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ENGINEERING SPECIFICATIONS (ELECTRONICS)

SMC-MRT7
- Approved
- Approved as Noted
- Disapproved, For Workshop
- For Workshop

D.M.Coruno
Dec. 20, 2024

SAN MIGUEL CORPORATION MASS RAIL TRANSIT 7, INC	DEPARTMENT OF TRANSPORTATION (DOTr)
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ITEM 1116 ELECTRONICS GENERAL PROVISIONS

1116.1 GENERAL

1116.1.1 Description

A. The General and Supplementary Conditions are a part of the requirements for the work under this Division of the Specifications.

1116.1.2 Work Included

A. Provide labor and materials required to install, test and place into operation the ELECTRONICS systems as called for in the Contract Documents, and in accordance with applicable codes and regulations.

B. Provide labor, materials, and accessories required to provide complete, operating ELECTRONICS systems. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating Electronics systems shall be provided.

C. Under this Division of the specifications, provide all materials and equipment and perform all the work necessary for the complete execution of all the Electronics Works as shown on the Electronics Drawings, and on the General Construction Drawings, as herein specified, or both, except as otherwise excluded, and which w/o excluding the generality of the foregoing, shall include but not limited to the following principal items of work.

1. Integrated Fire Detection and Alarm System
2. Integrated Security Management System
3. EQUIPMENT MONITORING AND CONTROL System
4. Complete Grounding System
5. Complete Testing and Commissioning of Electronics System.
6. Painting of electronics work (roughing-ins/containment systems, etc.) and equipment
7. Fire stopping of openings in floors and walls after all conduits or pipes or ducts are in place and sealing of all such openings if not used.
8. Coordination with other trades especially coordinating provisions for openings, chassis, inserts, etc., at site and to warn the builder of any corresponding construction error.
9. Provision of as-built drawings, operating instructions and maintenance annuals and training of employer's staff.
10. Anything that has been omitted if any item of work or materials usually furnished which are necessary for the completion of the electronics work.

1116.1.3 Quality Assurance

A. Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations and requirements of the utility companies serving the project and the Owner's insurance underwriter.

B. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the more stringent apply.

C. Should any change in drawings or specifications be required to comply with the governing regulations, notify the Project Manager prior to submitting bid.

D. All equipment and installations shall meet or exceed minimum requirements of the Standards and Codes listed under item 1.5.

E. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced, full-time Superintendent who is authorized to make decisions on behalf of the Contractor.

1116.1.4 Abbreviations and Definitions

A. Abbreviations:

1.	PECE	-	Philippine Electronics Code
2.	ANSI	-	American National Standards Institute
3.	ASTM	-	American Society for Testing and Materials
4.	ETL	-	Electrical Testing Laboratories
5.	NETA	-	International Electrical Testing Association
6.	IEC	-	International Electro-Technical Committee
7.	IEEE	-	Institute of Electrical and Electronic Engineers
8.	NEC	-	National Electrical Code
9.	NEMA	-	National Electrical Manufacturer's
10.	NFPA	-	National Fire Protection Association
11.	UL	-	Underwriters' Laboratories Inc.
12.	ISO	-	International Standard Organization
13.	EITC	-	Design Guidelines for Telecommunication
14.			Infrastructure
	EIA/TIA	-	Building Telecommunications Wiring
15.	BTFSM	-	Building Telephone Facilities Standards
16.	BICSI	-	Telecommunications Distribution Methods
17.	FCC	-	Federal Communication Commission
18.	PD NO. 1185	-	The Fire Code of the Philippines and Regulation
19.	R.A 9514	-	RIRR
20.	Other International Accepted Standards.		

B. Definitions

1. Where it is stated in these specifications to submit to Engineer for review and approval, refer to Architectural General and Special Conditions for proper procedures.
2. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application.
3. INSTALL means to join, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation.
4. PROVIDE means to FURNISH and INSTALL.
5. AS DIRECTED means as directed by the Project Manager, or his representative.
6. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, furniture wiring management or installed within hung ceilings.
7. SUBMIT means submit to Project Manager for review, comment/s, approval and or final resolution.
8. "Architect", "Project Manager/Engineer", "Owner", the Party or Parties responsible for interpreting, accepting and otherwise ruling on the performance under "this Contract".

1116.1.5 Guarantee

A. Submit a single guarantee stating that the work is in accordance with the Contract Documents. Guarantee work against faulty and improper material and workmanship for a period of one year from the date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are provided or specified herein, the longer term shall apply. Correct any deficiencies which occur during the guarantee period, within 24 hours of notification, to the satisfaction of the Owner. Obtain similar guarantees from subcontractors, manufacturers, suppliers and sub-trade specialists.

1116.1.6 Proposed Separation Of Work Between The Trades:

A. The specifications describe in detail the proposed work included for each trade when the Main Contractor divides the work among their Sub-Contractors. The following summary is an outline of the work to be "Provided", "Furnished" or "Installed" by each of the trades included in the contract, i.e., Plumbing and Sprinkler, (Div. 15) HVAC, Electrical (Div. 16) and other Divisions 1-14.

B. In the absence of more detailed information, consider the list as specific instructions to include such work in the named contract.

