: locate in main electrical room.
- .2 Electrical power generation and distribution systems: locate in power plant rooms.
- .3 Provide CAD diskette copy to Owner (CAD version to match drawings CAD version).

.2 Provide fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator. Provide CAD diskette copy to Owner. CAD version to match contract drawings CAD version.

.3 Drawings: 600 x 600 mm (24" x 24") minimum size.

## 3.19 USE OF EQUIPMENT

.1 For the duration of this contract, do not use any piece of equipment provided under this contract without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.

.2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

## 3.20 PREPARATION

.1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.
.2 Services that are no longer required shall be removed or cut back and capped as indicated to the satisfaction of Consultant.
.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.

## 3.21 SPECIAL TOOLS AND SPARE PARTS

.1 Identify spare parts containers as to contents and replacement parts number.
.2 Provide one set of special tools required to service equipment as recommended by manufacturers.
.3 Prepare a complete itemized list of special tools and spare parts and submit to consultant for review. List will be used as a checklist and should include provision for sign off by owner on receipt.

## 3.22 FIELD QUALITY CONTROL

.1 Temporary and Trial Usage
  .1 Allow the Owner the privilege of temporary and trial usage of installed equipment, as soon as work is complete, for a period of time required to conduct a thorough test.
  .2 Do not construe such usage as evidence of acceptance of work by Owner.
  .3 Repair damage to work tested, resulting from such trial usage, by this Contractor at no cost to Owner.
.2 Testing and Verification:
  .1 Verify the correct installation and proper operation of equipment and systems installed. Adjust and balance each system as necessary to achieve optimum operation of each system.
  .2 Co-operate with the Systems Verification agency as follows:
    .1 provide assistance when and as requested,
    .2 co-ordinate completion of work systematically to permit orderly verification and adherence to schedules,
    .3 provide additional necessary flow balancing devices as directed by agency,
    .4 notify Systems Verification Agency of tests being conducted.

## 3.23 ADJUST AND CLEAN

.1 Clean equipment and fixtures, lubricate equipment installed under this Division and leave items in perfect order ready for operation.
.2 Test and adjust control devices, instrumentation, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.
.3 Remove from the premises upon completion of work of this Division, debris, surplus, and waste materials resulting from operations.
.4 Cover wiring devices, fittings and covers to protect them from paint and other damage.

## 3.24 COMMISSIONING

.1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
.2 The Commissioning Team shall be comprised of;
  .1 Representatives of the Contractor and his sub-contractors as required,
  .2 The individual, company or agency undertaking the work of each Section,
  .3 Representatives of equipment manufacturers,
  .4 Representatives of the Consultants,
  .5 Representatives of the Owner.
.3 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the commissioning team and shall ensure that representatives of the equipment

manufacturers are present during the relevant commissioning tasks.

.4 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.

.5 Each Section shall prepare Check Sheets in accordance with the ASHRAE and SMACNA Guidelines and shall issue them to the commissioning team for use during the commissioning process.

.6 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
- .1 name and logo of Facility,
- .2 name of the project,
- .3 the Owner's project number,
- .4 identification of the system commissioned,
- .5 the date that the system was commissioned.

.7 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

## 3.25 EXTRAS AND CREDITS

.1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
- .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
- .2 Labour hours and unit costs.
- .3 Total materials and labour costs with each item priced separately and subtotalled as to actual cost.
- .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract shown as separate line items.
- .5 Prime Consultant's Notice of Change/Bulletin/Contemplated Change Order number and date of issue.

## 3.26 INSTRUCTION

.1 Instruct and familiarize Owner's operating personnel with the various electrical systems. Arrange instruction for each system separately.

.2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.

.3 Ensure each instruction period includes, but is not limited to the following;
- .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
- .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
- .3 demonstration of the proper operating procedures for each item of equipment,
- .4 explanation of the purpose and function of all safety devices provided,
- .5 demonstration of all measures required for safe and proper access for operation and maintenance.

.4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.

.5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

## 3.27 CASH ALLOWANCES

.1 The following cash allowance shall be carried and shall be be included in the bid price:
- .1 Electrical Supply Authority: refer to Section 16402, Underground Services.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16105 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16.

## 1.3 RELATED WORK

.1 Excavation and backfilling: See Section 02223, Excavating, Trenching and Backfilling.
.2 Concrete form work: See Section 03100, Concrete Form-Work and False-Work.
.3 Concrete reinforcement: See Section 03200, Concrete Reinforcement.
.4 Cast-in-place concrete: See Section 03300, Cast-in-Place Concrete.
.5 Brick: See Section 04210, Brick Masonry.
.6 Mortar: See Section 04100, Mortar and Grout for Masonry.

## 1.4 SUBMITTALS

.1 Shop drawings for precast manholes as per Section 16010.

# 2 Products

## 2.1 PVC DUCTS

.1 PVC ducts, type EB1, encased in reinforced concrete.

## 2.2 PVC DUCT FITTINGS

.1 Rigid PVC opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.
.2 Exansion joints.
.3 Rigid PVC 5° angle couplings.

## 2.3 CABLE RACKS

.1 Hot dipped galvanized cable racks and supports.
.2 1/2" x 4" (12 x 100 mm) preset inserts for rack mounting.

## 2.4 CABLE PULLING EQUIPMENT

.1 Pulling iron made of galvanized steel rods, size and shape as indicated.
.2 1/4" (6 mm) stranded nylon pull rope tensile strength 5 kN continuous throughout each duct run with 10' (3 m) spare rope at each end.

## 2.5 MARKERS

.1 Concrete type cable markers: 24 x 24 x 4" (600 x 600 x 100 mm), with words: "Cable", "Joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.
.2 Cedar post type markers: 3.5 x 3.5" (89 x 89 mm) square, 5' (1.5 m) long, pressure treated with clear or copper napthenate or 5% pentachlorophenol solution, water repellant preservative, with nameplate fastened near post top, on side facing duct.

.1 Nameplate: aluminum anodized 3.5 x 5" (89 x 125 mm), 5' (1.5 mm) thick mounted on cedar post with mylar label 0.125 mm thick with words "Cable" "Joint" "Conduit" with arrows to indicate change in direction.

.3 6" (150 mm) wide polyethylene underground warning tape, red colour "ELECTRICAL LINE BURIED", orange colour "TELEPHONE LINE BURIED".

## 3 Execution

### 3.1 INSTALLATION GENERAL

.1 Install underground duct banks including formwork. Hydro service ducts minimum 48" (1200 mm) below grade to top of ducts. Communications service ducts minimum 36" (900 mm) below grade to top of ducts. Maintain minimum 12" (300 mm) horizontal separation between hydro service and communications service ducts. See Section 16106 for cables separation.

.2 Build duct bank on undisturbed soil [or on well compacted granular fill not less than 6" (150 mm) thick, compacted to 95% of maximum proctor dry density.

.3 Open trench completely between manholes to be connected before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.

.4 Prior to laying ducts, construct "mud slab" not less than 3" (75 mm) thick.

.5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.

.6 Install base spacers at maximum intervals of 5' (1.5 m) levelled to grades indicated for bottom layer of ducts.

.7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 2" (40 mm) horizontally and vertically. Stagger joints in adjacent layers at least 6" (150 mm) and make joints watertight. Encase duct bank with 3" (75 mm) thick concrete cover.

.8 Make transpositions, offsets and changes in direction using 5° bend sections, do not exceed a total of 20° with duct offset.

.9 Use bell ends at duct terminations in buildings.

.10 Use conduit to duct adapters when connecting to conduits.

.11 Terminate duct runs with duct coupling set flush with the end of concrete envelope when dead ending duct bank for future extension.

.12 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.

.13 Allow concrete to attain 50% of its specified strength before backfilling.

.14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.

.15 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.

.16 Immediately after placing of concrete, pull through each duct a steel mandrel not less than 12" (300 mm) long and of a diameter 1/4" (6 mm) less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull still bristle brush through each duct immediately before pulling-in cables.

.17 Install four 10' (3 m) lengths of 15 M reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings. Wire rods to 15 M dowels at manhole or building and support from duct spacers. Protect existing cables and equipment when breaking into existing manholes. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.

.18 In each duct, install pull rope continuous throughout each duct run with 3 m (10') spare rope at each end.

## 3.2 MARKERS

.1 Mark location of duct runs under hard surfaced areas not terminating in manhole with railway spike driven flush in edge of pavement, directly over run. Place concrete duct marker at ends of such duct runs. Construct markers and install flush with grade.
.2 Mark ducts every 450' (150 m) along straight runs and changes in direction.
.3 Where markers are removed to permit installation of additional duct, reinstall existing markers.
.4 Lay concrete markers flat and centred over duct with top 1" (25 mm) above earth surface.
.5 Provide drawings showing locations of markers.
.6 Provide 6" (150 mm) wide polyethylene underground warning tape @ 12" (300 mm) below grade, centred lengthwise, above all electrical and communication's raceways and wiring buried exterior to building foundation walls.

## 3.3 INSPECTIONS

.1 Advise Consultant so that he may inspect ducts prior to placing and be present during placement of concrete and clean-out.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16106 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16.

## 1.3 RELATED WORK

.1 Excavation and backfilling: See Section 02223, Excavating, Trenching and Backfilling.

# 2 Products

## 2.1 CABLE PROTECTION

.1 38 x 140 mm planks pressure treated with clear or copper napthenate or 5% pentachlorophenol solution, water repellant preservative.

## 2.2 MARKERS

.1 Concrete type cable markers: 24" x 24" x 4" (600 x 600 x 100 mm) with words: "cable", "joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of cable and duct runs.
.2 Cedar post type markers: 3-1/2" X 3-1/2" (89 x 89 mm), 1.5 m long, pressure treated with clear or copper napthenate or 5% pentachlorophenol solution, water repellant preservative, with nameplate fastened near post top, on side facing cable or conduit to indicate depth and directional of duct and cable runs.
  .1 Nameplate: aluminum anodized 3-1/2" X 5" (89 x 125 mm) 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words "Cable", "joint", "Conduit" with arrows to indicate change in direction.
.3 6" (150 mm) wide polyethylene underground warning tape, red colour "ELECTRICAL LINE BURIED", orange colour "TELEPHONE LINE BURIED".

# 3 Execution

## 3.1 DIRECT BURIAL OF CABLE

.1 After sand bed specified in Section 02223 - Excavating, Trenching and Backfilling, is in place, lay cables maintaining 3" (75 mm) clearance from each side of trench to nearest cable. Do not pull cable into trench.
.2 Provide offsets for thermal action and minor earth movements. Offset cables 6" (150 mm) for each 200' (60 m) run, maintaining minimum cable separation and bending radius requirements.
.3 Make termination and splice only as indicated leaving 2' (0.6 m) of surplus cable in each direction.
  .1 Make splices and terminations in accordance with manufacturer's instructions using approved splicing kits.
.4 Underground cable splices not acceptable.
.5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic cables, 12 times diameter of cables or in accordance with manufacturer's instructions.

.6 Maintain 3" (75 mm) minimum separation between cables of different circuits. Maintain 12" (300 mm) horizontal separation between low and high voltage (above 750V) cables. When low voltage cables cross high voltage (above 750V) cables, maintain 12" (300 mm) vertical separation with low voltage cables in upper position. At crossover, maintain 3" (75 mm) minimum vertical separation between low voltage cables and 6" (150 mm) between high voltage cables. Maintain 12" (300 mm) minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables 2' (0.6 m) in each direction at crossings.

.7 After sand protective cover specified in Section 02223 - Excavating, Trenching and Backfilling, is in place, install continuous row of overlapping 1-1/2" X 6" (38 x 140 mm) pressure treated planks as indicated to cover length or run.

.8 Hydro service cables minimum 48" (1200 mm) below grade to top of cables. Communications cables minimum 36" (900 mm) below grade to top of cables.

## 3.2 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multi-conductor control cables, reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

## 3.3 MARKERS

.1 Mark cable every 450' (150 m) along cable or duct runs and changes in direction.

.2 Mark underground splices.

.3 Where markers are removed to permit installation of additional cables, reinstall existing markers.

.4 Install concrete cable markers within 550' (180 m) from each side of runway centreline; 45 m 137' from each side of taxi way centreline; 150' (50 m) from edge of taxi ramps or aprons.

.5 Install cedar post type markers.

.6 Lay concrete markers flat and centred over cable with top flush with finish grade.

.7 Provide 6" (150 mm) wide polyethylene underground warning tape @ 12" (300 mm) below grade, centred lengthwise, above all electrical and communications wiring and raceways buried exterior to building foundation walls.

## 3.4 FIELD QUALITY CONTROL

.1 Refer to Section 16010, General Electrical Requirements.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance tests:

- .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
- .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests:

- .1 Ensure that terminations and accessory equipment are disconnected.
- .2 Ground shields, ground wires, metallic armour and conductors not under test.
- .3 High potential (Hipot) Testing:
  - .1 Conduct hipot testing at 80% of original factory test voltage in accordance with manufacturer's recommendations.

.7 Provide Consultant with list of test results showing location at which each test was made, circuit

tested and result of each test.

.8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16111 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16

## 1.3 LOCATION OF CONDUIT

.1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

# 2 Products

## 2.1 CONDUITS

.1 Rigid hot dipped galvanized, steel or aluminum threaded conduit. Do not use aluminum conduit when embedded in concrete.
.2 Epoxy coated steel galvanized conduit: with zinc coating and corrosion resistant epoxy finish inside and outside.
.3 Electrical metallic tubing (EMT): with couplings.
.4 Electrical nonmetallic tubing (ENT): with couplings. Pliable, corrugated having circular cross-section and as defined by Manitoba Electrical Safety Code.
.5 Rigid PVC conduit.
.6 Flexible steel or aluminum conduit and liquid-tight flexible metal conduit.

## 2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 2" (50mm) smaller. Two hole steel straps for conduits larger than 2" (50 mm).
.2 Beam clamps to secure conduits to exposed steel work.
.3 Channel type supports for two or more conduits at 10' (3 m) oc.
.4 1/4" (6 mm) diameter threaded rods to support suspended channels.

## 2.3 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
.2 Factory "ells" where 90° bends are required for 1" (25 mm) and larger conduits.
.3 Steel rain tight connectors and couplings for EMT. Pressure cast fittings are not acceptable.
.4 For rigid threaded metallic conduit, use only threaded fittings of similar steel material. For rigid PVC conduit, use fittings of similar PVC material, solvent weld all joints as per manufacturer's recommendations to make watertight.

### 2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 4" (200 mm) linear expansion. Confirm acceptability with Structural Consultant when used in poured concrete.
.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 3/4" (19 mm) deflection in all directions.
.3 Weatherproof expansion fittings for linear expansion at entry to panel.

### 2.5 FISH CORD

.1 Polypropylene.

## 3 Execution

### 3.1 INSTALLATION

.1 Provide separate and independent raceway systems for each electrical system installed under this Contract, except as otherwise specifically indicated.
.2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
.3 Use rigid PVC conduit outside building below grade, up to and including 2" (50 mm), unless noted otherwise. Use rigid type I (concrete encased), type II (direct burial) or rigid PVC for larger sizes unless otherwise noted. Include separate grounding conductor. All joints shall be solvent welded and watertight. See 16111/3.6, Conduits Underground.
.4 Use rigid PVC conduit inside building below slabs on grade. Include separate grounding conductor. All joints shall be solvent welded and watertight. See 16111/3.6, Conduits Underground.
.5 Rigid PVC conduit and/or rigid threaded metallic conduit may be used within slabs on grade and within intermediate slabs where permitted by Structural Consultant. Include separate grounding conductor. All joints shall be solvent welded and watertight. Parking garages - hazardous Manitoba Electrical Code, Commercial garages, Repair and storage. See 16111/3.6, Conduits Underground.
.6 Electrical nonmetallic tubing (ENT) shall only be used within slabs on grade, intermediate slabs, and poured concrete walls where embedded in at least 2" (50 mm) of poured concrete and where permitted by Structural Consultant. Include separate bonding conductor as per Manitoba Electrical Code Provision for Bonding Continuity.
.7 Use rigid threaded metallic conduit: outside building above grade and within all poured concrete.
.8 Use EMT within building: above inaccessible and accessible finished ceilings, where exposed above finished floor, in walls where not poured concrete. See Section 16122 for allowable use of armoured cable (BX)/AC90.
.9 Flexible metal conduit shall be used for short drops to lighting fixtures (not more than 5' (1525 mm) per drop) in concealed ceiling spaces and for wiring in stud partitions as site approved, up to junction boxes in concealed ceiling spaces directly above the respective wall outlet. No horizontal runs of flex in stud walls will be allowed.
.10 Use flexible liquid-tight metal conduit for short connections to roof mounted equipment and flexible metal conduit for final short connections to motors and other vibrating equipment.
.11 Conduit to be of sufficient size to permit easy installation of wiring. Sizes shown on drawings are minimum and in no case to be reduced without approval of Consultant. Use larger sizes where necessary to facilitate installation of conductors. Where sizes are not shown on drawings, code requirements to be met. Minimum size of any conduit to be 1/2" (13 mm). Sizes indicated do not include allowance, regarding percentage conduit fill, for bonding and grounding conductors unless otherwise noted. Increase raceway size as necessary to comply with Manitoba Electrical Code, Conductors in Conduit.
.12 Fittings: see Section 16132.
.13 All conduit to be rigidly supported by clips or pipe hangers attached to building structure at intervals not exceeding code requirements.
.14 Where conduits are run exposed on masonry walls, support at 5 ft (1525 mm) intervals with lead anchors and one hole malleable iron pipe straps to secure 2" (50 mm) and smaller. Two hole steel strap for conduits larger than 2" (50 mm). Where run exposed on building steel, support conduits

with Caddy clips. Perforated pipe strap hangers will not be accepted.