C. Abbreviations are as follows:

1. "OD" - By other specialists (or contract)
2. "Plb" - Plumbing – Division 15
3. "Spr" - Sprinkler – Division 15
4. "Mech" - Mechanical – Division 15
5. "Elec" - Electrical/Electronics – Division 16
6. "f" - Furnished
7. "I" - Installed
8. "p" - Provided (Furnished and Installed)

ITEM	OD	Plb	Spr.	Mech.	Elec.	Remarks
Motors for Mech'l, Plumbing, Fire Protection Equip't	_	P	P	P	_	
Motor Controls for Mech'l., Plumbing, Fire Protection Equipment	_	P	P	P	_	Specification and drawings delineate detailed exceptions.
Wiring for Mech'l., Plumbing, Fire Protection Equip't Motors including the feeder cables from motor controller	_	P	P	P	_	Specification and drawings delineate detailed exceptions.
Wiring for Mech'l Equipment Motor Controls and Alarms	_	P	P	P	_	Specifications and drawings delineate in detail the work to be performed by each trade.
Temporary Light and Power	_	_	_	_	_	As per Contract Documents.
Temporary Water	_	_	_	_	_	As per Contract Documents.
Temporary Fire Protection	_	_	_	_	_	As per Contract Documents.
Hoisting	P	P	P	P	P	
Rigging	P	P	P	P	P	

ITEM	OD	Plb	Spr.	Mech.	Elec.	Remarks
Cutting, Chasing & Patching	P	_	_	_	_	Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade.
Framed Slots and Openings in Walls, Decks and Slabs	P	_	_	_	_	Includes drilling of holes when required. Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade.
Sleeves	_	P	P	P	P	
Waterproof Sealing of Sleeves through Waterproof, Slabs, Decks and Walls	_	P	P	P	P	
Fireproof Sealing of Excess Openings in Slabs, Decks and Fire Rated Walls	_	P	P	P	P	
Fastenings	_	P	P	P	P	
Concrete Encasement of Electrical & Auxiliary Conduits	_	_	_	_	P	

ITEM	OD	Plb	Spr.	Mech.	Elec.	Remarks
Base Flashing of Electric Conduits through Roof (Pitch Pockets)	P	_	_	_	_	Cap flashing by Trade.
Electrical & Auxiliary Manholes / Handholes and Covers	_	_	_	_	P	
Finish Painting (does not include I.D. marks or color coding specified and provided by each trade)	_	P	P	P	P	
Finished Walls and Ceiling Access Doors, Panels and Supporting Frames	P	_	_	_	_	Supplying list of location of all items requiring access doors included in the Division requiring same.
Plaster Rings and Frames	I	_	_	_	F	Plaster rings and frame furnished in electric only for lighting fittings which are so equipped.
Rubbish Removal	P	P	P	P	P	Where one trade furnishes and another installs, the installing trade removes the shipping and packing materials which accumulate.
Special Tools for Equipment Maintenance	F	F	F	F	F	

ITEMS	OD	Plb	Spr	Mech.	Elec.	Remarks
Electric Power Consuming Items and Controls for Other than Mechanical Equipment, e.g. Motorized Doors	P	_	_	_	_	
Concrete Foundations, Pads, Pits, Curbs, and Bases Inside Buildings	P	_	_	_	_	Furnishing exact dimensions of anchors, vibration mounts and templates included in each trade providing the associated equipment.
Prime Coat Painting	_	P	P	P	P	
Field Touch-up Painting of Damaged Shop Coats	_	P	P	P	P	
Rust proofing Field Cut and Assembled Iron Supporting Frames and Racks	_	P	P	P	P	
Grating and Exterior Wall Louvers	P	_	_	_	_	
Duct Connections to Louvers	_	_	_	P	_	
Equipment Delivered and Set in Place	P	_	_	_	_	Except Mechanical and Electrical Equipment by Divisions 15, & 16.

ITEMS	OD	Plb	Spr	Mech.	Elec.	Remarks
Vinyl Tape or Painted Colour Coding, Banding Arrows and Similar Identification for Mechanical and Electrical Work	P	P	P	P	P	
Under floor and Header Duct	_	_	_	_	P	Responsibility for coordination is included in this Section.
Lighting Fixtures	_	_	_	_	P	See Drawings.
Escalators and Dumbwaiters	P	_	_	_	_	Disconnect switch included in Electrical Section.
Catwalks and Ladders to Electrical Equipment	P	_	_	_	_	
Drainage Lines for Elect'l Manholes / Sump Pits	P	_	_	_	_	See Drawings
Roughing to Equipment Furnished by Others	_	P	P	P	P	See Drawings
Auxiliary Systems Cabling and Conduiting including the supply and installation of equipment					P	As indicated on the plans and specifications.

A. Each Division is required to supply all necessary supervision and coordination information to any other Division supplying work to accommodate that Division.

B. For items which are to be installed but not furnished as part of this Division, the electronics work includes:

1. Coordination of their delivery.
2. Unloading from delivery trucks driven into any point on the property line at grade level.
3. Safe handling/keeping and field storage up to the time of permanent placement in the project.
4. Correction of any damage, defacement or corrosion to which they may have been subjected.
5. Field make-up and internal wiring as indicated for their proper operation.
6. Mounting in place.
7. Connection to building wiring, including the purchase and installation of all termination junction boxes necessary to adapt and connect them to this wiring.

1116.2 PRODUCTS

1116.2.1 Equipment and Materials

A. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

B. Products and materials shall not contain asbestos, PCB, or any other material which is installed considered hazardous by the authority having jurisdiction.

C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Project Manager.

D. Provide name/data plates on major components of equipment with manufacturer's name. Model number, serial number, capacity data and Electrical characteristics attached in a conspicuous place.

E. Install materials and equipment with qualified trades people.

F. Maintain uniformity of manufacturer for equipment used in similar application and sizes.

G. Fully lubricate equipment where required.

H. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.

I. Where factory testing of equipment is required to ascertain performance and attendance by the Owner's representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.

J. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be derated with the method of derating identified on the submittals.

K. Enclosures for Electrical equipment installed in mechanical equipment rooms shall be NEMA type 1 gasketed. Enclosures for Electrical equipment installed outdoors shall be NEMA type 4 or greater required.

L. Energy consuming equipment shall meet local energy ordinances.

1116.3 EXECUTION

1116.3.1 Fees and Permits

A. Pay all required fees and obtain all required permits/right of ways related to the ELECTRONICS installation.

B. Pay royalties or fees required in connection with the use of patented devices and systems.

C. Provide controlled inspection where required by authorities having jurisdiction or by these specifications.

1116.3.2 Submittals and Reviews

General:

A. Submit shop drawings, manufacturer's product data sheets, samples, and test reports as specified.

B. Within two months after notice to proceed by the Project Managers, or after execution of Owner/Contractor Agreement, submit a complete typed list of all ELECTRONICS equipment manufacturers and materials suppliers for the equipment proposed to be provided on this project, as well as names of all subcontractors.