.15 In exposed ceiling areas, install raceways above bottom chord of OWSJ's and above beams unless otherwise approved.

.16 Where conduits cross structural joints, use "O.Z." expansion fittings complete with bonding jumpers. Running threads on conduits will not be permitted. All conduit ends to be reamed and bushed.

.17 Conceal conduits except as otherwise indicated and in mechanical and electrical service rooms. No horizontal runs will be permitted in walls except at top 6" (150 mm).

.18 Use epoxy coated conduit where indicated.

.19 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.20 Mechanically bend steel conduit over 3/4" (19 mm) diameter.

.21 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.22 Install fish cord in empty conduits.

.23 Run 2 @ 1" (25 mm) spare conduits up to ceiling space and 2 @ 1" (25 mm) spare conduits down to ceiling space from each flush panel unless otherwise indicated. Terminate these conduits in 6" x 6" x 4" (152x152x102mm) junction boxes in ceiling space or, in case of an exposed concrete slab, terminate each conduit in surface type box.

.24 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.

.25 Dry conduits out before installing wire.

.26 In EEMAC areas which are sprinklered & in EEMAC-2 to -12 areas as per CAN/CSA-22.2-94-M91 (R1997), provide O-rings at connections of raceways to panels, starter, etc. when raceways enter top of enclosure.

.27 Refer to 16010/3.10, Conduit and Cable Identification.

## 3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 5' (1.5 m) clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits where possible on suspended or surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 3" (75 mm) parallel to steam or hot water lines with minimum of 1" (25 mm) at crossovers.

## 3.3 CONCELED CONDUITS

.1 Do not install horizontal runs in masonry walls except at top 6" (150 mm) of wall on each floor.

.2 Do not install conduits in terrazzo or concrete toppings.

## 3.4 CONDUITS IN CAST-IN-PLACE

.1 Locate to suit reinforcing steel. Install in centre one third of slab.

.2 Protect conduits from damage where they stub out of concrete.

.3 Install sleeves where conduits pass through slab or wall.

.4 Where conduits pass through waterproof membrane provide oversized sleeve before membrane is installed. Use cold mastic between sleeve and conduit. Comply with Section 16195, Access Panel and Service Penetrations.

.5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter and unless Structural Consultant has approved same.

.6 Encase conduits completely in concrete with minimum 1" (25 mm) concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

## 3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

.1 Run conduits below slab. Provide 2" (50 mm) of sand over conduits and below floor slab. Conduits may only be installed within slabs when permitted by the Structural Consultant. Comply with Section 16195, Access Panels and Service Penetrations.

## 3.6 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.
.2 Waterproof joints of galvanized steel with heavy coat of bituminous paint. PVC raceway joints shall be solvent welded.
.3 Cementing PVC conduit for buried/submerged areas requiring air and/or water tightness:
  .1 Follow manufacturer's procedure for cementing conduit.
  .2 Test workmanship by conducting low pressure air (3.0 to 5.0 psi) test after system is installed and cemented joints are set.
  .3 Plug and block ends to prevent movement prior to pressurization.
  .4 Check for leaks with soap solution.
  .5 Even low pressure air can cause high thrust loads and caution must be observed.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16114 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16.

## 1.3 SUBMTTALS

.1 Submit product data in accordance with Section 16010.
.2 Indicate various types of cabletroughs with terminology used in Part 2.
.3 Show actual cabletrough installation details and suspension system.

## 1.4 MANUFACTURERS

.1 Acceptable manufacturers:
  .1 Canstrut Inc.
  .2 Mono-Systems Inc.
  .3 Pilgrim Technical Products Ltd.
  .4 Wiremold
  .5 B-Line

# 2 Products

## 2.1 CABLETROUGH

.1 Suspended type.
  .1 Ladder type Class C1 to CSA C22.2 No. 126-M91.
  .2 Aluminum tray 12" (305 mm) wide, with depth of 4" (100 mm), unless otherwise indicated in drawings. Tray to be complete with single centre spine, 1" (25 mm) wide open rungs at 6" (150 mm) centres suspended on a 1/2" (13 mm) treaded rod.
  .3 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, stiffener bars, expansion joints and reducers where required. Fittings: manufacturered accessories for cabletrough supplied. Radii on fittings: 18" (457 mm) minimum.
  .4 Barriers where different voltage systems are in the same cabletrough.

## 2.2 SUPPORTS

.1 Provide supports as required and as recommended by the manufacturer.

## 2.3 COMMUNICATION AND LOW VOLTAGE SUSPENSION CABLE FASTENERS (J-HOOKS)

.1 Cable fasteners and fittings:

.1 Wall mounted type.
  .1 Single-sided, 2 tier cable fastener, Cooper B-Line #BCH32-25.
  .2 Single-sided, 3 tier cable fastener, Cooper B-Line #BCH32-35.

## 3 Execution

### 3.1 IINSTALLATION

.1 Install complete cabletrough system.
.2 Support cabletrough on one side.
.3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

### 3.2 CABLES IN CABLETROUGH

.1 Install cables individually.
.2 Lay cables into cabletrough. Use rollers when necessary to pull cables.
.3 Secure cables in cabletrough at 18' (6 m) centres, with nylon ties.
.4 Identify cables every 91' (30 m) with size 2 nameplates in accordance with Section 16010, Subsection 3.10, Conduit and Cable Identification.

End of Section

# 1 General

## 1.1 GERNERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16122 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16.

## 1.3 SUBMITTALS

.1 Product data as per Section 16010.

# 2 Products

## 2.1 BUILDING WIRES

.1 General wiring inside building CSA approved, soft copper, 600 volt, TWH (75°C) or T90 (90°C) for # 10 AWG and smaller: 600 volt R90XL (90°C) or T90 (90°C) for #8 AWG and larger. Raceway size shall be based on use of TWH/RW90XL insulation.
.2 Minimum gauge: #12 AWG, unless specifically noted otherwise. Conductors #10 AWG and smaller to be solid and/or stranded. Conductors #8 AWG and larger to be stranded. Use #14 AWG for control wiring unless otherwise noted. Where distance from panel to first outlet on 15 ampere rated circuit exceeds 70 feet (21 metres), use #10 AWG to feed first outlet. See 16721 for fire alarm system wiring type and size.
.3 All wire and cable to be colour coded for phase and neutral identification and in accordance with Maintoba Electrical Safety Code (red, black, blue, and white or natural grey). Comply with Section 16010, Subsection 3.10, Conduit and Cable Identification.
.4 Lighting fixture wiring: Type AF, GTF or TEW.

## 2.2 ARMOURED CABLES

.1 Conductors: insulated, aluminum, size as indicated.
.2 Type: AC90-BX.
.3 Armour: interlocking type fabricated from galvanized steel or aluminum strip.
.4 Connectors: As per cable manufacturer's recommendations.
.5 Conform to CAN/CSA-C22.2-51-95 and Manitoba Electrical Safety Code..

# 3 Execution

## 3.1 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:
  .1 In conduit systems in accordance with Section 16111.
  .2 In cabletroughs in accordance with Section 16114.
  .3 In underground ducts in accordance with Section 16106.
  .4 In trenches in accordance with Section 16106.
  .5 Manitoba Electrical safety Code shall indicates conductors fed from separate panels shall

be installed in separate raceways. Conductors from different panels, systems, MCC's, starters and/or disconnects shall not share a common raceway.

.2 Size feeder and branch circuit wiring so that voltage drop from the supply side of the consumer's service (or equivalent) to the most remote outlet does not exceed 5%, in accordance with MESC and based on the calculated demand load or 80% of the rating of the protective device, whichever is smaller.

.3 Balance load on all feeders and branch circuits so that voltage drop at any outlet does not exceed 3% at calculated demand load of the circuit in accordance with MESC.

.4 Colour code all feeders at points of distribution. Comply with Section 16010, subsection 3.10, Conduit and Cable Identification.

.5 Neutral conductors to be full capacity unless otherwise noted. Neutral conductors to be continuous throughout the system without fuses, switches or breakers unless otherwise noted. Neutral conductors to be complete with white covering or as acceptable to the MESC.

.6 Provide dedicated neutral and dedicated, insulated ground per receptacle circuit and per dimming circuit. Shared neutral and ground conductors not allowed.

.7 Wiring to be continuous within raceways. Splices only permitted at outlets or junctions boxes.

.8 Do not pull wiring into raceway until work that may cause injury is completed and conduits cleaned inside. Use CSA approved lubricants that will not shorten life of insulations when pulling wires.

.9 Splice all sizes of wire up to and including #8 AWG with pressure type solderless connectors.

.10 Make equipment connections with compression type terminals unless bolted terminals are supplied with equipment. Coordinate supply conductor termination to Supply Authority equipment.

.11 Install all cables accurately in line, level and parallel to building lines.

.12 All surface mounted or suspended cables to be securely supported by staples, straps, hangers or approved devices attached to building structure at intervals not exceeding MEC requirements.

.13 Flexible armoured cable AC90 (BX) may be used only for short drops to lighting fixtures (not more than 5 feet (1525 mm) per drop) in concealed ceiling spaces and for wiring in stud partitions as site approved up to junction boxes in concealed ceiling spaces directly above the respective wall outlet. No horizontal runs of BX in stud wall will be allowed except at top 6" (150 mm) of wall. Comply with MESC.

## 3.2 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible.

.2 Install cable in trenches in accordance with Section 16106.

.3 Lay cable in cabletroughs in accordance with Section 16114.

.4 Terminate cables in accordance with Section 16151, Wire and Box Connectors, 0-1000 V.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16131 shall apply to all work of Division 16.
.2 Splitters shall comply with CSA-C22.2-76-M92.
.3 Junction and pullboxes shall comply with CSA-C22.2-40-M89.
.4 Conform to all Sections of Division 16.

## 1.3 SUBMITTALS

.1 Submit shop drawings and product data for cabinets in accordance with Section 16010.

# 2 Products

## 2.1 SPLITTERS

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
.3 At least three spare terminals on each set of lugs in splitters less than 400 A.

## 2.2 JUNCTION AND PULL BOXES

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
.2 Covers with 1" (25 mm) minimum extension all around, for flush-mounted pull and junction boxes.
.3 Cast junction boxes as required and/or as indicated

## 2.3 CABINETS

.1 Type E: sheet steel cabinet, with hinged door and return flange overlapping sides, handle, and catch, for surface mounting.
.2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 3/4" (19 mm) GIS plywood backboard for surface or flush mounting as indicated.

## 2.4 MANUFACTURERS

.1 Acceptable manufacturers; Eurobec Metal, Hammond, Hoffman, Robroy Industries.

# 3 Execution

## 3.1 SPLITTER INSTALLATION

.1 Install splitters and mount plumb, true and square to the building lines.
.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

## 3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.
.2 Mount cabinets with top not higher than 6'-6" (2 m) above finished floor. Comply with latest code requirements.
.3 Install terminal blocks as indicated in Type T cabinets.
.4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 91' (30 m) of conduit run between pull boxes.

## 3.3 IDENTIFICATION

.1 Provide equipment identification as per Section 16010, Subsection 3.8 Equipment Identification.
.2 Provide conduit and cable identification as per Section 16010, Subsection 3.10 Conduit & Cable Identification.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16132 shall apply to all work of Division 16.
.2 Boxes shall comply with CSA-C22.2-18-97.
.3 Conform to all sections of Division 16.

# 2 Products

## 2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA-C22.1-94.
.2 (4") 102 mm square or larger outlet boxes as required for special devices.
.3 Gang boxes where wiring devices are grouped.
.4 Blank cover plates for boxes without wiring devices.
.5 347 V outlet boxes for 347 V switching devices.
.6 Combination boxes with barriers where outlets for more than one system are grouped.

## 2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 3" x 2" x 1-1/2" (76 x 50 x 38 mm or as indicated. 4" (102 mm) square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted conduit, minimum size 4" x 2-1/8" x 1-7/8" (102 x 54 x 48 mm).
.3 4" (102 mm) square or octagonal outlet boxes for lighting fixture outlets.
.4 4" (102 mm) square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

## 2.3 MASONRY BOXES

.1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

## 2.4 CONCRETE BOXES

.1 Electro-galvanized sheet concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

## 2.5 FLOOR BOXES & SERVICE FITTINGS

.1 Individual type concrete tight flush electro-galvanized sheet steel floor box with adjustable finishing ring to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 1 1/4" (28 mm) for receptacles; 73 mm for communication equipment, similar to Steel City #68 series with P60-CACP duplex carpet plate and receptacle.

## 2.6 CONDUIT BOXES

.1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and/or receptacles, where indicated.

### 2.7 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.
.2 Knock-out fillers to prevent entry of debris.
.3 Conduit outlet bodies for conduit up to 1-1/4" (32 mm) and pull boxes for larger conduits unless otherwise noted.
.4 Double locknuts on sheet metal boxes if/when required by OESC-10-610.

## 3 Execution

### 3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.
.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 1/4" (6 mm) of opening.
.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

## 1.2 BASIC MATERIALS AND METHODS

.1 Manually operated general purpose AC switches shall comply with CSA-C22.2-111-M1986 (R1992).
.2 Snap switches shall comply with CSA-C22.2-55-M1986 (R1992).
.3 Receptacles, plugs, etc. shall comply with CSA-C22.2-42-M1984 (R1996).
.4 Conform to all Sections of Division 16.

# 2 Products

## 2.1 SWITCHES

.1 Switches of one manufacturer throughout project.
.2 Lighting switches: push-in connections are not acceptable, screw terminals shall be used, CSA approved, white, specification grade, 125 volt AC, rocker operated, screw terminals, as follows:

15 AMP

)

Single Pole: Hubbell #1201CN Series
Three Way: Hubbell #1203CN Series
Four Way: Hubbell #1204CN Series

.3 Dimming switches: CSA approved for incandescent lamps, white, 125 volt AC, vertical slider - to - "OFF" position at bottom limit, as follows: Provide separate neutral for each dimmer back to panel from which circuit is fed. Do not cut off cooling fins when mounting dimmers.

| Circuit Load Watts | Single Pole |
|---|---|
| 0-600 | Lutron #N-600 |
| 601-1000 | Lutron #N-1000 |
| 1001-1500 | Lutron #N-1500 |
| 1501 - 2000 | Lutron #N-2000 |

## 2.2 RECEPTACLES

.1 Receptacles of one manufacturer throughout project.
.2 Receptacles: push-in connections are not acceptable, screw terminals shall be used, CSA approved, white, specification grade, 125 volt AC, 3-wire, grounding, straight blade, screw terminals, duplex as follows:
15 amp: Hubbell #5252
Receptacles fed from standby power shall have red-coloured face and face plate.

.

## 2.3 SPECIAL WIRING DEVICES

.1 Special wiring devices:
- .1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic jewel flush type.

.2 Clocks: Battery operated quartz Edwards #2941-5B (grey) complete with 1.5 volt "C" type alkaline battery installed.

### 2.4 COVER PLATES

.1 Cover plates for wiring devices.
.2 Cover plates from one manufacturer throughout project.
.3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
.4 Stainless steel, 1 mm thick cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
.5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
.6 Weatherproof double lift, single spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
.7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

### 2.5 ACCEPTABLE MANUFACTURERS

.1 Equivalent devices by Bryant, Leviton, Circle F, P&S, Arrow-Hart, are acceptable.

## 3 Execution

### 3.1 INSTALLATION

.1 Switches:
  .1 Install single throw switches with handle in "UP" position when switch closed.
  .2 Install switches in gang type outlet box when more than one switch is required in one location.
  .3 Mount toggle switches at height specified or as indicated.
.2 Receptacles:
  .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  .2 Mount receptacles at height specified or as indicated.
  .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
.3 Cover plates:
  .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
  .2 Install suitable common cover plates where wiring devices are grouped.
  .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
  .4 Label switch and receptacles coverplates as per Section 16010/3.2.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16151 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16.

## 1.3 SUBMITTALS

.1 CSA-C22.2-65-93 Wire Connectors.

# 2 Products

## 2.1 MATERIALS

.1 Pressure type wire connectors: with current carrying parts of copper or copper alloy, sized to fit conductors as required.
.2 Fixture type splicing connectors: with current carrying parts of copper or copper alloy sized to fit conductors 10 AWG or less.
.3 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required.