C. Within four months after notice to proceed issued by the Project Managers, or after execution of Owner/Contractor Agreement, prepare an index of all submittals for the project. Include a submittal identification number, a cross-reference to the Specification sections or

Drawings number, and an item description. Prefix the submittal identification number by the Specification sections to which they apply. Indicate on each submittal, the submittal identification number in addition to the other data specified. All subcontractors shall utilize the assigned identification number.

D. After the Contract is awarded, obtain complete shop drawings, product data and samples from the manufacturer, suppliers, vendors, and all subcontractors, for all materials and equipment as specified. Submit data and details of such materials and equipment for review. Prior to submissions, certify that the shop drawings, product data and samples are in compliance with the Contract Documents. Check all materials and equipment upon their arrival on the job site and verify their compliance with the Contract Documents. Modify any work which proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.

E. Review of submittals is for general compliance with the design concept and contract documents. Comments or absence of comments shall not relieve the Contractor from compliance with the full scope and requirements of the Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner, and for coordinating the work with that of other trades.

F. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted as well as No equipment shall be procured nor delivered to the job site unless a shop drawing for the same has been submitted and accepted or approved or similar words.

G. A minimum period three working days, exclusive of transmittal time, will be required in the Engineer's office each time a shop drawing, product data and/or samples are submitted for review. This time period must be considered by the Contractor in the scheduling of the work.

H. Submit five (5) copies or as per Project Manager's requirement items, shop drawings, and manufacturer's product submittals.

I. Submittals will be stamped as follows:

Stamp	Interpretation

Approved/Unaltered	Fabrication, manufacture, or construction may proceed providing submittal complies with the Contract Documents.
Approved with corrections/comments as noted prior to general issue	Fabrication, manufacture, or construction may proceed providing submittal complies with the Contract Documents and the Engineer's notation are complied with.
For Re-submission	The submittal does not comply with the Contract Documents; do not proceed with fabrication, manufacture, or construction. The work and shop drawings are not permitted at the job site. Re-submit appropriate shop drawings.

J. Submit materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalog material. Maintenance and operating manuals are not acceptable substitutes for shop drawings.

K. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finishes.

L. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping and service connection data.

M. Maintain a complete set of reviewed and stamped shop drawings, product data and samples on site.

N. For each room or area of the building containing ELECTRONICS equipment, submit the following:

1. Floor Plans: Plan and elevation layout drawings indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1:50. They shall be prepared in the following manner:

   Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).

   a. Illustrate all ELECTRONICS equipment propose to be contained therein. Include top & bottom elevation of all ELECTRONICS equipment. The drawings shall be

prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.

b. Illustrate all other equipment therein such as conduits, detectors, ducts, registers, pull boxes, wire-way, structural elements, etc.

c. Indicate the operating weight of each piece of equipment.

d. Indicate the heat release from each piece of Electronics equipment in terms of BTU per hour. This information shall be that which is supplied by the respective manufacturers.

e. Indicate dimensions to confirm compliance with code required clearances.

f. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendations).

g. Equipment removal routes.

O. The work described in shop drawings submission shall be carefully checked by the Contractor for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.

P. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of Shop Drawings, product data and samples.

Q. Indicate the following on the lower right hand corner of each shop drawing and on the front cover of each product data brochure cover. The submittal identification number; title of the sheet or brochure; name and location of the Product; names of the Architect, Engineer, Contractor, Subcontractor, manufacturer, supplier, and vendor; the date of submittal; and the date of each correction, version and revision. Number all pages and drawings in product data brochures consecutively from beginning to end. Unless the above information is included, the submittal will be returned for resubmission. Re-submittals of product data or brochures shall include a cover letter summarizing the corrections made in response to the review comments.

R. The distribution equipment, short circuit and coordination study (shall be submitted, before or in parallel with the Panel boards/CB Submittals)

and room layout submittals shall be submitted concurrently. Failure to submit concurrently may result in the immediate return of the submittal marked FOR RESUBMISSION.

1116.3.3 Coordination of Work

A. Contract documents establish scope, materials and quality but are not detailed installation instruction. Drawings are diagrammatic.

B. Coordinate work with related trades and furnish in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

C. The ELECTRONICS drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other trade will permit. Provide off- sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other trades to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

D. It shall be understood that the final location of smoke detectors, other FDAS devices, Electronics panel boards, etc. may be moved in the field by a distance of 4.57 meters (15 ft.) from the location shown provided such notice is given prior to installation and approval from designer has been given.

E. Exercise particular caution with reference to the location of panels, outlets, etc., and have the precise and definite locations accepted by the Project Manager before proceeding with the installation.

F. The drawings show only the general run of utilities and approximate location of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Project Manager for review before such alterations are made. Modifications shall be made.

G. Verify with the Project Manager the exact location and mounting height of outlets, thermostats and equipment not dimensionally located on the drawings.

H. Circuit tags in the form of numbers are used where shown to indicate the circuit designation numbers in Electronics panels. Show the actual circuit numbers on the as built Record Drawings and on the associated typed panel board directory card. Where circuiting is not indicated, provide required circuiting in accordance with the loading indicated on the drawings and/or as indicated.

I. The drawings generally do not indicate the number of wires in conduit for the branch circuit wiring of fixtures and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated, the control intent, referenced wiring diagrams (if any).

J. Carefully check space requirements with other trades to ensure that equipment can be installed in the space alloted.

K. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (remote ballast, pull boxes, etc.) requiring access in order that the Ceiling Trade will know where to install access doors and panels.

L. Consult with other trades regarding equipment so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.

M. Furnish and set sleeves for passage of Electronics risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each Electronics riser passing through building surfaces.

N. Provide fire stopping of approved materials around all pipes, conduits, ducts, sleeves.

O. Provide detailed information on openings and holes required in pre-cast members for ELECTRONICS utilities.

P. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loading of structures.

Q. Examine and compare the contract drawings and specifications with the drawings and specifications of other trades, and report any discrepancies between them to the Project Manager and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interference.