# 3 Execution

## 3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:
  .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer.
  .3 Install fixture type connectors and tighten.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16191 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16.

## 1.3 MANUFACTURERS

.1 Acceptable manufacturers:
  .1 Canstrut Inc.
  .2 Champion Fibreglas
  .3 Electrotray Cantruss
  .4 FRE (Fiberglass Reinforced Epoxy)
  .5 Pilgrim Technical Products Ltd.
  .6 Sasco Strut

# 2 Products

## 2.1 SUPPORT CHANNELS

.1 U shape, size 1 1/2 x 1 1/2" (41 x 41 mm), 1/8" (2.5 mm) thick, surface mounted, suspended and/or set in poured concrete walls and ceilings as indicated.

# 3 Execution

## 3.1 INSTALLATION

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
.2 Secure equipment to poured concrete with expandable inserts.
.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
.4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
.6 Fasten exposed conduit or cables to building construction or support system using straps.
  .1 One-hole steel straps to secure surface conduits and cables 2" (50 mm) and smaller.
  .2 Two-hole steel straps for conduits and cables larger than 2" (50 mm).
  .3 Beam clamps to secure conduit to exposed steel work.
.7 Suspended support systems.
  .1 Support individual cable or conduit runs with 1/4" (6 mm) dia threaded rods and spring clips.
  .2 Support 2 or more cables or conduits on channels supported by 1/4" (6 mm) dia threaded rod hangers where direct fastening to building construction is impractical.
.8 For surface mounting of two or more conduits use channels at 10' (3m) oc spacing.
.9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicted or as required to support conduit and cable runs.
.10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
.11 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.12 Do not use supports or equipment installed for other Trades for conduit or cable support except with permission of other Trade and approval of Consultant.

.13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Requirements of Section 16195 shall apply to all work of Division 16.
.2 Conform to all sections of Division 16.

## 1.3 SUBMITTALS

.1 Submit shop drawings in accordance with Section 16010 for:
  .1 Fire stop sealants.
  .2 Access panels.

## 1.4 MANUFACTURERS

.1 Acceptable manufacturers:
  .1 Tremco
  .2 3M

# 2 Products

## 2.1 ACCESS PANELS

.1 Access panels: square, fabricated from 14 gauge prime coated steel, and complete with counter sunk screws, minimum size 12" x 12" (305 mm x 305 mm), one piece concealed hinged door with positive locking and self opening Phillips head screw driver lock. Type of panel to match ceiling finish and assembly as approved by Consultant.
.2 Doors in fire separations or fire rated assemblies shall be ULC labelled. Obtain required rating from Architectural drawings.

## 2.2 FIRE STOP AND SMOKE SEALS

.1 Materials: ULC listed components suitable for the fire resistance ratings indicated.
.2 Acceptable Manufacturers: as listed for specific ULC "Service Penetration Firestop System" (SPFS) employed.
.3 All openings in fire separations for service penetrations (SP) shall be protected with ULC listed "Service Penetration firestop Systems" (SPFS).
.4 The service penetration firestop system shall have F, FT, FH, FTH ratings equal to or greater than ratings specified by the Prime Consultant for the fire separation and joint firestop system (JF).
.5 All components employed in the service penetration firestop system shall conform to the ULC listing.
.6 Contractor shall prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation assembly.

## 2.3 SLEEVES

.1 Provide sleeves of minimum 20 ga. thick galvanized sheet steel with lock seam joints or cast iron.
.2 Use steel pipe sleeves with annular fin continuously welded at midpoint:
  .1 Through foundation walls. Comply with Subsection 3.3.
  .2 Where sleeve extends above finished floor.

## 3 Execution

### 3.1 ACCESS PANELS

.1 Provide access panels in walls, plaster ceilings, and ceilings with permanently installed tile as required by MESC for access to electrical equipment and wiring.

### 3.2 FIRE STOP AND SMOKE SEALS

.1 Provide fire stop sealants as per manufacturer's recommendations, BOCA, NFPA, and Manitoba Building Code.
.2 Coordinate with architectural drawings to determine fire separation ratings for appropriate fire stop installation.
.3 Contractor shall prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation assembly.

### 3.3 SLEEVES

.1 Provide sleeves in all wall, floor and ceiling assemblies where electrical services penetrate fire separation.
.2 Refer to architectural drawings for wall, floor and ceilings assembly construction and fire resistance ratings thereof and coordinate therewith.
.3 Provide sleeves at points where electrical services pass horizontally and/or vertically through masonry or concrete.
.4 Sizes:
  .1 Provide 1/4" (6 mm) clearance all around, between sleeve and electrical service penetrating a fire separation.
  .2 Where raceways pass below footings, provide minimum clearance of 2" (50 mm) between sleeve and raceways. Backfill up to underside of footing with concrete of same strength as footing.
.5 Terminate sleeves flush with surface of concrete and masonry in walls and 2" (50 mm) above finished floors unless otherwise directed on site. Not applicable to concrete floors on grade.
.6 For raceways passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction as directed by roofing contractor; caulk between sleeve recess and raceway; fasten roof flashing to clamp device; make water-tight durable joint. Co-ordinate with roofing contractor.
.8 For raceways passing through roofs, run services in Liquid Tight Flexible Conduit Flashing Thaler Metal Industries MEF series (or approved equivalent) to suit service and as per MESC bending radius requirements. Flashing to carry 20 year warranty against leaks, condensation and material/manufacturer defects. Flashing design shall be maintenance free. Anchor sleeve in roof construction as directed by roofing contractor. Make joints watertight and durable. Coordinate with roofing contractor. Seal bottom of flashing after roofing and service is installed with caulking. Install EPDM end cap seal in exposed end of flashing (not caulking).
.9 Fill voids around electrical services penetrating a fire separation.
.10 Seal between services and sleeve in foundation walls and below grade floors with penetration seals (Link-Seal). Install as per manufacturer's installation instructions.
.11 Where services penetrate pass through non-fire rated walls or floors, caulk space between service and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening mastic.
.12 Ensure no contact between service and ferrous sleeve.
.13 Fill future-use sleeves with easily removable filler.
.14 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint.
.15 Where electrical services penetrate fire rated walls, floors, and partitions, caulk space between with sealants specified under this section and in accordance with manufacturer's written instruction.
.16 Temporarily plug all openings during construction.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.
- .3 This Section applies to and governs all Sections of Division 16.

## 1.2 WORK INCLUDED

.1 This Section provides minimum acceptance requirements for seismic restraints for all electrical equipment, raceways and conduit systems.

## 1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Concrete work is provided in Division 3.
.2 Concrete Floating Floors are specified in Division 3.
.3 Flexible conduit connections are specified elsewhere in Division 16.

## 1.4 QUALITY ASSURANCE

.1 Unless otherwise directed by the local authority having jurisdiction, the following codes and standards will apply:
- .1 National Building Code of Canada
- .2 Canadian Electrical Code
- .3 Manitoba Building Code

## 1.5 SUBMITTALS

.1 All vibration isolation and seismic restraint systems shall be by one manufacturer.
.2 Submit shop drawings for all devices specified herein and as indicated on the drawings. Submittals shall include dimensions, materials, attachment and anchorage requirements. Indicate compliance with each specification item herein.
.3 Provide calculations for selection of seismic restraints, certified by a qualified professional engineer licensed in the province where the project is located. Design calculations shall use the following parameters:
- .1 Building site classification for seismic site response is D.
- .2 Earthquake importance factor for the building, IE, is 1.5.
- .3 Spectral response acceleration for short periods, Sa(0.2), is: 0.18.
- .4 Spectral response acceleration for 1-second periods, Sa(1.0), is: 0.04.
- .5 Importance factor for wind load, IW, is 1.25.
- .6 The reference hourly wind velocity pressure, q, in kPa, is 0.47. '

.4 Product Data: Provide schedule of vibration isolator type with location and load on each. e. Manufactuer's Installation Instructions: Indicate special procedures and setting dimensions.
.5 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

## 1.6 PROJECT RECORD DOCUMENTS

.1 Record actual locations of seismic restraints including attachment points.

### 1.7 SEISMIC ENGINEER

.1 Professional Engineer holding a Certificate of Authorization in the Province of Manitoba with a minimum of 5 years experience in seismic design, and a minimum of $1 million Professional Liability Insurance including Errors and Omissions Insurance.
.2 A common seismic engineer shall provide seismic design, vibration isolation, and seismic restraint. Coordinate with Division 16.
.2 At the completion of the project, the Seismic Engineer shall review the installations on site, and shall prepare a written report, with a letter signed, sealed and dated by the Seismic Engineer, certifying that the installations have been completed in accordance with their design and shop drawings.

### 1.8 SEISMIC CONTROL MEASURES

.1 Seismic restraints are to be provided for all operational and functional components of building services in accordance with current requirements of the Manitoba Building Code.
.2 Cable restraint systems, rod stiffener clamps and seismic isolator capacities shall be verified by an independent test laboratory.
.3 Connection materials shall be selected by and site specific designs to be prepared by the Seismic Engineer. The Seismic Engineer may select and specify materials and anchors to be provided by the contractor where this is appropriate.
.4 Contractor shall ensure that the Seismic Engineers' requirements and specification are met.
.5 Seismic Force: the Importance Factor for this project is 1.5.

## 2 Products

### 2.1 SEISMIC AND WIND RESTRAINTS

.1 Vibration isolators with integral seismic restraint: Floor mounted isolators shall meet the requirements as listed above. For those devices intended to provide restraint from seismic and wind forces, housings shall be capable of withstanding the applicable design forces for the specific installation.
  .1 Seismic Spring Floor Mounts: Type SFS - Laterally stable, restrained spring type with support plate for bolting to the equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a neoprene noise isolation pad, minimum 6 mm (0.25") thick, bonded to the base plate. Mount shall include integral all-directional limit stops with elastomeric grommets preventing metal-to-metal contact and with minimum 3 mm (1/8") clearance under normal operation.
  .2 Seismic Restrained Spring Isolator: Type SCSR - Laterally stable, restrained spring type with housings and heavy top plates for supporting the equipment and resisting seismic and wind loading. Housings shall be of welded steel construction and include vertically restraining limit stops. Maximum clearance around the restraining bolts shall be 6 mm (0.25"). Top plate and restraining bolts shall be out of contact with the housing during normal operation and neoprene grommets shall be incorporated to minimize short-circuiting of restraining bolts.
  .3 Seismic Restrained Neoprene Mount: Type SRD - Neoprene type, including steel baseplate with mounting holes for anchors. Isolator shall include leveling and restraining bolt for mounting to the equipment and prevent metal-to-metal contact of the restraining bolt to the baseplate.
.2 Seismic Cable Restraints: Type SRK - Seismic cable sway bracing restraints shall consist of 7x19 galvanized steel aircraft cable sized to resist seismic loads with a safety factor of five (5). Cable end connections shall use heavy brackets, thimbles, and wire rope clips or compression sleeves.
.3 Hanger Rod Stiffener: Structural steel angle attached with a formed steel clamp to threaded rod support.
.4 Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for

interior applications and stainless steel for exterior applications.

.5 Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications.

## 3 Excecution

### 3.1 GENERAL

.1 Coordinate size, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint devices. Ensure housekeeping pads have adequate space to mount equipment and isolator housings and shall also be large enough to ensure adequate edge distance for isolator anchor bolts to avoid housekeeping pad breakout failure.

.2 Coordinate locations and sizes of structural supports with locations of seismic restraints (e.g., transformers, load banks, engine-generator sets, etc.).

### 3.2 SEISMIC RESTRAINT

.1 General:

.1 Provide restraint devices as required for isolated and non-isolated equipment. Provide positive seismic and wind restraints on those systems and components required by the applicable building code and by the local authority having jurisdiction.

.2 All bus duct, conduit, cable tray, and equipment shall be restrained to resist seismic forces per the applicable building code(s) as a minimum. Additional requirements specified herein are included specifically for this project.

.3 Install seismic restraint devices per the manufacturer's submittals. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.

.4 Unless otherwise directed, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

.5 Provide hanger rod stiffeners where indicated or as required to prevent buckling of rods due to seismic forces.

.6 Refer to Federal Emergency Management Agency manual 413 for additional guidance on typical seismic restraint installation practices.

.2 Concrete Anchor Bolts

.1 Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.

.2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

.3 Mechanical Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

.4 Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

.5 Set anchors to manufacturer's recommended torque, using a torque wrench.

.3 Equipment Restraints:

.1 Install adequate restraint for non-isolated equipment, substantiated by engineering calculations

.2 Install seismic snubbers on electrical equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and attach to equipment base and supporting structure as required. Alternatively, provide vibration isolators with seismically-

rated restraint housings.

.3 Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm)

.4 Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

.4 Cable Tray Systems:

.1 Seismically restrain all cable trays listed below, using seismic cable restraints:

.1 All cable trays carrying fire alarm, telephone, or other communication cabling, or life safety system control wiring that may be used in the event of an emergency.

.2 Any cable tray which if it were to fail would result in damage to a piece of equipment or building function that is or is related to a life safety function.

.3 Any cable tray whose accumulated weight (including design load for wiring) is equal to or greater than 146 N/m (10 lbs/ft).

.2 Space lateral supports a maximum of 9 m (30') o.c., and longitudinal supports a maximum of 18 m (60') o.c.

.3 Brace a change of direction longer than 3.7 m (8') and locate restraints within 0.6 m (2') of the direction change or end of cable tray.

.4 nstall restraint cables so they do not bend across edges of adjacent equipment or building structure.

.5 Bus Duct and Conduit Systems:

.1 Seismically restrain all bus duct and conduits listed below, using seismic cable restraints:

.1 All bus ducts and conduits carrying fire alarm, telephone, or other communication cabling, life-safety system control wiring or power wiring serving critical equipment that may be used in the event of an emergency.

.2 Conduits greater than 65 mm (2.5") inside diameter or, if more stringent, in compliance with local code standards.

.3 Any trapeze support with multiple conduits or bus duct whose accumulated weight (including design load for wiring) is equal to or greater than 146 N/m (10 lbs/ft).

.4 Any bus duct or conduit that is deemed critical and must remain functional at the conclusion of a seismic event except as exempted by code requirements.

.5 Any bus duct or conduit, if it were to fail, would result in damage to a critical piece of equipment or building function.

.2 For supports with multiple conduits (trapezes), secure conduits to trapeze member with clamps approved for application.

.3 Space lateral supports a maximum of 12 m (40 feet) o.c., and longitudinal supports a maximum of 24 m (80 feet) o.c.

.4 Brace a change of direction longer than 3.7 m (8') and locate restraints within 0.6 m (2') of the direction change.

.5 Install restraint cables so they do not bend across edges of adjacent equipment or building structure.

.6 Install flexible conduit loops in conduits which cross building seismic joints, sized for the anticipated amount of movement.

.7 Install flexible conduits where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

## 3.3 INSPECTION AND CERTIFICATION

.1 After installation, arrange and pay for the seismic retraint product manufacturer to visit the site to verify that the seismic restraint systems are installed properly, and shall submit a certificate so stating.

End of Section

# 1 General

## 1.1 GENERAL REQUIRMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to all sections of Division 16.

## 1.3 CO-ORDINATION WITH POWER SUPPLY AUTHORITY

.1 Co-ordinate and meet requirements of Supply Authority. Ensure availability of power when required.
.2 Include in Base Bid price, the amount of Seventy Five Thousand Dollars ($75,000.00) plus GST as a Cash Allowance for payment of Supply Authority charges with respect to this project.
.3 Advise Supply Authority when construction begins and when work is being done.

# 2 Products

## 2.1 MATERIAL

.1 Underground ducts: to Section 16105, Concrete encased Duct Banks
.2 Rigid steel galvanized conduit and fittings: to Section 16111 - Raceways.
.4 Conductors: refer to Section 16122 - Wires and Cables, size and number of conductors
.5 Meter socket: weatherproof, to supply Authority approval.
.6 6" (150 mm) wide polyethylene underground warning tape, red colour "ELECTRICAL LINE BURIED", orange colour "TELEPHONE LINE BURIED".

# 3 Execution

## 3.1 INSTALLATION

.1 Install cables in trenches and in ducts and/or conduit in accordance with Section 16106, Installation of Cables in Trenches and in Ducts and Section 16111 - Raceways.
.2 Allow adequate conductor length for connection to supply by Supply Authority.
.3 Install meter socket and conduit.
.4 Allow adequate conductor length for connection to service equipment.
.5 Make grounding connections in accordance with Section 16450, Grounding -Secondary.
.6 See Section 16105, 16106, 16107 for depth of hydro service and communications service cables and ducts.
.7 Provide 6" (150 mm) wide polyethylene underground warning tape, centred lengthwise, @ 12" (300 mm) below grade above all electrical and communications raceways and wiring buried exterior to building foundation walls.

End of Section

# 1 General

## 1.1 GENERAL REQUIRMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to all sections of Division 16.
.2 Conform to CSA-C22.2-31.
.3 Coordinate equipment physical size and space limitations

## 1.3 SUBMITTALS

.1 Shop drawings and product data in accordance with Section 16010.
.2 Indicate on shop drawings:
  .1 Floor anchoring method and foundation template.
  .2 Dimensioned cable entry and exit locations.
  .3 Dimensioned position and size of bus.
  .4 Overall length, height and depth.
  .5 Dimensioned layout of internal and front panel mounted components.
.3 Include time-current characteristic curves for breakers and fuses rated above 400 A.

## 1.4 MAINTENANCE DATA

.1 Provide maintenance data for service entrance board for incorporation into manuals specified in Section 16010.
.2 Submit 3 copies maintenance data for complete assembly including components.

## 1.5 MAINTENANCE MATERIAL

.1 Include:
  .1 3 fuses for each type above 600 A.
  .2 6 fuses for each type up to and including 600 A.

## 1.6 SOURCE QUALITY CONTROL

.1 Consultant may wish to witness final factory tests.
.2 Notify Consultant in writing 10 days in advance that service entrance board is ready for testing.

## 1.7 MANUFACTURERS

.1 Acceptable manufacturers: Federal Pioneer, Siemens, Square D, Westinghouse, Commander.

## 1.8 SUBMITTALS

.1 Shop drawings and product data in accordance with Section 16010.
.2 Fuse/breaker coordination study on log-log paper showing;
  .1 Consumer's service box fuse or breaker interrupting time-current characteristics coordinating with Supply Authority's fuse or breaker time-current characteristics so that consumer's protection will interrupt before the Supply Authority's protection interrupts.
    .1 Include transformer(s) withstand curve data.
    .2 Maximum system short circuit capacity;
    .3 Associated cabling withstand curves data.
    .4 Main service branch breakers/fuses time-current characteristics and coordination thereof with service box fuse or breaker.

## 2 Products

### 2.1 SERVICE ENTRANCE BOARD

.1 Rating amps as per drawings, short circuit current 42kA (rms symmetrical). Breakers and/or fuses minimum interrupting rating not less than service entrance board short circuit rating.
.2 Where fuses with maximum let-through current are indicated, provide a lamacoid label on front cover of equipment as per paragraph 16010/3.8 reading "System Capacity [35,000] AIC, Peak Let-Through [10,000] AIC Fuse".
.3 Cubicles: wall-mounted, dead front, size as indicated.
.4 Barrier metering section from adjoining sections.
.5 Provision for installation of Supply Authority metering.
.6 Distribution section.
.7 Hinged access panels with captive knurled thumb screws.
.8 Bus bars and main connections; 99.3% copper.
.9 Cable from load terminals of main disconnect switch to metering section and cable from metering section to lugs of distribution section.
.10 Identify phases with colour coding.
.11 Note maximum physical dimension limitations must suit layout shown on contract drawings.

### 2.2 GROUNDING

.1 Copper ground bus extending full width of cubicles and located at bottom.
.2 Lugs at each end for grounding cable size as indicated.

### 2.3 SUPPLY AUTHORITY METERING

.1 Mounting accessories and wiring for following, supplied by Supply Authority:
  .1 potential transformers.
  .2 current transformers.
  .3 Watthour meter.
  .4 Demand meter
.2 Separate cubicle and metal raceway for exclusive use of Supply Authority metering.

### 2.4 FINISHES

.1 Apply finishes in accordance with Section 16010, Electrical General Requirements.
  .1 Service entrance board exterior green.
  .2 Supply 2 spray cans touch-up enamel.

### 2.5 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 16010, Electrical General Requirements.
.2 Nameplates:
  .1 White plate, black letters, size 7.
  .2 Complete board labelled: "120/208 V."
  .3 Main disconnect labelled: "Main Switch".
  .4 Branch breakers labelled: "as indicated".

## 3 Execution

### 3.1 INSTALLATION

.1 Locate service entrance board and fasten to wall.
.2 Connect main secondary service to line terminals of main disconnect switch.
.3 Connect load terminals of distribution breaker's to feeders.
.4 Check factory made connections for mechanical security and electrical continuity.
.5 Run one grounding conductor ] AWG green insulated copper in 1" (25 mm) conduit from ground

bus to building ground.

.6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

End of Section

# 1 General

## 1.1 DOCUMENTS

.1 Please note: that this section of the Specifications forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts listed by the appropriate parties below.

## 1.2 SECTION INCLUDES

.1 Furnishing all equipment, Materials, labor, and services for the detailed design, supply, delivery, installation, testing, commissioning, demonstration, operations training, and warranty for a complete system.
.2 Provide all detail design documentation to produce a complete operating system meeting the intent and performance of the systems concepts presented in these Specifications.
.3 Supply and install all wiring and cabling, whether rated conduit, tray, plenum, or surface-mounted enclosures.
.4 All appropriate programming software provided and specified by the vendor.
.5 Testing, documentation, and commissioning of the completed system.
.6 Demonstrate completion and compliance.
.7 Train personnel on system operation and maintenance.

## 1.3 RELATED SECTIONS

.1 Conform to all sections of Diviison 16.

## 1.4 STANDARDS

.1 Provide equipment of this Section in full compliance with the following applicable portions of the latest revisions of the following standards:
  .1 CSA Standard C22.2 No. 225-M90
  .2 CSA Standard C22.1 Part 1 Canadian Electrical Code
  .3 ANSI C12.1 & C12.20 at 0.5 Accuracy Class
  .4 Must meet LMB-EG-07 Specification
  .5 UL Certified to IEC/EN/UL/CSA 61010-1 2nd Edition.

## 1.5 SHOP DRAWINGS

.1 All shop drawings submitted with product data, covering all equipment to be supplied in accordance with Section 16010.
.2 Minimum requirements include:
  .1 A Single System Infrastructure (SSI)
  .2 Manufacturer's literature and Specifications
  .3 Component connections wiring diagrams
  .4 Communication system Specifications
  .5 Manufacturer's reference list
  .6 Equipment layout schematic for all electrical rooms

## 1.6 SYSTEM DESCRIPTION

.1 The electronic Power Monitoring system shall be fully automated microprocessor-based electrical energy measurement system for Measurement and Verification purposes. The system shall incorporate complete metering, communications, reporting functions, including a web based software package; energy monitoring and threshold limit capabilities.
.2 Meters must be capable of directly metering North American 120/208V wye series.
.3 Metering Units shall have the capability of a single incoming cable containing 25 pairs of 22 AWG wire, with associated current transformers (CT's).
.4 Shall meet all ISO 9001 standards for quality control where all meters test to a minimum of +/- 0.5% accuracy.
.5 Metering unit(s) shall be able to meter a minimum of 24 single-pole circuits, 12 single phase/Network meters and 8 three phase type meters

.6 The system shall be as described below:
- .1 To consist of electronic multi-meters with embedded communications capability, and solid or split-core current transformer technology. The current transformers shall have a full scale output of 330mV, 80mA or 5A outputs for safety purposes.
- .2 Meters to be used for Power Measurement power monitoring applications
- .3 The meters will be capable of remote communication from each metering device. A data aggregator or collecting device shall not be used. Each device shall have multiple IP and Modbus sockets to accommodate data transmission via Modbus TCP and standard Ethernet. Data shall be transmitted by one or a combination of the following:
  - .1 Standard Ethernet interface
  - .2 On board V90 modem capable of data transmission up to 56k baud rate.
  - .3 Modbus TCP/IP
  - .4 Ethernet connection to PC or laptop via crossover cable.

.7 Supply online software services to provide consumption information in graphical formats. The software should be capable of:
- .1 Displaying consumption by individual circuits or category (i.e. lighting, HVAC, etc) as well as water and gas consumption if requested
- .2 Calculating demand charges, and identifying contributing loads to peak demand
- .3 Providing a "what if" analysis tool to allow users to model and trend the effects of energy consumption reductions and changes
- .4 Displaying Power Factor
- .5 Generating theoretical bills for any type of rate structure (i.e. Time of use, demand, straight consumption)
- .6 Providing user access at different levels

Each stakeholder (i.e. tenant, property manager) shall be given a software account password to view all appropriate energy meters

Raw data shall be accessible from the meter, and provided in a standard .csv type file format if required

.8 Systems to have backup storage power to key components so no data is lost during power outages. Device must be capable of holding 2 years of interval data for a 20 year period. The system shall continue to function after resumption of power.

.9 Failure of the building electrical normal power system shall not result in loss of data and will not require manual restarting of the metering system.

## 1.7 SYSTEM MEASUREMENTS

.1 Meters to be complete with a Liquid Crystal Display (LCD) to access all energy measurements and phase diagnostics when needed

.2 Energy Parameters:

| | |
|---|---|
| kWh | real consumption |
| kW | instantaneous consumption |
| kVAh | apparent consumption |
| kVA | apparent power |
| kVARh | reactive consumption |
| kVAR | reactive power |

.3 Phase Diagnostics: Parameters to be displayed for each individual phase of each metered load:

| | |
|---|---|
| Voltage | Phase to neutral or phase to phase |
| Amps | Instantaneous amperage for each phase |
| kW | Instantaneous real energy |
| kVA | Instantaneous apparent energy |
| kVAR | Instantaneous reactive energy |

## 1.8 INSTALLATION, OPERATION, AND MAINTENANCE MANUALS

.1 Submit installation, operation, and maintenance manuals for the electronic energy management system in accordance with Sections 16010 or Manufactures specifications.

### 1.9 TECHNICAL PERFORMANCE

.1 Minimum measured technical performance of each installed equipment shall meet the Specifications published by the manufacturer for that equipment.
.2 System performances shall not be limited to the specified performance of any item of installed equipment.
.3 Optimize technical performance of all systems to produce the highest achievable technical performance, to the satisfaction of the Consultant and or Client.
.4 Any deficiencies in the system, particularly information communication errors or operational deficiencies, shall be cause for rejection. Rectify any such deficiencies prior to calling for substantial completion review.

### 1.10 TESTING AND COMMISSIONING

.1 Refer to Section 16010.
.2 Perform final testing, adjustment, and commissioning of the systems, report results to the Consultant, and include the results in the installation, operation, and maintenance manuals. Provide qualified technicians and professional test equipment for the testing and commissioning.
.3 Perform sufficient technical and operational tests to ensure the technical performance of the system meets the intent of the Contract Documents. Typical testing to include but not be limited to:
  .1 Verification of meter readings
  .2 Communication system error checking
.4 Test every device and control equipment after programming and submit a signed commissioning certificate and report to the Consultant and to the Client.

### 1.11 DEMONSTRATION AND TRAINING

.1 Refer to Section 16010.
.2 Demonstrate the operation of the system to the Owner at a time suitable to them. Such demonstration to include training on how to conduct the programming of the energy management system.

## 2 Products

### 2.1 MANUFACTURER

.1 The system is based on the Schneider PowerLogic E4880 platform or approved equal.

### 2.2 METERS AND CURRENT TRANSFORMERS

.1 The Digital Instrumentation Package shall be the PowerLogic E4880 or equal.
.2 Solid or Split core current transformers, with full scale output of 80mA. Refer to main service riser diagram on drawing E3.2.
.3 For services greater than 120/208V, Potential Transformers shall be supplied. PTs are to be installed in a separate enclosure mounted beside the metering unit.

### 2.3 METER COMMUNICATIONS OPTIONS: ETHERNET

.1 Ethernet interface at each metering device shall be direct to the unit and shall not use external serial-Ethernet converters or external Ethernet Serial Servers.
.2 Modbus TCP communications for interface to client systems
.3 V90 modem included in each metering device
.4 Ethernet communications shall be supplied for each device.

### 2.4 PULSE INPUTS

.1 Pulse Inputs installed On Board of the Data Collection Unit
.2 Pulse inputs from gas, water, BTU and Steam meters
.3 Gas/water meter to be supplied with a dry-contact pulse output device, contact closure >50msec
.4 Minimum 2 pulse input per PowerLogic 4880 Device

## 2.5 METER SOFTWARE

.1 The Software supplied shall be web based and provide reporting capabilities for energy consumption. Separate web accounts for each stakeholder shall be provided. for minimum 5 years.
.2 Must have Modbus TCP capabilities and an open architecture type protocol for easy data transfer and simple interfacing options.
.3 Software shall be supplied and commissioned by the vendor or local approved integrator.

## 2.6 WARRANTY

.1 Manufacturer needs to provide a comprehensive warranty for the products free from defects in a materials and workmanship from the date of substantial completion for a period of 2 years.

# 3 Excecution

## 3.1 WIRING AND CONNECTIONS

.1 All wiring must meet and or exceed the Canadian Electrical Code and ESA standards
.2 Metering points shown on submitted drawings only to be connected or installed
.3 Install all wiring in conduit and in accordance with Section 16122. Wiring shall be copper #22 AWG unless otherwise specified.
.4 Contractor shall supply Ethernet drop for remote meter reading and diagnostics of the system.
.5 Contractor is responsible for testing communications connectivity and ensuring communications from the device to the remote monitoring computer. Contractor shall ensure Internet communications connectivity.
.6 Prepare and submit record drawings and installation, operation and maintenance manuals for the energy management system as required in accordance with Section 16010.

## 3.2 FIELD VERIFICATION, ACCEPTANCE & TRAINING

.1 Provide all "AS BUILT" DRAWINGS and data showing each meter, serial number, address, cross reference, load and CT ratio prior to field verification.
.2 Manufacturer's representative shall verify, adjust and test the system. Verification of the energy monitoring system is to be carried out with the assistance of an electrical contractor at all times. Upon completion, the manufacturer shall issue a "CERTIFICATE OF ACCEPTANCE" to the owner, electrical consultant, contractor and client.
.3 Manufacturer's representative shall demonstrate operation of the system as follows:
  .1 Local and Remote Meter readings
  .2 Phase Diagnostics
  .3 Provide manual of the chosen installed system.
.4 Setup of system software as directed by client.
.5 Provide training and software manual for owner's staff to review.

## 3.3 STANDARDS

.1 Install according to Canadian Electrical Code CSA Standard C22.2 and in accordance with the approved manufacturer's documentation and installation instructions.

## 3.4 INSTALLATION

.1 Install meter units and CTs at specified branch circuit distribution, panel, main feeder, or High Voltage Switchboard as shown on provided Drawings. Locate units with easy access for maintenance and testing.
.2 Install all wiring in conduit and in accordance with Section 16122. Wiring shall be copper #22 AWG RW90 unless otherwise indicated.
.3 Perform all necessary system calibration, testing, commissioning, and demonstrations as outlined in Item 1.0 and per Item 3.3.
.4 Prepare and submit record drawings and installation, operation and maintenance manuals for the revenue metering system as required in accordance with Section16010.

## 3.5 FIELD QUALITY CONTROL

.1 Submit a detailed testing and commissioning procedure to the Consultant and Client for review and approval prior to undertaking this Work. The procedure shall indicate all test equipment required and acceptance criteria.

.2 Upon completion of all testing and commissioning, submit a copy of the test results and certify the system as acceptable for revenue metering purposes.

.3 Undertake the testing and commissioning Work with the manufacturer's factory representative(s).

## 3.6 INSTRUCTION TO STAFF

.1 Upon completion of the installation, a competent instructor representing the system manufacturer shall provide a lecture to the operating and maintenance staff concerning the intent, use, and operation and maintenance of the system.

.2 Staff training shall include a minimum of four hours per shift and training sessions shall be videotaped and turned over to the Owner. Allow for two shifts of staff training.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.
.2 Where fuses with maximum let-through current are indicated, provide a lamacoid label on front cover of equipment as per paragraph 16010/3.8 reading "System Capacity [35,000] AIC, Peak Let-Through [10,000] AIC Fuse".

## 1.3 SUBMITTALS

.1 Submit product data in accordance with Section 16010.

## 1.4 MANUFACTURERS

.1 Acceptable Manufacturers:
  .1 Square 'D'
  .2 Federal Pioneer
  .3 Commander
  .4 Siemens
  .5 Cutler Hammer

# 2 Products

## 2.1 DISCONNECT SWITCHES

.1 Fusible and non-fusible disconnect switch in CSA Enclosure, size as indicated.
.2 Provision for padlocking in on-off switch position by three locks.
.3 Mechanically interlocked door to prevent opening when handle in ON position.
.4 Fuses: size as indicated, to Section 16478, Fuses - Low Voltage.
.5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
.6 Quick-make, quick-break action.
.7 ON-OFF switch position indication on switch enclosure cover.

## 2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 16010, Subsection 3.8.
.2 Indicate name of load controlled on size 4 nameplate.

# 3 Execution

## 3.1 INSTALLATION

.1 Install disconnect switches complete with fuses.
.2 Provide disconnect switch ahead of each piece of equipment as required by applicable codes and/or as indicated.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.
.3 Provide complete grounding and bonding system in accordance with MESC.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.