R. Wherever the work is of sufficient complexity, prepare additional detail drawings scaled to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of record drawings.

S. Furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate work with the work of other trades. No work shall be installed without coordinating with other trades.

T. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

U. Adjust location of conduits, panels, equipment, etc., to accommodate the work to prevent interference, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.

1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. For example: coordinate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of- way over lines whose elevations can be changed.
2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper head room and pitch on sloping lines.

V. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Project Manager.

1116.3.4 Examination of Site

A. Prior to the re-submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

B. The Contract Documents do not make representations regarding the character or extent of the existing structural installations which will be encountered during the work, based on examination of the site or other information.

1116.3.5 Cutting and Patching

A. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the

building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trades people of the trades required.

B. Do not cut, channel, chase or drill unfinished masonry, tile, etc., unless permission from the Project Manager is obtained. If permission is granted, perform this work in a manner acceptable to the Project Manager.

C. Where conduit or equipment are mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.

D. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching using appropriate Trade Contractor to accommodate penetrations.

1116.3.6 Sealing of Penetrations

A. Holes in Roof

1. Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve designed to seal the pop or cable and the roof structure, regardless of the roof profile. Flashings to the roof strictly in accordance with the manufacturer's instruction.
2. All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.

B. Air Tight Seals

1. All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.

C. Fire Rated Penetrations

1. Where services penetrate any fire rated barrier, the Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.

2. The Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.

1116.3.7 Mounting Heights

A. Mounting height of equipment listed below is from finished floor to center line of equipment unless specified or indicated otherwise.

1. Fire alarm pull stations: 1200mm
2. Fire alarm speaker-strobe light: 2100mm
3. Emergency fire alarm telephones: 1200mm

B. If mounting height of equipment is not indicated, verify with Architect's representative before proceeding with installation.

1116.3.8 Cleaning Up

A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.

B. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive just prior to occupancy.

C. All Electronics equipment shall be thoroughly vacuumed and wiped clean prior to operation and at the completion of the project. Equipment shall be opened for observation by the Project Manager as required.

1116.3.9 Waterproofing

A. Restore waterproof integrity of walls or surfaces after they have been penetrated.

1116.3.10 Supports

A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in auxiliary closets and mechanical equipment room.

C. Provide supporting frames or racks for equipment which is installed in a free standing position.

D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.

E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on piping, auxiliary conduits, raceways, or cables for support.

F. Any equipment shall not reset on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Provide independent support of ELECTRONICS equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

G. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure. ELECTRONICS equipment and supports shall not come in contact with work of each other's trades.

1116.3.11 Fastenings

A. Fasten equipment to building in accordance with the best industry practice.

B. Where weight applied to the attachment points is 45 kg or less, conform to the following as a minimum:

1.	Wood	:	Wood screws
2.	Concrete and solid masonry	:	Bolts and expansion
3.	Solid metal	:	Machine screws in with welded studs
4.	Steel decking or sub-floor	:	Fastenings as specified applied weights in

C. Where weight applied to the building attachment points exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:

1. At concrete slabs provide 60 cm x 60 cm x 13 cm steel faceplate on top with through bolts. Faceplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.
2. At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

D. Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Project Manager and conform to the following as a minimum:

1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

E. For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

F. Wall mounted equipment may be directly secured to wall by means of steel bolts.

Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Hilti or Unistrut or Eristrutt are acceptable.

G. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an alternative the mounting screws may pass through the gypsum board and be securely attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

1116.3.12 Identification

A. Identify ELECTRONICS equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates for equipment connected to the emergency power system shall be red white lettering. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates are unacceptable.

B. Cable tags shall be nameplate secured with nameplate non-metallic cord.

C. Provide an engraved nameplate for each switch controlling loads which are not local to the switch.

D. Wherever raceways for future use are terminated outside of the building, stake the location with a 60 cm long, 25 mm x 25 mm wooden stake.

E. See individual section for additional identification requirements.

1116.3.13 Prohibited Labels and Identifications

A. In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.

B. Required UL labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

1116.3.14 Delivery, Drayage and Hauling

A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time it is required, the Contractor shall be responsible for its proper storage and protection until the time it is required. Pay for all costs of demurrage or storage.

B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime cost, etc.

1116.3.15 Equipment and Material Protection

A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damage caused.

B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment subject to moisture damage in dry, heated spaces.

C. Provide adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

D. Lighting fixture troffers with parabolic reflectors shall be installed with factory mounted plastic protective bags around parabolic reflector assembly. Remove protective bags just prior to occupancy.

1116.3.16 Testing of Electronics Systems

A. Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and Contract closeout. Complete any adjustments and/or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date. See individual sections for extend of testing required.

B. Provide a detailed schedule of completion indicating when each system is to be completed and outlining when field testing will be performed. Submit completion schedule for review within one week after the notice to proceed by Owner or Owner's Representative has been given. Update this schedule periodically as the project progresses.

1116.3.17 Operating Instructions

A. Provide the services of factory trained specialists to provide an operating instructions seminar for equipment and systems. The seminar shall be conducted over a five days (consecutive) period. Instruction time is defined as straight time working hours and does not include nights, weekends or travel time to and from the project.

B. Submit seminar agenda, schedule and list of representatives to the Owner for approval one week prior to suggested date of seminar. Do not commence seminar until the Owner has issued a written acceptance of the starting time and attendees. Confirm attendance of seminar by written notification to participants.

C. Instruct Owner's operating personnel in proper starting sequences, operation, shutdown, general maintenance and preventative maintenance procedures, including normal and emergency procedures. Obtain signatures of Owner's attendees.

D. Submit final copies of record drawings and operating and maintenance manuals to Owner at Seminar.

E. Submit a written record of minutes and attendees of the seminar to the Owner.

1116.3.18 Operating and Maintenance Manuals

A. Provide Operating and Maintenance Manuals for equipment and materials furnished under this Division.

B. Submit five copies of Operating and Maintenance Manuals for review at least one week before the completion date. Assemble data in a completely indexed volume or volumes in three-ring binders and identify the size, model, and features indicated for each item. Print the project name on the outside of the binders.