# 2 Products

## 2.1 EQUIPMENT

.1 Clamps and conductors for bonding to ground of non-electrical equipment in accordance with MESC.
.2 Copper conductor minimum 18'-0" (6 m) long for each concrete encased electrode, bare, stranded, un-tinned, soft annealed. Comply with MESC.
.3 Rod electrodes, galvanized steel 3/4" (19 mm) dia. by 10'-0" (3m) long. Comply with MESC.
.4 Plate electrodes, galvanized steel, surface area 1.86SF, (0.2 m2), 1/16" (1.6 mm) thick. Comply with MESC.
.5 System grounding conductor material in accordance with MESC. Bonding conductor material in accordance with MESC.
.6 Insulated grounding conductors: green, type RW90. Grounding conductor size in accordance with MESC.. Bonding conductor size in accordance with MESC.
.7 Ground bus: copper, complete with insulated supports, fastening, connectors.
.8 Non-corroding accessories including but not necessarily limited to:
  .1 Grounding and bonding bushings.
  .2 Protective type clamps.
  .3 Bolted type conductor connectors.
  .4 Bonding jumpers, straps.
  .5 Pressure wire connectors

# 3 Execution

## 3.1 INSTALLATION GENERAL

.1 Install complete permanent, continuous, bonding system and circuit grounding system conforming to requirements of local authority having jurisdiction and MESC.
.2 Provide grounding electrodes in accordance with MESC.
.3 Provide artificial grounding electrodes in accordance with MESC.
.4 Protect exposed grounding conductors from mechanical injury.
.5 Provide grounding conductor connection to electrodes in accordance with MESC.
.6 Bond to ground all non-electrical equipment in accordance with MESC.
.7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
.8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
.9 Install separate ground conductor to outdoor lighting standards.
.10 Connect building structural steel and metal siding to ground by welding copper to steel.

.11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
.12 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

## 3.2 ELECTRODES

.1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
.2 Install water meter shunt.
.3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
.4 Install rod electrodes and make grounding connections.
.5 Bond separate, multiple electrodes together.
.6 Use size 4/0 AWG copper conductors for connections to electrodes.
.7 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails.

## 3.3 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections.
.2 Install dedicated insulated ground conductor from panel ground bus for each receptacle circuit.

## 3.4 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to, following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, distribution panels and outdoor lighting.

## 3.5 GROUNDING BUS

.1 Install coper grounding bus mounted on insulated supports on wall of electrical room.
.2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0 AWG.

## 3.6 COMMUNICATION SYSTEM

.1 Install grounding connections for telephone, sound fire alarm, intercommunication systems as follows:
  .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
  .2 Sound, fire alarm, intercommunication systems.

## 3.7 PERMAFROST

.1 Bond non-current carrying metal parts together with copper equipotential conductor. Run conductor from separate lug or service neutral bar to, but not necessarily limited to, following in door systems and equipment:
  .1 Hot water heating system.
  .2 Main water pipe.
  .3 Main building drain.
  .4 Oil line/gas line.
  .5 Telephone, radio/tv, emergency and fire alarm lean-in or service conduits, near panels.
  .6 Make connections to pipes on building side of main valves and tanks. Connect jumpers across boilers to supply and return hot water heating pipes.
.2 Drive three -3/4" x 10'-0" copper clad ground rods at least 6' (1.8 m) apart in original undisturbed ground. If rods will not penetrate permafrost, drive at angle not more than 60° from vertical, and in same direction. Rods must be driven, not trenched.
.3 Install ground wire from service neutral bar to rods and, where buried, use bar copper not smaller than size 1 AWG 7 - strand or size 4 AWG solid, and at least 18" (460 mm) below ground. Bond

ground conductor, or short tap from it, to outside metal sheathing of building close to power service conduit. Use lug or cast clamp, with bronze or plated bolt, nut and washers (not sheet metal screw of wood screw). Remove paint from sheathing for good contact. Conduit is required only on outside wall of building. Indoors, run bare and fasten as specified for equipotential bonding wire.

.4 Install electrode interconnections where metal parts, circuits or grounding conductors and/or electrodes are in proximity to lightning rod conductors.

**3.8 FIELD QUALITY CONTROL**

.1 Perform tests in accordance with Section 16010.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.

.3 Perform test before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.
.3 Panelboards based on CSA-22.2-29-M1989.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.
.2 Coordinate equipment physical size and space limitations.

## 1.3 RELATED DATA

.1 Plywood Backboard: See Section 16010-3.2

## 1.4 SUBMITTALS

.1 Shop drawings as per Section 16010.
.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
.3 Contractor's Material and Test Certificate as per Section 16010.
.4 Submit final commissioning report with record drawings. See paragraph 16010, 1.4.

## 1.5 PLANT ASSEMBLY

.1 Assemble panelboard interior before shipment. Ship fuses loose for on site installation.

## 1.6 MANUFACTURERS

.1 Acceptable Manufacturers:
  .1 Siemens
  .2 Square D
  .3 Westinghouse
  .4 CGE
  .5 Commander
  .6 Cutler-Hammer

# 2 Products

## 2.1 PANELBOARDS

.1 Panelboards: product of one manufacturer.
.2 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
.3 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated. Short circuit bracing shall be equal to or greater than system interrupting capacity at panel location.
.4 Two keys for each panelboard and key panelboards alike.
.5 Copper bus with neutral of same ampere rating as mains.
.6 Mains: suitable for bolt-on breakers.
.7 Trim and door finish: baked grey enamel.
.8 Comply with Part 3: Execution regarding spare breakers and breaker spaces to be provided in each panel.
.9 Note maximum physical dimension limitations must suit layout shown on contract drawings.

## 2.2 BREAKERS

.1 Breakers: to section 16477, Moulded Case Circuit Breakers.
.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
.4 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Owner.

## 2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 16010/3.8.
.2 Nameplate for each panelboard size 4 engraved in accordance with Section 16010/3.8.
.3 Nameplate for each circuit in distribution panelboards size 2 engraved as in accordance with Section 16010/3.8.
.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

# 3 Execution

## 3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
.2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard. See Section 16010/3.2.
.3 Mount panelboards to height specified in Section 16010, as indicated, or as per applicable codes.
.4 Connect loads to circuits.
.5 Connect neutral conductors to common neutral bus with respective neutral identified.
.6 From each recessed panel, except residential suite panels, and unless otherwise noted, provide minimum 2 @ 1" (25 mm) empty conduits up to accessible ceiling space directly above panel. Terminate each in a 4" (100 mm) square box with BM cover.
.7 Provide 25% spare breakers in each panel based on number of circuits in use.
.8 Provide 25% breaker spaces in each panel based on number of circuits in use.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.

## 1.3 SUBMITTALS

.1 Shop drawings as per Section 16010.
.2 Include time-current characteristic curves for breakers with ampacity of 400 A and over with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage**]**.
.3 Contractor's Material and Test Certificate as per Section 16010.

## 1.4 MANUFACTURERS

.1 Acceptable Manufacturers:
  .1 As supplied by panel manufacturer.

# 2 Products

## 2.1 BREAKERS - GENERAL

.1 Bolt-on moulded case circuit breaker: thermal magnetic unless otherwise indicated, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 C ambient.
.2 Plug-in moulded case circuit breakers: thermal magnetic unless otherwise indicated, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 C ambient.
.3 Moulded case circuit breakers 400 ampere and larger and circuit breakers feeding transformers of 112-1/2 kVA and larger shall be solid-state trip type.
.4 Common-trip breakers: with single handle for multi-pole applications.
.5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips from 3-8 times current rating for motors protections.
.6 Circuit breakers with interchangeable trips as indicated.
.7 Main breakers: minimum 42,000A-RMS symmetrical interrupting @ 240 VAC, 35,000-AIC @ 600VAC, unless otherwise indicated. When breaker is tripped automatically, handle to assume position between on and off. Current rating as indicated. Minimum interrupting rating shall not be less than switchboard or panel rating wherein breakers are installed.
.8 Branch breakers: minimum 22,000 A-RMS symmetrical interrupting @ 240VAC, 35,000-AIC @ 600VAC, unless otherwise indicated. When breaker is tripped automatically, handle to assume position between on and off. Current rating as indicated. Minimum interrupting rating not less than switchboard or panel rating wherein breakers are installed.
.9 All breakers to be clearly labelled as to frame size, voltage, current rating, trip rating and model number.

### 2.2 ARC-FAULT CIRCUIT INTERRUPTERS

.1 As a minimum branch circuits that supply receptacles installed in sleeping facilities on this dwelling unit shall be protected by a panel mounted arc-fault circuit interrupter (AFCI) per the 2002 CEC. AFCI's shall be bolt-on type rated 15A max. AFCI's shall have visual indication of a trip condition.
.2 Refer to electrical drawings for panels requiring AFCI type breakers.
.3 AFCI's shall be Square D #Q0115AFI or equivalent by panel manufacturer.

### 2.3 OPTION FEATURES

.1 Include:
- .1 shunt trip.
- .2 auxiliary switch.
- .3 motor-operated mechanism
- .4 under-voltage release.
- .5 on-off locking device
- .6 handle mechanism.

## 3 Execution

### 3.1 INSTALLATION

.1 Install circuit breakers as indicated.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.
.3 Plug and standard cartridge fuses based on CSA-C22.2-59.1-M87(R1997), CSA-C22.2-59.2-M86 (R1997), and CSA-C22.2-59.3-M90(R1997). HRC fuses based on CSA-C22.2-106-M92)R1997).

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.

## 1.3 SUBMITTALS

.1 Shop drawings and product data as per Section 16010.
.2 Submit fuse performance data characteristics for each fuse type and size above 200 A. Performance data to include: average melting time-current characteristics, I2t (for fuse coordination), and peak let-through current.
.3 Contractor's Material and Test Certificate as per Section 16010.

## 1.4 MAINTENANCE MATERIALS

.1 Provide maintenance materials in as per Section 16010.
.2 Three spare fuses of each type and size installed above 600 A.
.3 Six] spare fuses of each type and size installed up to and including 600 A.

## 1.5 DELIVERY AND STORAGE

.1 Ship fuses in original containers.
.2 Do not ship fuses installed in switchboard.
.3 Store fuses in original containers in storage cabinet.

## 1.6 MANUFACTURERS

.1 Acceptable Manufacturers:
  .1 Ferraz Shawmut
  .2 Bussmann
  .3 English Electric
  .4 Littelfuse

# 2 Products

## 2.1 FUSES - GENERAL

.1 Fuse type references L1, L2, J1, etc, have been adopted for use in this specification.
.2 Fuses: product of one manufacturer.

## 2.2 FUSE TYPES

.1 HRC-L (formerly Class L).
  .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  .2 Type L2, fast acting.
.2 HRCI-J fuses (formerly Class J).
  .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  .2 Type J2, fast acting.
.3 HRCI-R fuses (formerly Class R). For UL Class RK1 fuses, peak let-through current and I2t values not to exceed limits of UL-198E-1982, table 10.2.

.1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
.2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

.5 Where fuses with maximum let-through current are indicated, provide a lamacoid label on front cover of equipment, as per paragraph 16010/3.8 reading ASystem Capacity [35,000] AIC, Peak Let-Through [10,000] AIC Fuse.

.6 For VFD and sft start feeders: HSJ-High speed class J fusing, Ferraz Shawmut or approved equivalent by drive manufacturers.

### 2.3 FUSE STORAGE CABINET

.1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 32" (750 mm) high, 24" (600 mm) wide. 12" (300 mm) deep, hinged, lockable front access door finished in accordance with Section 16010, Electrical General Requirements.

## 3 Execution

### 3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.
.2 Ensure correct fuses fitted to physically matched mounting devices.
.3 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.
.4 Install type J2, non-time delay, non-renewable, maximum 600 A 250 V 200,000A-RMS symmetrical interrupting rated HRCI-J fuses except for motor circuits.
.5 Install type J1, time-delay, non-renewable, maximum 600 A 250 V, 200,000A-RMS symmetrical interrupting rated HRCI-J-TD for motor circuits.
.6 Provide Class JSH iin VFD and solid state drive feeder protectoin size to drive manufacturer's recommendations in shop drawings.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.
.3 Contactors based on CSA-C22.2-14-95(R2000).

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.
.2 Contractor's Material and Test Certificate as per Section 16010.

## 1.3 SUBMITTALS

.1 Submit shop drawings and product data as per Section 16010.

## 1.4 MANUFACTURERS

.1 Acceptable Manufacturers: same manufacturer as starters, Section 16811.

# 2 Products

## 2.1 CONTACTORS

.1 Contactors: to EEMAC-1CS-1970.
.2 Electrically held unless otherwise indicated, controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
.3 Breaker combination contactor as indicated.
.4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
.5 Mount in CSA Enclosure 1 unless otherwise indicated.
.6 Include following options in cover:
  .1 Hand-Off-Auto selector switch unless otherwise indicated.
  .2 Red indicating lamp.
  .3 Stop-Start pushbutton
  .4 On-Off selector switch.
.7 Control transformer: as necessary to provide 120V control circuit.

## 2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification as per Section 16010, Subsection 3.8.
.2 Size 4 nameplate.

# 3 Execution

## 3.1 INSTALLATION

.1 Install contactors and connect auxiliary control devices.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.

## 1.3 SUBMITTALS

.1 Submit shop drawings as per with Section 16010.
.2 Submit complete photometric data prepared by independent testing laboratory for luminaires here specified, for review by Consultant.
.3 Photometric data to include: total input watts, candlepower summary, candela distribution zonal lumen summary, luminaire efficiency, CIE type, coefficient of utilization, lamp type and lumen rating in accordance with IESNA testing procedures.
.4 Fixture shop drawings must indicate wattage of lamps as per Contract drawings and lamp type and manufacturer as recommended by fixture manufacturer.
.5 Fixture shop drawings must include ballast data such as maximum THD, power factor, noise rating,

# 2 Products

## 2.1 LAMPS

.1 Incandescent lamps: rated 125 volts, wattage and type as noted in schedule, 1000 hours, clear or inside frosted as indicated in schedules, as manufactured by CGE, Sylvania, Philips, and as recommended by fixture manufacturer.
.2 Fluorescent lamps: T8 energy saving, wattage and type as noted in schedule, minimum 85-CRI (recommended 85 CRI for better colour rendition), 4100 K , 20,000 hour rated lamp life, as manufactured by GE, OSRAM Sylvania, Philips, and as recommended by fixture manufacturer.
.3 HID lamps: clear or inside frosted, wattage and types as noted in schedule, 24,000 hours lamp life, as manufactured by GE, OSRAM Sylvania, Philips, and as recommended by fixture manufacturer.
.4 Compact fluorescent lamps: twin or quad tube configuration, wattage as indicated, 4100 K colour, starter in base, G23 or GX23 base, 10,000 hours rated lamp life, as manufactured by GE, OSRAM Sylvania, Philips, and as recommended by fixture manufacturer.
.5 All lamps for project to be new. Similar lamp types shall be of one manufacturer.

## 2.2 BALLASTS

.1 All ballasts shall comply with ASHRAE/IESNA-90.1-1989 regarding ballast efficiency factor (BEF).
.4 Fluorescent ballasts: high power factor, rapid start, 100% electronic solid state, energy saving, suitable for use with fluorescent lamps indicated. Maximum crest factor shall comply with ANSI recommendations. 10% THD.
.5 HID ballasts: integral part of fixture unless otherwise noted, with power factor of 90%, minimum input voltage range + 13% of nominal, minimum starting temperature of minus 30 degrees centigrade at 87% nominal line voltage. Voltage and wattage rating as indicated, as manufactured by Philips, Sola Electric, GE., or Universal.

## 3 Execution

### 3.1 INSTALLATION

.1 Locate and install luminaires as indicated.

### 3.2 WIRING

.1 Connect luminaires to lighting circuits as indicated.

### 3.3 LUMINAIRE SUPPORTS

.1 For suspended ceiling installations, support luminaires independently of ceiling in accordance with local inspection requirements. Refer to OESC Bulletin 30-4-5 concerning OESC 30-302.
.2 Support fluorescent luminaires mounted in continuous rows once every 24" (610mm).

### 3.4 LUMINAIRE ALIGNMENT

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.
.3 Aim accent lighting as indicated during darkness and in presence of Consultant.
.4 Lock accent lighting in final aiming position after Consultant's approval.

### 3.5 LAMPS

.1 Install new lamps for each fixture.
.2 Supply to the Owner's stock on site, 15% spare T8 lamps of each type specified, rounded up to the next full box, to replace failures during the first 20,000 hours of operation after the date of Substantial Performance of the Work of Division 16.
.3 Supply to the Owner's stock on site, 15% spare compact fluorescent lamps of each type specified, rounded up to the next full box, to replace failures during the first 10,000 hours of operation after the date of Substantial Performance of the Work of Division 16.
.4 All metal halide, mercury, high pressure sodium, and compact fluorescent lamps shall be operated, by the Contractor, for 100 hours "settling down" period accomplished by continuous burn or ten (10) 10-hour minimum periods, or as otherwise directed by the manufacturer.
.5 Dimming compact fluorescent lamps and dimming linear fluorescent shall be operated at full brightness, by the Contractor, for minimum 100 hour "settling down" period accomplished by continuous burn or ten (10) 10-hour minimum periods, or as otherwise directed by the manufacturer.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.
.2 Conform to CAN/CSA-C860-01, Performance of Internally Lighted Exit Signs.

## 1.3 SUBMITTALS

.1 Submit product data as per Section 16010.

# 2 Products

## 2.1 EXIT LIGHTS

.1 Housing: cold rolled steel minimum 1/25" (1.0 mm) thick, die-cast or anodized extruded aluminum frame, anodized aluminum finish.
.2 Face and back plates: extruded aluminum alloy or die formed cold rolled steel, anodized aluminum colour.
.3 Lamps: LED type, 120VAC, and emergency power source, maximum 5 watts consumption.
.4 Designed for minimum 50,000 hours of continuous operation without relamping.
.5 Letters: 6" high x 3/4" wide (150 mm high x 19 mm wide), red, reading "EXIT".
.6 Wording shall be in both English and French.

## 2.2 DESIGN

.1 Recessed, wall, end to wall or ceiling mounting as indicated. Include necessary canopy mounting plate.
.2 Single or double face as indicated.
.3 Arrow: right, left or both directions as indicated.
.4 Wireguard as indicated.

## 2.3 ACCEPTABLE MANUFACTUERS

.1 Lightguard
.2 Uniglo
.3 Emergi-lite
.4 Lumacell
.5 Luxnet
.6 Lithonia
.7 Beghelli

# 3 Execution

## 3.1 INSTALLATION

.1 Install exit lights as indicated, in accordance with MBC.
.2 Connect fixtures to exit light circuits as indicated.
.3 Connect emergency lamp sockets to emergency circuits as indicated.
.4 Ensure that exit light circuit breaker is locked in on position.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other Sections of Division 16.
.2 Emergency lighting shall comply with CSA C22.2-141-M1985(R1999).

## 1.3 SUBMITTALS

.1 Product data and shop drawings as per Section 16010.
.2 Data to indicate system components, mounting methods, source of power and special attachments.
.3 Contractor's Material & Test Certificate as per Section 16010.

## 1.4 DELIVERY

.1 Deliver batteries in dry state unless hermetically sealed.
.2 Provide electrolyte in hazard-proof container.

# 2 Products

## 2.1 EQUIPMENT

.1 Supply and install solid state emergency lighting equipment as indicated. Equipment to meet the requirements of CSA Standard C22.2-141-M1985(R1999), Equipment for Emergency Lighting.
.2 Provide battery units of voltage noted and capable of supplying load for time indicated to 91% end voltage, and to automatically shut-off.
.3 Provide charger and controls with the following components:
  .1 Solid state pulse type charger.
  .2 Solid state transfer and low voltage drop-out circuit.
  .3 Ready/disconnect switch and light.
  .4 Red high rate charge light.
  .5 Voltmeter.
  .6 Press-to-test switch.
  .7 Output protection where remote fixtures are used.
.4 Include with units, appropriate mounting brackets and 3-wire cordset. Include receptacle by each unit.
.5 Each unit to contain a sealed Maintenance Free Battery encased in a high-impact, heat resistant translucent plastic. Battery to operate longer than 10 years entirely unattended and have a 5 year full guarantee and pro-rata for the next 5 years.
.6 Size wiring from units to remote fixtures for no greater than 5% voltage drop. Submit shop drawings for review showing wire sizing to all units.
.7 Provide wire guards where indicated.
.8 Supply voltage: 120 V, ac.
.9 Output voltage: 12 V dc.
.10 Operating time: see drawings.
.11 Battery: vented sealed, maintenance free.
.12 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected.
.13 Solid state transfer.
.14 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
.15 Signal lights: solid state, life expectancy 1000,000 h minimum, for "AC power ON" and "High

Charge".

.16 Lamp heads: integral on unit and remote, 360 horizontal and 180 vertical adjustment. Lamp type: tungsten-halogen, 9 W, glare free minimum lumen output.

.17 Cabinet: suitable for direct to wall and c/w knockouts for conduit. Removable front panel for easy access to batteries.

.18 Finish: white.

.19 Auxiliary equipment:

- .1 Ammeter.
- .2 Voltmeter.
- .3 Lamp disconnect
- .4 Test switch.
- .5 Time delay relay.
- .6 Battery disconnect device.
- .7 ac input and dc output terminal blocks inside cabinet.
- .8 Bracket.
- .9 Cord and plug connection for ac.
- .10 RFI suppressors.

## 2.2 WIRING OF REMOTE HEADS

.1 Conduit: to Section 16111, Conduits Fastenings and Conduit Fittings.

.2 Conductors: to Section 16122, Wires and Cables 0-1000 V, sized in accordance with manufacturer's recommendations.

## 2.3 MANUFACTURERS

.1 Battery Unit: Lumacell RG12S or equivalent Hubbell, Emergi-lite, Dual-lite, Lightguard, Beghelli. Refer to drawings for capacities.

.2 Remote surface lighting heads: Lumacell MT1-12 volt, 9 watt (single head), MT2-12 volt, 9 watt double head), or equivalent Hubbell, Emergi-lite, Dual-lite, Lightguard, Beghelli.

.3 Remote recessed lighting heads: Lumacell RS22-12 volt, 25 watt, or equivalent Hubbell, Emergi-lite, Dual-lite, Lightguard, Beghelli.

# 3 Execution

## 3.1 INSTALLATION

.1 Install unit equipment and remote mounted fixtures as indicated. Confirm exact mounting height on site prior to installation.

.2 Direct heads as indicated.

.3 Connect all exit lights to closest unit equipment as indicated.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other Sections of Division 16.

## 1.3 QUALITY ASSURANCE

.1 The design of poles shall conform to AASHTO AStandard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals@ at the 1/100 hourly wind pressure given in the Manitoba Building Code for the place of installation including a 1.3 gust factor.
.2 Deflection of the pole shall not exceed 14% of the pole height at full loading with a 1.3 gust factor.
.3 Selection of pole and structural aspects of pole design, including fabrication methods shall be reviewed by structural engineer, licensed in Manitoba. The design shall be project specific for each pole/luminaire combination indicated. Shop drawings shall bear the seal and signature of the structural engineer.

## 1.4 SUBMITTALS

.1 Submit product data as per Section 16010.

# 2 Products

## 2.1 STEEL POLES

.1 Steel poles: to NEMA-SH5-1969 (R1974), designed for underground wiring and:
  .1 Mounting on concrete anchor base without transformer base.
  .2 Style: monotube, minimum 3.0 mm thick, tapered round.
  .3 Straight for one luminaire mounting bracket.
  .4 Terminating in single curved davit.
  .5 Finish: flat black.
  .6 Grounding lug.

## 2.2 LUMINAIRE MOUNTING BRACKETS

.1 Mounting brackets steel for metal halide fixtures and:
  .1 Single brackets as indicated.

## 2.3 LUMINAIRES

.1 As per Section 16505 and as indicated.

# 3 Execution

## 3.1 INSTALLATION

.1 Install brackets on poles, as indicated.
.2 Erect poles on foundations, true and plumb as indicated.

.3 Install luminaires on pole brackets, connect to pole wiring and install lamps.
.4 Connect pole wiring to underground street light circuit in handhole at pole base.
.5 Perform tests as indicated.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to other sections of Division 16.

## 1.3 REFERENCES

.1 CAN/ULC-S524-2001 Installation of Fire Alarm Systems.
.2 ULC-S525-1999 Audible signal Appliances, Fire alarm.
.3 CAN/ULC-S527-99 Control Units, fire Alarm.
.4 ULC-S528-1991(R1999) Manually Actuated Signalling Boxes, Fire Alarm.
.5 CAN/ULC-S529-M87 (R1995) Smoke Detectors, Fire Alarm.
.6 ULC-S530-1991(R1999) Heat Actuated Fire Detectors, Fire Alarm.
.7 CAN/ULC-S531-M87 (R1995) Smoke Alarms.
.8 CAN/ULC-S536-M97 Inspection and Testing of Fire Alarm Systems.
.9 CAN/ULC-S537-M97 Verification of fire Alarm Systems.
.10 DFC No. 310 (M)-1979 Computer Systems.
.11 DFC No. 410 (m) - Fire Alarm Systems.
.12 NBC-National Building Code of Canada.
.13 MBC - Manitoba Building Code.

## 1.4 DESCRIPTION OF SYSTEM

.1 System includes:
  .1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.
  .2 Trouble signal devices.
  .3 Power supply facilities.
  .4 Manual alarm stations.
  .5 Automatic alarm initiating devices.
  .6 Audible signal devices.
  .7 End-of-line devices.
  .8 Annunciators.
  .9 Visual alarm signal devices.
  .10 Ancillary devices.

## 1.5 REQUIREMENTS OF REGULARTORY AGENCIES

.1 System:
  .1 To Dominion Fire Commissioner DFC No. 410(M)-1979.
  .2 Subject to Fire Commissioner of Canada (FC) approval.
  .3 Subject to FC inspection for final acceptance.
  .4 To Canadian Forces Fire Marshal approval.

## 1.6 SUBMITTALS

.1 Shop drawings and product data as per Section 16010 for the following items:
  .1 Fire alarm and emergency voice communication system components and detailed wiring diagrams.
  .2 Fire alarm and emergency voice communication system single line riser diagrams.

## 1.7 OPERATION AND MAINTENANCE DATA

.1 Provide 3 copies of operation and maintenance data for Fire Alarm System for incorporation into manuals specified in Section 16010.
.2 Include:
  .1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.
  .2 Technical data - illustrated parts lists with parts catalogue numbers.
  .3 Copy of approved shop drawings.

## 1.8 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with Section 16010.
.2 Include:
  .1 5 spare glass rods for manual pull box stations.

## 1.9 MAINTENANCE

.1 Provide one year's free maintenance with two inspections by manufacturer during year. Inspection tests to conform to ULC-S536-97. Submit inspection report to Consultant.

## 1.10 TRAINING

.1 Arrange and pay for on-site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

# 2 Products

## 2.1 FIRE ALARM SYSTEM

.1 Fire alarm system components to be supplied by manufacturer and installed, wired and connected by electrical contractor. Verification and certification by manufacturer.
.2 The building is to be divided into multiple signal zones. Operation is to be such that upon activation of a manual station, or automatic sensing device within a building alarm zone. The system shall:
  .1 sound an evacuation tone over all signaling devices
  .2 shut down selected fan systems
  .3 activate a signal for remote monitoring devices
  .4 indicate the alarmed area and zone number and device location in alarm on the main command centre and remote annunciators
.3 The system is to provide individual visual/audible supervision and annunciation of all sprinkler valve monitor switches (supervised valves) and flow switches, at the command centre and all annunciation locations.
.4 All standard alarm input and output devices are to be hard wired or multiplexed, and utilize either remote data acquisition and control or true distributed processing.
.5 The system to be modular in its design to allow for future expansion.
Network operations are to be via communication links that connect all microprocessor based devices and include data transfer.
The network to operate using half-duplex, digital RS485 communication techniques at a data rate of 57.6K band. Communication to be via twisted adn shielded #18 AWG wire.
.6 All standard alarm input and output devices are to be hard wired or multiplexed, and utilize either remote data acquisition and control or true distributed processing.
.7 The operation of this system shall not require personnel with special operating skills.

.8 The main Command Centre shall be provided with the following:
- .1 Control switches for the control panel are to include an integral status indicator and be physically correlated to the building representation.
- .2 All controls and indicators are to be protected by a locked door with a full viewing window.
- .3 The control panel is to be suitable for semi-flush surface mounting and complete with factory supplied trim/frame.
- .4 Provide communication ports to:
  - .1 Interface to keyboards to access system information and perform control as programmed at the Simplex Control Panel.
  - .2 Interface to serial printer(s) to record system information as programmed at the Simplex Control Panel.
- .5 Total control and indicator capacity for the integrated system to be sized for future expansion.
- .6 The common control and indicators are to include, but not be limited to, trouble signal, trouble indicator and silencing switch, power on indicator, system reset switch, alarm signal silence complete with indicator, fire department alert indicator, emergency power in operation indicator.
- .7 The command centre is to contain separate historical logs for fire alarm and trouble conditions. Logs to be accumulated in a non-volatile format. Each distinct log to house 5000 events. It will not be possible for trouble events to be stored in or to overwrite alarm log events.

.9 Walk Test

The actuation of the "enable walk test" program at the control panel is to activate the "Walk Test" mode of the system which is to cause the following to occur:
- .1 Control relay functions are to be bypassed.
- .2 The control panel is to show a trouble condition.
- .3 The alarm activation of any initiating device will cause the system to sound a code on all selected signal circuits indicating zone number being tested.
- .4 The panel will automatically reset itself after signaling is complete.
- .5 Any momentary opening of an initiating or indicating appliance circuit will cause the system to sound a code on all selected signal circuits indicating trouble test confirmed.
- .6 The system is to have the capacity of distinctive walk test groups. Such that only a portion of the system need be disabled during testing. These groups are to be programmed per instructions from the Owner.

.10 Control Panel:
- .1 The integrated control panel shall be microprocess based to provide an interface between the standard alarm input/output devices.
- .2 The system is to provide alarm receiving circuits for initiating devices such as manual stations, heat detectors, and smoke detectors, wired in a Class A configuration.
- .3 An open circuit fault in the field wiring is to activate the common trouble sequence and illuminate the zone and trouble indicator at the control panel, annunciator, and printer.
- .4 A ground fault condition in the field wiring of the alarm receiving circuit is to activate the common trouble sequence and illuminate the system ground fault indicator at the control panel, annunciator, and printer. Indication to be provided per system power supply.
- .5 The control panels are to provide termination for all input circuit wiring. The system's initiating circuits are to provide a subsequent alarm and trouble feature. A subsequent trouble from another circuit is to reactivate the trouble sequence. A subsequent alarm from another circuit will reactivate the alarm sequence.
- .6 The system is also to provide integrated signal output circuits for signal appliances such as horns and strobe lights. The appliances are to be wired in a Class A configuration. An alarm o the system is to cause the audible signal appliance to distribute the selected signal output to the output circuits, and cause the strobe lights to operate throughout the building.
- .7 Each signal circuit is to be supported by a single power amplifier or to be grouped according to system operation requirements.
- .8 The field wiring of the signal output circuit is to be supervised for open and short circuit conditions. An open or short fault condition in the field wiring of the signal circuit to activate a common trouble sequence and indicate the trouble status at the control panel, annunciator, and printers. Indication to be per circuit.

.9 The control panels hall include the equipment and capability for "cross zoning" of addressable devices at a later date by only having the manufacturer reprogram the system. No parts shall be necessary.

.10 The control panel shall provide termination for all output circuit wiring and Class A alarm circuits. All circuits are to provide a trouble feature. A subsequent trouble from another circuit will reactivate the trouble sequence. The system is to provide auxiliary contacts for control of functions such as fan control, door release and elevator signal. Field wiring connections are to be made at the control devices or control panel. An alarm on the system is to case the auxiliary relay contacts to operate. Each auxiliary relay is to be provided with a circuit status indicator at the control panel. The system is to include a microprocessor basic based controller to monitor all internal and external circuits and be connected to the central panel.

.11 Annunciators

.1 As indicated, provide an LED annunciator. The annunciator shall have a stainless steel finish and shall provide one alarm lamp and one trouble lamp per initiation device circuit. The annunciator shall communicate to the control panel over one twisted shielded pair of wire and operating power shall be 24VDC and be fused at the control panel. Point-wired annunciators will not be considered as equal.

.12 Graphic Display

.1 Provide passive graphic annnciator as indicated. Graphic shall be mounted adjacent to the remote annunciator. The graphic shall be constructed of a non-fading mylar plotting installed in an aluminum frame with a white plexi background and a clear plexi cover comeplete with tamper proof mounting hardware. Adjacent zones on the graphic shall be diferent colours to ease zone separation identification. The graphic shall be oriented to the viewer with a red "you are there" indication. The graphic must be approved by the consultant and owner prior to manufacture.

.13 Battery:

.1 Standby batteries are to be sized to power the system in accordance with the latest ULC Standards. Continuous supervision of the wiring for the external initiating and alarm circuits will be maintained during power failure.

.2 The main control unit shall have sufficient battery backup to operate the system under supervisory conditions with AC power disconnected for 24 hours and at the end of this period, operate the alarm devices for two hours.

.14 Addressable Smoke Detectors, Heat Detectors, Interface Devices and Pull Stations

.1 Smoke detectors pull stations and heat detectors are to be addressable devices. Devices are to indicate their exact identity, location and status to the system control, where information is to be displayed in the English language.

.2 The plug-in detector base is to house the device network address, in order to avoid addressing errors during maintenance and sensor replacement.

.3 Heat Detectors: Addressable 135° rate of rise/fixed temperature - Simplex #4098-9731C head complete with 4098-9781 base. Addressable 135° fixed temperature - Simplex #4098-9407 head complete with 2098-9211C base. Addressable 190° fixed temperature - Simplex #4098-9407 head complete with 2098-9211C base.
Note: Addressable heat detector heads and addressable smoke detector heads are to utilize common base types to allow on site devices type changes without disturbing system wiring.