C. Maintenance manuals shall include complete cleaning and servicing data compiled in a clear and easily understandable format. Show model numbers of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.

D. Provide the following where applicable:

1. Identifying name and mark number
2. Locations (where several similar items are used, provide a list)
3. Complete nameplate data
4. Certified Record Drawings and Final Reviewed submittals
5. Parts list
6. Performance curves and data
7. Wiring diagrams
8. Manufacturer' recommended operating and maintenance instructions with all non-applicable information deleted.
9. List of spare parts recommended for normal service requirements
10. Assembly and disassembly instructions for normal service requirements.
11. Test reports
12. Trouble shooting diagnostics instructions where applicable.
13. Address of service organization including phone and fax numbers.

1116.3.19 Record Drawings

A. Maintain on a daily basis at the project site a complete set of Record Drawings, reflecting an accurate dimensional record of deviations between work shown on Drawings and that actually installed.

B. Record dimensions clearly and accurately to delineate the work as installed; suitably identify locations of all equipment by at least two dimensions to permanent structures. In addition, mark the Record Drawings to show the precise location of concealed work and equipment, including concealed or embedded raceways and cables and all changes and deviations in the Electronics work form that shown on

the Contract Documents. This requirement shall not be construed as authorization to make changes in the layout or work.

C. Upon completion of the installation obtain from the Architect's representative, a complete set of diskettes of architectural drawings. In a neat and accurate manner, provide a complete record of all revisions of the original changes as actually installed. The cost for transparencies and for making required changes shall be included in the contract. Submit one set of black line prints of those revised transparencies for review. After review, make necessary changes to review for accuracy nor will the Engineer assume any responsibility for accuracy or completeness.

D. All record drawings should be in AutoCAD 2010. Both prints (5 sets) and a disk file of those record drawings should be submitted to the Owner after approval.

1116.3.20 Final Punch List

A. Prior to the Final Punch list, certify that systems and equipment are complete, operational, and are in compliance with the Contract Documents.

B. During the final punch list, provide personnel with access keys, hand held radios, and necessary expertise to operate each system and piece of equipment to demonstrate operational compliance with the Contract Documents.

C. Any deficiencies noted on the Final Punch list shall be expeditiously corrected and certified in writing.

ITEM 1117 EQUIPMENT CONNECTIONS AND COORDINATION

1117.1 GENERAL

1117.1.1 Description

A. Provide equipment connections and coordination in accordance with the Contract Documents.

1117.1.2 Submittals

A. No requirements.

1117.2 PRODUCTS (NOT APPLICABLE)

1117.3 EXECUTION

1117.3.1 General

A. Provide equipment connections and coordination in accordance with manufacturers recommendations and product submittals.

B. Where equipment is supplied from conduit run under or within the floor slab, extend conduit to a junction box mounted on a 600 mm stub up of rigid steel conduit. Provide suitable bracing on conduit stub up.

C. Where equipment is fed from overhead, support conduit on flanged floor type fitting.

1117.3.2 Equipment Connection Types

A. Provide equipment connection types as indicated on the equipment connection schedule.

1117.3.3 Owners Furnished Equipment

A. Provide electronics connections to owner furnished equipment.

B. Inspect owner furnished equipment for damage, defects, missing components, etc.

Report deficiencies to the Owner immediately. Do not install or connect deficient equipment.

C. Provide supports, fastenings, and auxiliary hardware necessary for a complete installation in accordance with the finished building conditions.

ITEM 1118 HANGERS AND SUPPORTS FOR ELECTRONICS SYSTEMS

1118.1 GENERAL

1118.1.1 Summary

A. Section includes:

Hangers and supports for electronics equipment and systems.
Construction requirements for concrete bases.

1118.1.2 Performance Requirements

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five (5) times the applied force.

1118.1.3 Submittals

A. Product Data: For steel slotted support systems.

B. Shop Drawings: [Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

Trapeze hangers. Include Product Data for components.
Steel slotted channel systems. Include Product Data for components.
Equipment supports.

C. Welding certificates.

1118.1.4 Quality Assurance

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1118.2 PRODUCTS

1118.2.1 Support, Anchorage, and Attachment Components

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.; a division of Cooper Industries.
    c. ERICO International Corporation.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut; Tyco International, Ltd.
    g. Wesanco, Inc.
    h. Asia Phil
    i. LJ Industrial Fabrication
    j. R. S. Thomas
    k. Versatrunk
    l. Obo Betterman

3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
6. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron, hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or

plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
      5) Fischer/ E.C. Daughson

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.
6) Fischer/ E.C. Daughson

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

1118.2.2 Fabricated Metal Equipment Support Assemblies

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

1118.3 EXECUTION

1118.3.1 Application

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for IMC shall be 1200mm interval minimum. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

C. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

1118.3.2Support Installation

A. Raceway Support Methods: In addition to methods described in NECA 1, IMC may be supported by openings through structure members, as permitted in NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

1118.3.3 Installation of Fabricated Metal Supports

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

1118.3.4 Concrete Bases

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section Cast-in-Place Concrete.

C. Anchor equipment to concrete base.

Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
Install anchor bolts to elevations required for proper attachment to supported equipment.
Install anchor bolts according to anchor-bolt manufacturer's written instructions.

1118.3.5 Painting

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 9 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

ITEM 1119 FIRESTOPPING FOR ELECTRONICS WORKS

1119.1 GENERAL

1119.1.1 Description of Work

Only tested firestop systems shall be used in specific locations as follows:

A. Penetrations for the passage of duct, cable, conduit, piping, electronics and electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

B. Opening and penetrations in fire-rated partitions or walls containing fire doors.

C. Opening around structural members, which penetrate floors or walls.

1119.1.2 Related Documents

A. All work specified in this Section is subject to the provisions of Item 1116.

B. Refer to the following sections of related work in connection with Fires topping:

Item 1116 – Electronics General Provisions
Item 1120 – Basic Materials and Methods
Item 1121 – Control Communications Cables
Item 1122 – Raceways and Boxes
Item 1105 – Grounding System (by Electrical)

C. Fire stopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

D. All works specified in this Section is subject to Architectural Fire Compartmentation plans.

E. Firestopping rating shall be as follows:

(Except as noted in fire life safety/architectural drawings). However, the more stringent applies:

Zone-to-Zone	2hrs
Floor-to-Floor	2hrs
Penetrations to External Wall	3hrs
Critical Zone within compartmentation	1hr
Penetrations to Lift stairwell shaft & duct chases	2hrs

1119.1.3 Quality Assurance

A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Firestop System installation must meet requirements of ASTM E-814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not re-establish the structural integrity to load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgement derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation.