.4 Addressable Pull Stations: Pull stations to be Simplex 2099-9795C single stage complete with "T" bar handle and keylock reset/test, English. Provide manual station protective shields complete with local alarm horn and battery, on all manual pull stations except those in spaces inaccessible to the students i.e.staff areas, mechanical rooms etc., Simplex # 2099 Series.

.5 Addressable Smoke Detectors: Detector base to be Simplex #4098-9781 complete with # 4098-9716C ionization head or type 4098-9701C photoelectric head (interchangeable heads to suit site/owner requirements). Provide relay bases or corridor detectors and on detectors which close required fire separation doors as shown. Relay base shall be wired to door holders such that door closes when detector senses smoke.

.6 Addressable Duct Detectors: Simplex truealarm #4098-9714C c/w 4098-9752C housing and 2098-9798 sampling tube to suit duct width and remote alarm indicator #2098-9808.

.15 Signal Devices:
.1 Corridor horn or horn/strobe combination units wired separately to allow modification of sound coding without modifying strobe output 95 dBa at 10 feet x/w 117 cd Xenon strobe flashing one per sedond, 24 VDC. Simplex #NS-2415W-FR-ULC horn strobe complete with DSM-12/24-R-ULC Sync Module for synchronizing strobes.

.16 Alternate Manufacturers:
The base bid is to include the Simplex 4100 System or one of the following approved equivalent systems:
.1 Siemens XLS System.
.2 Edwards EST-3 System
All other manufacturers will be considered alternates subject to the requirements of 16010/2.03/B., Equivalents and Alternates.

.17 Provide line isolation modules where loop penetrates each floor slab and where loop passes between designated fire alarm zones.

## 3 Execution

### 3.1 FIRE ALARM SYSTEM

.1 Wiring
.1 Use solid copper conductors, rated for 300 volt.
.2 Wiring to devices to be Securex II Type FAS 105°C, PVC jacket, 300 volt, 18 gauge, twisted shielded pair in EMT conduit.
.3 All initiation zone wiring to be Class A except as noted.

.2 Install detectors in accordance with ULC Standard S524 M91 "Installation of Fire Alarm Systems".

.3 Install anti-tamper screws in all detectors in areas accessible to students.

.4 Do not install detectors within 900 mm of supply and exhaust registers and diffusers.

.5 Install detectors on ceiling minimum 610 mm from wall.

.6 All initiating and D.C. signal circuits extending from the fire alarm control to be current limited and protected, in accordance with Canadian Electrical Code Class 2 requirements.

.7 The extended circuit wiring to each alarm receiving circuit or signal circuit is to be individually supervised.

.8 Install all wiring in EMT metal conduit. Run conduits above ceilings, surface in mechanical spaces and in maintenance/storage spaces with exposed ceilings.

.9 Locate manual pull stations at the noted heights above finished floor level.

.10 Locate alarm signals called for on the Drawings.

.11 Testing of all flow switches and supervisory valve switches is to be actual water flow activation.

.12 Verify operating voltage of magnetic locks for tie into system. Provide any necessary transformation or relays.

.13 ALL manual pull stations must be by a single manufacturer.

.14 Back boxes supplied by communication's manufacturer/contractor are to be installed directly on the building structure and not onto another electrical box. Provide all required openings in back boxes additional to pre-punched openings as required.

.15 Verification and Certification of Fire Alarm Equipment
.1 Verify the system is in accordance with ULC Standard S537 M90 "Verification of Fire Alarm System".
.2 The Contractor/Equipment Manufacturer is to inspect the fire alarm equipment, including all components necessary to the direct operation of the system such as manual stations, smoke detectors, controls and horn/strobes. The inspection is to comprise of an examination of such equipment in accordance with CSA Standard S537-M90, including:
.1 That the type of equipment is that designated by the Consultant's Specifications.
.2 That the wiring connections to all equipment components show that the installer undertook to have observed ULC, CSA and OHESC requirements.
.3 That equipment has been installed in accordance with the manufacturer's recommendations and that all signaling devices of whatever manufacturer have been operated or tested to verify their operation

.4 That the supervisory wiring for items of equipment connected to a supervised circuit is operating and that the governmental regulations, if any, concerning such supervisory wiring, have been met, to the satisfaction of the inspecting officials.
.5 Verification is to be done on an individual item basis.
.6 Verification is to include signal strength in all parts of buildings.
.7 The manufacturer is to supply to the Electrical Contractor, technical assistance with respect to any changes necessary to conform to item (1) above. During the period of inspection by the manufacturer, make available to the manufacturer as many electricians as designated by the manufacturer to complete the verification within the specified time frame.
.8 Verification is to be completed in stages to match the Work Schedule, Section 01010, 14.

.16 Inspection Certification
On completion of the inspection and when all the above conditions have been complied with, the manufacturer is to issue to the Consultant:
.1 A copy of the inspecting technician's report showing location of each device and certifying the test results of each device.
.2 A certificate of verification confirming that the inspection has been completed showing the conditions upon which such inspection and certification have been rendered.
.3 Proof of liability insurance for the inspection.

.17 Inspection Costs: include all cost involved with this inspection in the total Tender Price.

.18 Testing: tests of the complete system in the presence of the Owner and the Consultant are to include:
.1 Spot check of devices to ensure proper connections and supervision.
.2 Operation of an alarm initiating device on each detection circuit is to verify the required operation of alarm devices, annunciators, etc.
.3 Operation of all other alarm initiating devices in a convenient, silent method (buzzer, light, mete, etc.) are to ensure connection to the proper circuit and function of the device.
.4 Live smoke or open flame are not to be used for testing.
.5 Demonstrate to Consultant/Owner operation of fan shutdown relay systems and elevator recall functions.

## 3.2 DEVICE LOCATION

.1 Locate all new heat and smoke detectors away from walls and bulkheads. Keep 900 mm away from supply and exhaust registers. Adjust location to suit. Location of devices shown on Drawings is approximate and must be adjusted to site conditions.

.2 Locate duct detectors in ductwork as per manufacturer's recommendations.

## 3.3 SYSTEM PROGRAMMING

.1 Include all monies to program the new system to provide standard system requirements as previously specified, plus the following special functions:
.1 Alarm Verification: Corridor smoke detectors and stairwell smoke detectors are to be polled in such a way that an alarm condition is confirmed for up to 30 seconds before an evacuation alarm is sounded. During this 30 second period, the following events will take place:
.1 An alert signal is to sound at the Command Centre with acknowledge at CRT keyboard.
.2 The device location and room number to appear on CRT screen and be printed at Command Centre.
.3 During the 30 second verification cycle, if another zone's smoke detector or any manual station, heat detector or water flow switch activates, the alarm shall be confirmed and activate the evacuation signal. If a second device does not activate during the 30 second delay, the system shall reset and begin a 60 second confirmation cycle should any device on any other zone activate during this 60 second period, the evacuation signal will be activated. If the confirmation cycle ends without incident, the system is to return to its normal state.

.2 Programmed Sensitivity Adjustment: Program corridor smoke detectors such that the sensitivity will automatically be set LOW for a specific time of day/night and set to HIGH for the rest of the day/night.

End of Section

# 1 General

## 1.1 GERERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to all sections of Division 16.
.2 Provide raceways as indicated.

## 1.3 DESCRIPTION OF SYSTEM

.1 Telephone/Data raceways system consists of outlet boxes, coverplates, conduits, cabletroughs, J-hooks, pull boxes, sleeves and caps, fish wires as indicated.

# 2 Products

## 2.1 MATERIALS

.1 Conduits: refer to Section 16111, Raceways.
.2 Cabletroughs & J-hooks: refer to Section 16114, Cabletroughs & J-hhoks.
.3 Junction boxes, cabinets type: refer to Section 16131, Splitters, Junction, Pull Boxes and Cabinets.
.4 Outlet boxes type, conduit boxes, and fittings: refer to Section 16132, Outlet Boxes, Conduit Boxes and Fittings.
.5 Fish wire: polypropylene type.

# 3 Execution

## 3.1 INSTALLATION

.1 Install raceway system, including fish wire, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cabletroughs, miscellaneous and positioning material to constitute complete system as indicated.
.2 Where the local telephone company decides to place concealed wiring within hollow spaces in the walls to service additional outlet locations, it shall not penetrate a fire separation. It must be placed during construction by the local telephone company who shall place the extra outlet boxes, wiring and covers. The Contractor must co-operate with the forces of the local telephone company and must give timely notice to enable them to schedule their work.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to all sections of Division 16.
.2 Provide complete system as indicated.

## 1.3 CARE, OPERATION AND START-UP

.1 Provide instructions in accordance with Section 16010.
.2 Manufacturer's factory service engineer to instruct:
  .1 Maintenance personnel in the maintenance of system.
  .2 Operating personnel in the use of system.

## 1.4 SUBMITTALS

.1 Product data and shop drawings as per Section 16010.
.2 Include, riser diagram, block diagram of complete public address system.
.3 Submit public address system design criteria for approval.
.4 Contractor's Material & Test Certificates as per Section 16010.

## 1.5 MAINTENANCE AND OPERATION

.1 Provide data for incorporation into maintenance manual specified in Section 16010.
.2 Include description of system operation.
.3 Include parts list, using component identification numbers standard to electronics industry.

## 1.6 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with Section 16010.
.2 Include : list spare parts required.

## 1.7 MANUFACTURERS

.1 Acceptable manufacturers: listed below.

# 2 Products

## 2.1 SOUND SYSTEM

.1 Furnish and install all equipment, accessories and materials as indicated to provide a complete and operating audio visual sound system.
.2 Quality Assurance:
  .1 All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
  .2 The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least five years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.
  .3 Show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The

contractor shall maintain, at his facility, the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

.3 Wiring:

.1 System wiring and equipment installation shall be in accordance with good engineering practices. Wiring shall meet all local codes. All wiring shall test free from all grounds and shorts. Provide Manitoba Hydro Special Inspection if required.

.2 Wiring shall be 18/2 stranded/jacketted rated FT-4 (Plenum).

.3 Wiring shall run from the AV Cabinet to each speaker within conduit where required.

.4 Components:

.1 Public Address Amplifier shall be TOA A912 MkII (120watt) with the following modules:

.1 One S-04 Signalling Module (Gong).

.2 Two B-01S Line I/P modules for Radio Audio and Intercom "All Calls".

.3 One M-11s for the Dispatch Desk Microphone.

.2 Dispatch Office Desk Microphone shall be TOA PM-660U, run 3 x 22 gauge wire from the AV Cabinet to the desk micrphone.

.3 Speakers shall be TOA BS-1030W within all areas of Firestation unless noted otherwise, speakers shall be mounted to ceiling or wall as noted on electrical drawings. Finish shall be white for speakers, any brackets required and for surface mounted boxes.

.4 Speakers shall be TOA CS-304 PA Horns shall be provided within Apparatus Bay area complete with mounting stem, finish shall be white.

.5 Exterior Mounted Speakers shall be TOA CS-154 complete with wall mounted bracket, finish shall be white, provide wireguards if required.

.6 Priority Volume Controls - priority relay bypasses volume control setting during "Alarm" announcements.

.7 AV Cabinet shall be Middle Atlantic DWR-18-26PD, double swing wall mounted cabinet, 24" deep, 38.5" height, 18 spaces for housing of PA amplifier, Gong circuitry and Intercom Controller, finish shall be black.

.5 Gong circuitry shall be provided by Owner's forces.

## 2.2 INTERCOM SYSTEM

.1 Furnish and install all equipment, accessories and materials as indicated to provide a complete and operating intercom system.

.2 Quality Assurance:

.1 All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

.2 The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least five years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.

.3 Show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain, at his facility, the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

.3 Wiring:

.1 System wiring and equipment installation shall be in accordance with good engineering practices. Wiring shall meet all local codes. All wiring shall test free from all grounds and shorts. Provide Manitoba Hydro Special Inspection if required.

.2 Wiring shall be Cat 6 from the AV Cabinet to each intecom station within conduit where required.

.4 Components:

.1 Master Station within Dispatch shall be Airphone AN-8000MS.
.2 Other Intercom Stations shall be Airphone AN-8000DS wthin all areas of Firestation unless noted otherwise.
.3 Apparatus Bay Intercom Stations shall be Airphone AN-8000DSW.

### 2.3 RADIO SYSTEM

.1 Furnish and install all equipment, accessories and materials as indicated to provide a complete and operating radio system.
.2 Quality Assurance:
.1 All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
.2 The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least five years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.
.3 Show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain, at his facility, the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.
.3 Wiring:
.1 System wiring and equipment installation shall be in accordance with good engineering practices. Wiring shall meet all local codes. All wiring shall test free from all grounds and shorts. Provide Manitoba Hydro Special Inspection if required.
.2 Antenna Coax whall be LMR400FR (fire rated), the coax shall run from the antenna mast to the Dispatch Office 107.
.4 Components:
.1 Antenna and mast shall be supplied by Owner, General trades shall install, electrical contractor shall provide electrical connections required.
.5 Owner's forces shall supply the Radio power supply, microphone, base tray and Gong circuitry.
.6 Electrical Contractor shall provide a single wire (Cat 6) from the Dispatch Office to the AV Cabinet for the alarms and Gong.

## 3 Execution

### 3.1 INSTALLATION

.1 Install equipment in accordance with manufacturer's instructions.

### 3.2 TESTS

.1 Perform tests in accordance with Section 16010.
.2 Conduct intelligibility test.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to all sections of Division 16.
.2 Provide raceways as indicated.

# 2 Products

## 2.1 TV CABLE RACEWAY SYSTEM

.1 Supply and install complete empty conduit, outlet box and coverplate system as shown on drawings and as described herein.
.2 From each outlet, provide raceways as indicated.
.3 Supply and install 3/4" (19 mm) thick - GIS plywood panels painted both sides with ASA #61 light grey before installation, where shown.
.4 Include pull boxes in conduit runs as required by TV cable company. Install nylon fish wire in all raceways leaving 12" (305 mm) tails at each end of each run. Label each end of each run using string tags.
.5 Wall outlets: 4" (100 mm) square boxes or single gang boxes with suitable single gang plaster rings and coax type F connectors on single gang TV cable coverplates matching devices coverplates in Section 16141.
.6 Advise TV cable company when construction begins as to when wiring will be required.
.7 Provide zone conduits as indicated.
.8 Provide TV cable service raceways as indicated.

# 3 Execution

## 3.1 TV CABLE RACEWAY SYSTEM

.1 Provide empty raceway, outlet box and coverplate system as indicated.
.2 Provide nylon fish wire in all raceways with string tags at each end of each run leaving 12" (305 mm) tails at each end of each run.
.3 Where the local TV cable company decides to place concealed wiring within hollow spaces in the walls to service additional outlet locations, it shall not penetrate a fire separation. It must be placed during construction by the local television company who shall place the extra outlet boxes, wiring and covers. The Contractor must cooperate with the forces of the local TV cable company and must give timely notice to enable them to schedule their work.

End of Section

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.
.3 Starters shall be based on CSA-C22.2-14-M91.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to all sections of Division 16.

## 1.3 SUBMITTALS

.1 Shop drawings in accordance with Section 16010 for the following items:
  .1 All motor starters supplied by this Division.
.2 Indicate:
  .1 Mounting method and dimensions.
  .2 Starter size and type.
  .3 Layout of identified internal and front panel components.
  .4 Enclosure types.
  .5 Wiring diagram for each type of starter.
  .6 Interconnection diagrams.
.3 Provide operation and maintenance data for each type and style of starter for inclusion in maintenance and operation manuals noted in Section 16010.
.4 Contractor's Material & Test Certificates as per Section 16010.

## 1.4 MAINTENANCE MATERIALS

.1 Provide listed spare parts for each different size and type of starter:
  .1 2 contacts, stationary.
  .2 2 contacts, movable.
  .3 1 contacts, auxiliary.
  .4 1 control transformer.
  .5 1 operating coil.
  .6 2 fuses.
  .7 4 indicating lamps.

## 1.5 MANUFACTURERS

.1 Acceptable manufacturers: the following manufacturers of starters and contactors will be considered equal subject to requirements stipulated. All starters to be of one manufacturer.
  .1 Allen Bradley
  .2 Square D
  .3 Cutler Hammer
  .4 Klockner Moeller
  .5 CR Control
  .6 Sprecher & Schuh
  .7 Furnas
  .8 Siemens
  .9 SAF Drive System

## 2 Products

### 2.1 MOTOR STARTERS

.1 Starters and contactors: CSA Certified, EEMAC rated, sized as indicated complete with EEMAC enclosure suitable for environment in which installed. IEC rated starters and contactors will not be accepted. Half size starters are not acceptable.
.2 Magnetic starters and contactors: complete with 100VA or larger 120V individual control transformers protected by control fuses.
.3 Control voltage: 120 volt unless otherwise noted.
.4 Unless noted otherwise, all electrically held magnetic starters shall include hand-off-auto 3 position, maintained contact on-off selector switches so that motors and other equipment automatically re-energize after power interruption.
.5 Three phase magnetic starters and contactors: minimum EEMAC size 1. solid state soft start starters for 30 HP (22.4 kW) and larger unless otherwise noted. Set ramp-up and ramp-down times as site directed.
.6 Single phase magnetic starters and contactors: minimum EEMAC size 0.
.7 Each magnetic starter to have 2-NC and 2-NO auxiliary contacts.
.8 Starters shall have thermal magnetic overloads with external manual reset, sized in accordance with voltage and full load current as certified by motor manufacturer.
.9 Starters shall have overload relays in each ungrounded phase, Class 20.
  .1 Class 20 (standard trip) melting alloy.
  .2 Class 20/Class 10 convertible (quick trip) timetables.
.10 All 3 phase starters shall have single phasing protection.