1119.1.4 Applicable Publications

A. American Society for Testing and Materials (ASTM):

E 814 - Fire Tests of Through- Penetration Fire Stops

B. Underwriter's Laboratories, Inc. (UL):

UL 1479 - Tests for Fire Resistance of Building Joint Systems

UL 2079 - Fire Tests of Through -Penetration Fire Stops

1119.1.5 Submittals

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL firestop systems to be used and manufacturer's installation instructions.

B. Manufacturer's engineering judgement identification number and drawing details when no UL system is available for an application. Engineer judgement must include both project name and contractor's name that will install firestop system as described in drawing.

C. Submit material safety data sheets provided with product delivered to job-site.

1119.1.6 Manufacturers

A. The Fire stopping Sealant shall be from one of the following manufacturers or approved equal.

1. Hilti
2. Promat
3. Metacaulk
4. Specseal (Specified Technology Inc.)

B. Installer qualification

Engage an experienced Installer who is certified, licensed, or otherwise qualified by the fire stopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A supplier's willingness to sell its fire stopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

1119.2 PRODUCTS

1119.2.1 General Product Requirements

A. Provide fire stopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the fire stopping under conditions of service and application, as demonstrated by the fire stopping manufacturer based on testing and field experience.

B. Provide components for each fire stopping system that are needed to install fill material. Use only components specified by the fire stopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Fire stopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed". Provide cast-in-place fire stop devices prior to concrete placement.

D. Use only firestop products that have been UL 1479, ASTM E-814, or UL 2079 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

E. Appropriate sealant shall be used in the following materials:

1. Cast-in place firestop devices for use with non-combustible plastic pipe (closed and open piping systems) penetrating concrete floors.
2. Sealants or caulking materials for use with fire-rated construction joints and other gaps.
3. Sealants, caulking or spray materials for use with fire-rated construction joints and other gaps.
4. Intumescent sealants for caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PV jacketed, flexible cable or cable bundles and plastic pipe.
5. Intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles.
6. Non-curing, re-penetrable intumescent sealant, caulking or putty materials for use with flexible cable or cable bundles.
7. Wall opening protective materials for use with UL listed metallic and specified non-metallic outlet boxes.
8. Firestop collar wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems).
9. Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
10. Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
11. Provide a firestop system with an "F" Rating as determined by UL 1479 or ASTM E814, which is equal to the rating of construction being penetrated.
12. Provide a firestop system with an Assembly Rating as determined by UL 2079, which is equal to the time rating of construction being penetrated.

1119.3 EXECUTION

1119.3.1 Preparation

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify penetrations are properly size and in suitable condition for application materials.
2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
3. Provide masking and temporary covering to prevent soiling adjacent surfaces by fire stopping materials.
4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of fire stopping.
5. Do not proceed until unsatisfactory conditions have been corrected.

1119.3.2 Coordination

A. Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

B. Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

1119.3.3 Installation

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.

1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hammer the performance of fire dampers as it pertains to duct work.
3. Protect materials from damage on surfaces subjected to traffic.

1119.3.4 Field Quality Control

A. Examine sealed penetration areas to ensure proper installation before concealing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of fire stopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

1119.3.5 Adjusting and Cleaning

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

1119.3.6 Certification

The Contractor shall secure certification from the Manufacturer (not distributor nor supplier) that the Installation done by the Contractor is in conformance set by the U.L.

ITEM 1120 BASIC MATERIALS AND METHODS

1120.1 GENERAL

1120.1.1 Description

A. This Section, Basic Methods and Requirements (Electronics) applies to all sections of Division 17.

B. Furnish and install electronics systems, equipment and accessories in accordance with the specifications and drawings.

C. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized.

1120.1.2 Minimum Requirements

A. References to the Philippine Electrical Code (PEC), Philippine Electronics Code (PECE), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) National Electrical Code (NEC) are minimum installation requirement standards.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1120.1.3 Test Standards

A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed; equipment or device of a kind mentioned which:

   a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.
   b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.

2. Labeled; equipment or device is when:

   a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.
   b. The laboratory makes periodic inspections of the production of such equipment.
   c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.

3. Certified; equipment or product is which:

   a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
   b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
   c. Bears a label, tag, or other record of certification.

4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations.

1120.1.4 Qualifications (Products and Services)

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:

   1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately fifteen (15) years unless noted otherwise.
   2. The Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1120.1.5 Manufactured Products

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.
2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing Is Specified:

1. The Owner/Engineer shall have the option of witnessing factory tests. The contractor shall notify the Owner through the Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.

1120.1.6 Equipment Protection

Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.

A. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.

B. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.

C. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

D. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1120.1.7 Work Performance

A. Coordinate location of equipment and conduit with other trades to minimize interferences. See Item 1116 – Electronics General Provisions.

1120.1.8 Equipment Installation and Requirements

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces shall not be less than specified in the PEC for all voltages specified.

C. Inaccessible Equipment:

1. Where the Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed.
2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1120.1.9 Equipment Identification

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4-inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1120.1.10 Submittals

A. The Owner's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of

equipment or material which has no approval from the engineer will not be permitted at the job site.

B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Owner to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

C. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.

1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
3. Submit each section separately.

D. The submittals shall include the following:

1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

F. Manuals:

1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish eight copies, (One Original Copy), bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor

installing the system or equipment and the local representatives for the system or equipment.

3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:

    a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
    b. A control sequence describing start-up, operation, and shutdown.
    c. Description of the function of each principal item of equipment.
    d. Installation and maintenance instructions.
    e. Safety precautions.
    f. Diagrams and illustrations.
    g. Testing methods.
    h. Performance data.
    i. Lubrication schedule including type, grade, temperature range, and frequency.
    j. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
    k. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
    l. Provide a dvd copy of all the above for easy browsing and for storage to database.

G. Approvals will be based on complete submission of manuals together with shop drawings.

H. After approval and prior to installation, furnish the Engineer with one sample of each of the following:

1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
2. Each type of conduit coupling, bushing and termination fitting.
3. Conduit hangers, clamps and supports.
4. Duct sealing compound.
5. Each type of receptacle, toggle switch, outlet box, manual motor starter, device plate, engraved nameplate, wire and cable splicing

and terminating material and single pole molded case circuit breaker.

6. Each type of light fixture shown on the drawings.

1120.1.11 Singular Number

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

ITEM 1121 CONTROL COMMUNICATION CABLES

1121.1 GENERAL

1121.1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1121.1.2 Summary

A. Section Includes:

1. STP Cable
2. Fiber Optic Cable
3. RS-485 Cabling
4. Low-voltage Control Cabling
5. Fire Rated Cable and Wire
6. Control-circuit Conductors
7. Identification Products.

1121.1.3 Definitions

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

G. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

H. RCDD: Registered Communications Distribution Designer.

1121.1.4 Submittals

A. Product Data: For each type of product indicated.

B. Shop Drawings: For layout, showing conduits route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of conduits.
3. Vertical elevation of conduits above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1121.1.5 Quality Assurance

A. Products referenced under this section establish the minimum acceptable standards of products quality, features and performance.

1. Codes

a. Philippine Electrical Code (PEC 2017 Edition)
b. National Electrical Code (NEC 2008 Edition)
c. Fire Code of the Philippines and RIRR
d. National Fire Protection Code (NFPC)
e. Applicable Local Ordinances
f. Revised National Building Code
g. Philippine Electronics Code (PECE)

2. Standards

a. Underwriter’s Laboratories (UL)
b. American Society of Testing and Materials (ASTM)
c. National Electrical Manufacturers Association
d. National Fire Protection Association (NFPA)
e. Institute of Electrical and Electronics Engineers (IEEE)
f. American National Standards Institute (ANSI)
g. International Electro-Technical Commission (IEC)

h. Factory Mutual Engineering Corps (FMEC)
i. International Standard Organization (ISO: 9000)
j. Other Internationally Accepted Standards

B. Engineer in-charge supervising the work shall be a duly Registered Electronics under the supervision of a Professional Electronics Engineer as required by R.A. 9292 and revised National Building Code.

C. Test cables upon receipt at Project site.

1121.1.6 Project Conditions

A. Environmental Limitations: Do not deliver or install STP and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1221.2 PRODUCTS

1121.2.1 Pathways

A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Conduit and Boxes: Comply with requirements in Division 17 Section "Raceways and Boxes." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

1121.2.2 Backboards

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Division 6 Section "Rough Carpentry."

1121.2.3 STP Cable

A. Manufacturers:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated.
7. Mohawk; a division of Belden CDT.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand.
11. 3M.
12. Tyco Electronics/AMP Net connect; Tyco International Ltd.
13. Approved Equal

B. Description: 100-ohm, four-pair STP.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, General Purpose: Type CM or Type CMG.
    b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
    c. Communications, Riser Rated: Type CMR complying with UL 1666.
    d. Communications, Limited Purpose: Type CMX
    e. Multipurpose: Type MP or Type MPG.
    f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    g. Multipurpose, Riser Rated: Type MPR complying with UL 1666.

5. All wires and cables used in enclosed stations and train-ways shall comply to NFPA 130 Chapter 12 “Wire and Cable requirements”.

1121.2.4 STP Cable Hardware

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
9. Siemon Co. (The).
10. Tyco Electronics/AMP Net connect; Tyco International Ltd.
11. Approved Equal

B. STP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

1121.2.5 Fiber Optic Cable

A. Manufacturers:

1. AMP Netconnect/Tyco Electronics/Krone/Commscope
2. Belden/Nordx/CDT
3. Cavicel
4. Clipsal
5. Draka
6. FIBER-REX
7. General/Cable/Carol
8. ICSI

B. Description: Single mode, 9/125-micrometer, as per plan-fiber, nonconductive, tight buffer, optical fiber cable

1 Comply with ICEA S-83-596 for mechanical properties.
2 Comply with ANSI/TIA-568-D.3 for performance specifications.
3 Comply with ANSI/TIA-492AAAB-B or ANSI/TIA-492AAAB-A for detailed specifications.
4 Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. General Purpose, Nonconductive: Type OFN or OFNG
b. Riser Rated Nonconductive: Type OFNR complying with UL 1666.

c. Riser Rated Conductive: Type OFCR complying with UL 1666.

5 Conductive cable shall be steel armored type.
6 Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7 0.4dB/km @ 1310nm, 0.3dB/km @ 1550nm

C. Jacket

1. Jacket Color: Aqua for 9/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to ANSI/TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

1121.2.6 Fiber Optic Cable Hardware

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AMP Netconnect/Tyco Electronics/Krone/Commscope
2. Belden/Nordx/CDT
3. Cavicel
4. Clipsal
5. Draka
6. FIBER-REX
7. General Cable/Carol
8. ICSI
9. Legrand/Bticino
10. Leviton
11. LS Cables
12. Panduit
13. Premium Line
14. Schneider/Actassi
15. Seimon
16. Uni Cabwire

B. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of ANSI/TIA-604-2-B, and ANSI/TIA-604-3-B, and ANSI/TIA-604-12. Comply with ANSI/TIA-568-D.3.

1. Quick-connect, simplex and duplex, connectors. Insertion loss not more than 0.75 dB.
2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

1121.2.7 RS-485 Cable

A. Standard Cable: NFPA 70, Type CM or Type CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

C. All wires and cables used in enclosed stations and train-ways shall comply to NFPA 130 Chapter 12 “Wire and Cable requirements”.