### 2.2 MANUAL MOTOR STARTERS

.1 Single and three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  .1 Switching mechanism, quick make and break.
  .2 Overload heater(s) in each ungrounded phase, manual reset, trip indicating handle.

### 2.3 FINISHES

.1 Apply finishes to enclosure in accordance with Section 16010.

### 2.4 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 16010, Electrical General Requirements.
.2 Manual starter designation label, size 1, engraved as indicated.
.3 Magnetic starter designation label, size 3, engraved as indicated.

## 3 Execution

### 3.1 INSTALLATION

.1 Install starters as indicated and fasten securely. Connect power and control wiring as indicated.
.2 Ensure correct fuses and overload devices elements are installed.

### 3.2 TESTS

.1 Perform tests in accordance with Section 16010, and manufacturer's instructions.
.2 Operate switches, contactors to verify correct functioning.
.3 Perform starting and stopping sequences of contactors and relays.
.4 Check that sequence controls interlocking with other separate related starters, equipment and control devices, operate as indicated.

End of Section

# 1 General

## 1.1 GENERAL REQUIRMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to the Mechanical General Requirements of Section 15010.

## 1.2 MECHANICAL - ELECTRICAL SCHEDULE

.1 The following Mechanical-Electrical Schedule is provided to assist the Contractor in coordinating the efforts of mechanical and electrical sub-trades. The division of work among subcontractors is the Contractor's responsibility and the Contractor is free to amend the schedule as he sees fit.
.2 The Mechanical-Electrical Schedule also describes work that is required that may or may not be assembled elsewhere. All work indicated in the Mechanical-Electrical Schedule shall be included in the Tender Price.
.3 The Mechanical-Electrical Schedule shall not be interpreted as limiting the extent of the Contract in any way. Work indicated elsewhere or otherwise needed for a complete and functioning installation shall be provided whether or not shown in the Mechanical-Electrical Schedule.

## 1.3 CONTROL CODES

1. Responsibility Codes in the Electrical Equipment Schedule shall be interpreted as follows:
  .1 "Supplied by Div." means that the equipment is to be supplied to the site under the Division described by number.
  .2 "Installed by Div." means that the equipment is to be received from the supplier, handled, set in place and installed at the site under the Division described by number.
  .3 "Wired and connected by Div." means that the equipment and its associated devices are to be wired and connected to the various electrical systems in accordance with the equipment manufacturer's installation instructions and wiring diagrams under the Division described by number.

End of Section

| No. | Equipment | | | | Controls | | | Responsibility | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Item | Characteristics (FKW = Fractional KW) | | Location | Type | Location | Manufacturer's Reference | Supplied by Div. | Installed By Div. | Wired & Connected by Div. |
| 1 | LAVATORY & WASH BASIN | KW | FKW | HC WASHROOM 102 | Disconnect | At Transformer | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 120 | | Junction Box | See drawings | See Elec Spec | 16 | 16 | 16 |
| | | Phase | 1 | | Transformer | See drawings | See Mech Spec | 15 | 15 | 16 |
| | | Freq. | 60 | | Low Voltage wiring | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 to provide 120volt feed to transformer. Division 15 to locate transformer, wiring in conduit between controller & transformer. | | | | | | | | | |
| 2 | GAS FIRED DOMESTIC HOT WATER HEATERS (Quantity 2) | KW | FKW | MECHANICAL ROOM 105 | Disconnect (2) | At Door | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 120 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Phase | 1 | | | | | | | |
| | | Freq. | 60 | | | | | | | |
| | Connect hot water heaters to Building Management System | | | | | | | | | |
| 3 | DOMESTIC HW RE-CIRC PUMP | Watts | 90 | MECHANICAL ROOM 105 | Disconnect | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 120 | | Starter | by unit | AB# 512 Series | 16 | 16 | 16 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Starter complete with HOA and red pilot light in cover. Before final connection to pump, Division 16 to notify Division 15 Control Contractor and provide junction box as required for Division 15 to install relay for control of pump. Connect pump to Building Management System. | | | | | | | | | |
| 4 | HYDRATION STATION | Watts | 370 | EXERCISE ROOM 125 | Disconnect | At Unit | See Elec Spec | 16 | 16 | 16 |
| | | Voltage | 120 | | Starter | In Unit | See Mech Spec | 15 | 15 | 15 |
| | | Phase | 1 | | | | | | | |
| | | Freq. | 60 | | | | | | | |
| 5 | AIR COMPRESSOR | KW | 3.75 | MAINTENANCE SHOP 126 | Disconnect | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | By Unit | AB# 512 Series | 16 | 16 | 16 |
| | | Phase | 1 | | | | | | | |
| | | Freq. | 60 | | | | | | | |
| 6 | EXHAUST EF-1A | KW | 2.25 | APPARATUS FLOOR 124 | Disconnect | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 208 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Phase | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect exhaust fan to Building Management System. | | | | | | | | | |
| 7 | EXHAUST EF-1B | KW | 2.25 | APPARATUS FLOOR 124 | Disconnect | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 208 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Phase | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect exhaust fan to Building Management System. Starter to be complete H-O-A & red pilot light in cover. | | | | | | | | | |
| 8 | APPARATUS FLOOR EXHAUST EF-2 | KW | 0.56 | APPARATUS FLOOR 124 | Disconnect | In VFD | See Mech Spec | 15 | 15 | 15 |
| | | Voltage | 208 | | VFD | See drawings | See Mech Spec | 15 | 15 | 16 |
| | | Phase | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect exhaust fan to Building Management System. Exhaust fan interlocked with Make Up Air Unit. Division 16 to provide (special) wiring from VFD to unit as per VFD manufacturers recommendations. | | | | | | | | | |
| 9 | TURN-OUT ROOM EXHAUST EF-3 | KW | 0.38 | TURN-OUT ROOM ROOF | Disconnect (WP) | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 208 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect exhaust fan to Building Management System. Starter to be complete H-O-A & red pilot light in cover. | | | | | | | | | |

| No. | Equipment | | | | Controls | | | Responsibility | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Item | Characteristics (FKW = Fractional KW) | | Location | Type | Location | Manufacturer's Reference | Supplied by Div. | Installed By Div. | Wired & Connected by Div. |
| 10 | MAINTENANCE SHOP EF-4 | KW | 0.13 | MAINTENANCE SHOP ROOF | Disconnect (WP) | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 120 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect exhaust fan to Building Management System. Starter to be complete H-O-A & red pilot light in cover. | | | | | | | | | |
| 11 | EXERCISE ROOM EXHAUST EF-5 | KW | FKW | EXERCISE ROOM ROOF | Disconnect (WP) | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 120 | | Starter | See Elec Dwgs | See Elec Spec | 16 | 16 | 16 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect exhaust fan to Lighting Occupancy Sensor & Building Management System. | | | | | | | | | |
| 12 | MECHANICAL ROOM EXHAUST EF-6 | KW | 0.19 | MECHANICAL ROOM 105 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 120 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Motorized Dampers | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | | | | RA Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | Connect exhaust fan to Building Management System. | | | | | | | | | |
| 13 | KITCHEN HOOD EXHAUST EF-7 | KW | 1/4 | ROOF | Disconnect | In Unit | By Manufacturer | 15 | 15 | 16 |
| | | Voltage | 120 | | Starter | By Unit | AB 509 Series | 16 | 16 | 16 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Division 16 to provide H-O-A switch complete with pilot light in starter cover. Fan shuts down upon activation of hood extinguishing system. | | | | | | | | | |
| 13 | MAINTENANCE SHOP DRYER EXHAUST EF-8 | KW | FKW | MAINTENANCE SHOP 126 | Disconnect | In Unit | By Manufacturer | 15 | 15 | 16 |
| | | Voltage | 120 | | Starter | At Unit | See Mech Spec | 15 | 15 | 15 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect exhaust fan to Building Management System. Divison 16 shall interlock exhaust fan to dryer, refer to details on electrical drawings. | | | | | | | | | |
| 14 | CONDENSING UNIT CU-1 | MCA | 30 | MECHANICAL ROOM 105 | Disconnect | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect condensing unit to Building Management System. | | | | | | | | | |
| 15 | CONDENSING UNIT CU-2 | MCA | 30 | MECHANICAL ROOM 105 | Disconnect | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect condensing unit to Building Management System. | | | | | | | | | |
| 16 | RADIANT HEAT TUBE RHT-1 | FLA | 1.1 | APPARATUS FLOOR 124 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 115 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Phases | 1 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Connect radiant heat tube to Building Management System. Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |

| No. | Equipment | | | | Controls | | | Responsibility | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Item | Characteristics (FKW = Fractional KW) | | Location | Type | Location | Manufacturer's Reference | Supplied by Div. | Installed By Div. | Wired & Connected by Div. |
| 17 | RADIANT HEAT TUBE RHT-2 | FLA | 1.1 | APPARATUS FLOOR 124 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 115 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Phases | 1 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Connect radiant heat tube to Building Management System. Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 18 | MAKE-UP UNIT MUA-1 | kW | 3.75 | APPARATUS FLOOR 124 | Disconnect | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 208 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Phases | 3 | | VFD | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Freq. | 60 | | Control Panel | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | | | | Sensors | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | | | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Connect make-up air unit to Building Management System. Division 16 to provide wiring from disconnect switch to VFD. Division 16 to provide (special) wiring from VFD to unit as per VFD manufacturers recommendations. Division 15 shall interlock MUA-1 to EF-2, EF-3 & EF-4. Division 16 shall provide 1/2" conduit from Control Panel to Unit & from Sensors to Unit. | | | | | | | | | |
| 18 | MAKE-UP UNIT MUA-2 | kW | 3.75 | ROOF | Disconnect (WP) | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Voltage | 120 | | Starter | See drawings | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Fan shuts down upon activation of hood extinguishing system. | | | | | | | | | |
| 19 | BOILER B-1 | KW | FKW | MECHANICAL ROOM | Disconnect | At Door | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 120 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Phases | 1 | | | | | | | |
| | | Freq. | 60 | | | | | | | |
| | Division 16 to provide lamacoid label over each disconnect switch reading "Boiler Disconnect". Do not gang with lighting switch. Boiler controlled by Building Management System. | | | | | | | | | |
| 20 | ENERGY RECOVERY UNIT ERV-1 | kW | 0.60 | MECHANICAL ROOM 105 | Disconnect | At Unit | FPL#C1332SN/F | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Phases | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect energy recover unit to Building Management System. | | | | | | | | | |
| 21 | DUCT HEATER DH-1 | kW | 12 | MECHANICAL ROOM 105 | Disconnect | At Unit | FPL#C5636 | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | See Elec Dwgs | AB 509 Series | 16 | 16 | 16 |
| | | Phases | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect duct heater to Building Management System. | | | | | | | | | |
| 22 | REFRIGERANT HEAT EXCHANGER AU-1 & AU-2 | kW | 0.015 | MECHANICAL ROOM 105 | Disconnect (2) | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter (2) | See Elec Dwgs | AB 512 Series | 16 | 16 | 16 |
| | | Phases | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect refrigerant heat exchangers to Building Management System. | | | | | | | | | |
| 23 | BRANCH CONTROLLER BC-1 | kW | 0.314 | CORRIDOR 109 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Phases | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Division 16 shall provide 1/2" conduit complete with pullwire from BC-1 to Fan Coil Units for controls connection by Division 15. | | | | | | | | | |

| No. | Equipment | | | | Controls | | | Responsibility | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Item | Characteristics (FKW = Fractional KW) | | Location | Type | Location | Manufacturer's Reference | Supplied by Div. | Installed By Div. | Wired & Connected by Div. |
| 24 | FAN COIL UNIT FC-1 | kW | 0.060 | COMPUTER STUDY 108 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15. | | | | | | | | | |
| | Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 25 | FAN COIL UNIT FC-2 | kW | 0.110 | STATION OFFICER /DISPATCH 107 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15. | | | | | | | | | |
| | Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 26 | FAN COIL UNIT FC-3 | kW | 0.110 | CORRIDOR 109 (SUPPLYING W/R AND SHOWERS) | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15. | | | | | | | | | |
| | Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 27 | FAN COIL UNIT FC-4 | kW | 0.120 | LOUNGE/DAY ROOM 115 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15. | | | | | | | | | |
| | Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 28 | FAN COIL UNIT FC-5 | kW | 0.120 | KITCHEN 116 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15. | | | | | | | | | |
| | Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 29 | FAN COIL UNIT FC-6 | kW | 0.110 | CORRIDOR 117 | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15. | | | | | | | | | |
| | Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 30 | FAN COIL UNIT FC-7 | kW | 0.050 | EXERCISE ROOM | Disconnect | At Unit | HBL#13R92MD | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | See Mech Spec | 15 | 15 | 16 |
| | | Phases | 1 | | Thermostat | See drawings | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15. | | | | | | | | | |
| | Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring. | | | | | | | | | |
| 31 | GEOTHERMAL PUMP P-1 | kW | 2.250 | MECHANICAL ROOM 105 | Disconnect | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | AB 512 Series | 16 | 16 | 16 |
| | | Phase | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect geothermal pump to Building Management System. | | | | | | | | | |

| No. | Equipment | | | | Controls | | | Responsibility | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Item | Characteristics (FKW = Fractional KW) | | Location | Type | Location | Manufacturer's Reference | Supplied by Div. | Installed By Div. | Wired & Connected by Div. |
| 32 | GEOTHERMAL PUMP P-2 | kW | 2.250 | MECHANICAL ROOM 105 | Disconnect | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | AB 512 Series | 16 | 16 | 16 |
| | | Phase | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect geothermal pump to Building Management System. | | | | | | | | | |
| 34 | BOILER PUMP P-3 | kW | 0.750 | MECHANICAL ROOM 105 | Disconnect | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | AB 512 Series | 16 | 16 | 16 |
| | | Phase | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect boiler pump to Building Management System. | | | | | | | | | |
| 35 | INFLOOR PUMP P-4 | kW | 0.375 | MECHANICAL ROOM 105 | Disconnect | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 208 | | Starter | At Unit | AB 512 Series | 16 | 16 | 16 |
| | | Phase | 3 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect infloor pump to Building Management System. | | | | | | | | | |
| 36 | GLYCOL FILLING PUMP GLP-1 | KW | FKW | MECHANICAL ROOM 105 | Disconnect | See Starter | See Starter | 16 | 16 | 16 |
| | | Voltage | 115 | | Starter | At Unit | AB 512 Series | 16 | 16 | 16 |
| | | Phase | 1 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Freq. | 60 | | | | | | | |
| | Connect glycol filling pump to Building Management System. | | | | | | | | | |
| 37 | MANIFOLD PUMPS (4) | KW | FKW | APPARATUS FLOOR 124, FOYER 101, W/R 114 | Disconnect (4) | See drawings | See Elec Spec | 16 | 16 | 16 |
| | | Voltage | 115 | | Other Controls | See Mech Spec | See Mech Spec | 15 | 15 | 15 |
| | | Phase | 1 | | | | | | | |
| | | Freq. | 60 | | | | | | | |
| | Connect manifold pumps to Building Management System. | | | | | | | | | |

# 1 General

## 1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
.2 Conform to Section 16010.

## 1.2 BASIC MATERIALS AND METHODS

.1 Conform to all sections of Division 16.

## 1.3 SUBMITALS

.1 Shop drawings as per Section 16010 for the following equipment items:
  .1 All electrical hand dryer units shown.
.2 Contractor's Material and Test Certificate as per Section 16010.

## 1.4 MANUFACTURES

.1 Acceptable manufacturers:
  .1 World Dryer.
  .2 Nova
  .3 American Dryer

# 2 Products

## 2.1 HAND DRYER UNITS

.1 Hand dryer units shall be 120 volt single phase, 2300 watts, no-touch initiation, surface mount.
.2 Mounting base to be die cast aluminum with openings for four 3" diameter bolts.
.3 Housing to be die cast zinc alloy with all exposed metal surfaces to be chrome plated.
.4 Cover to mount to mounting base with positive locating brackets and two 3" tamperproof flush screws.
.5 Blower to have induction brushless motor with resilient mounting rings and a 100 CFM discharge rate.
.6 Dryer unit to be protected with integral manual reset circuit breaker.
.7 Dryer to have field adjustable drying cycle time.

# 3 Execution

## 3.1 HAND DRYER UNITS

.1 Mount dryer units to walls securely in such manner as to prevent easy removal.
.2 No units shall be installed until all walls and floors are finished and painted. Any units damaged shall be replaced at this Contractor's expense.

End of Section