1121.2.8 Low-Voltage Control Cable

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

C. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

E. All wires and cables used in enclosed stations and train-ways shall comply to NFPA 130 Chapter 12 “Wire and Cable requirements”.

1121.2.9 Fire Rated Cable and Wire

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the list of manufacturers.

1. Belden
2. Prysmian
3. Keystone
4. LAPP
5. Nexans
6. Betaflam
7. Sigma
8. Phelps Dodge
9. Far East Cable
10. DOHA Cables Fire Rated
11. Columbia

B. General Wires and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Shielded twisted pair, not less than No. 18 AWG or size as recommended by system manufacturer.

1. Circuit Integrity Cable: Shielded twisted pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying UL 1424 and UL 2196 for a 2-hour rating.

D. Non-Power Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Retain subparagraph below if use of cable is an option.
4. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation., plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

1121.2.10 Control-Circuit Conductors

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN or Type XHHN, in raceway, complying with UL 83 or UL 44.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway power-limited cable, concealed in building finishes, complying with UL 83 or UL 44.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

D. All wires and cables used in enclosed stations and train-ways shall comply to NFPA 130 Chapter 12 “Wire and Cable requirements”.

1121.2.11 Identification Products

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.
5. Approved Equal

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 16 Section "Electrical Identification."

1121.2.12 Source Quality Control

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

1121.3 EXECUTION

1121.3.1 Installation of Pathways

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Division 17 Section "Raceways and Boxes" for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
2. Secure conduits to backboard if entering room from overhead.
3. Extend conduits 3 inches (75 mm) above finished floor.
4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

1121.3.2 Installation of Conductors and Cables

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. STP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not twist STP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 17 Section "Raceways and Boxes."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (305 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

1121.3.3 Removal of Conductors and Cables

A. Remove abandoned conductors and cables.

1121.3.4 Control-Unit Conductors

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, **No 18** AWG.
2. Class 2 low-energy, remote-control, and signal circuits, **No. 16** AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, **No 12** AWG.

1121.3.5 Firestopping

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

1121.3.6 Grounding

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 16 Section "Grounding and Bonding."

1121.3.7 Identification

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."

1121.3.8 Field Quality Control

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect STP materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test STP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test

operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

ITEM 1122 RACEWAYS AND BOXES

1122.1 GENERAL

1122.1.1 Description

A. Provide raceways and boxes in accordance with the Contract Documents.

1122.1.2 Standards

A. American Society for Testing and Materials (ASTM):

ASTM A 446	Steel Sheet Zinc-Coated (Galvanized) by the Hot Dip Process, Structural Physical Quality
ASTM A 525	Steel Sheet Zinc-Coated, Galvanized by the Hot Dip Process

B. American National Standards Institute (ANSI):

ANSI 61	Gray Enamel Finish Coat.
ANSI C80.1	Rigid Steel Conduit, Zinc-Coated.
ANSI C80.3	Electrical Metallic Tubing, Zinc- Coated.
ANSI/NEMA FB 1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies

C. National Electrical Manufacturer's Association (NEMA):

NEMA OS 1	Sheet - Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
NEMA VE 1	Metallic Cable Tray Systems

D. Philippine Electrical Code (PEC):

PEC 2000 (PART 1:2017)

E. Philippine Electronics Code

1122.1.3 Submittals

A. Conduit, Boxes, Wireways, Manholes, Handholes and Auxiliary Gutters:

1. Manufacturer's product data sheets
2. Samples

B. Shop Drawings:

1. Size and location of main feeders. Size and location of panels and pull boxes. Layout or required conduit penetrations through structural elements.
2. The specific item proposed and its area of application shall be marked on the catalog cuts.

1122.1.4 Identifications

A. Mark junction box covers with permanent stencil identification of panel board and circuit numbers of wiring contained within.

B. Paint fire alarm and life safety system boxes and conduits red.

C. Paint boxes and conduits of other auxiliary systems in a color coding system or provide color bonding for system every after 5m.

1122.2 PRODUCTS

1122.2.1 Acceptable Manufacturers

A. Conduit

1. Metal Conduit: Matsushita/Panasonic, Allied, Sumitomo, or Royal Steel, Smart Tube
2. PVC Conduit: Neltex, Emerald, or Moldex

B. Wireways and Auxiliary Gutters:

1. RS Thomas, Asiaphil, LJ Ind'l Fabrication, or Versa Trunk

C. Manhole Cover & Cast Iron Gutters Iron boxes:

1. Crouse - Hinds or Makati Foundry

1122.2.2 Conduit and Fittings

A. Intermediate Metal Conduit:

1. Mild steel conduit, heavy wall, hot dipped galvanized inside and out, threaded ends.
2. ANSI/NEMA FB1 – Threaded type fittings.

B. Electrical Metallic Tubing:

1. ANSI C80.3; continuous, seamless steel tubing galvanized or sherardized on exterior, coated on interior with smooth hard finish of lacquer, varnish or enamel.
2. NEMA FB1; Steel, set screw or compression type fittings. Provide concrete type fittings where required.

C. Flexible Steel Conduit:

1. Single strip, continuous, flexible interlocked double-wrapped steel, hot dip galvanized inside and out forming smooth internal wiring channel.
2. NEMA FB 1; Steel, compression type fittings.

D. Liquid Tight Flexible Conduit:

1. Same as flexible steel conduit except with tough, inert, watertight plastic outer jacket.
2. NEMA FB1; Fittings shall be cast malleable iron body and gland nut, cadmium plated with one-piece brass grounding bushings threaded to interior of conduit. Spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.

E. Polyvinylchloride (PVC) Conduit:

1. Schedule 40 polyvinyl chloride suitable for 90°C.
2. Solvent cemented type fittings.
3. 20 mm. Minimum.

F. Loading capacity shall meet include weight of cables installed plus a safety factor of 1.5.

1122.2.3 Wireways and Auxiliary Gutters

A. Sizes and shapes as indicated and/or as required.

B. Provide necessary elbows, tees, connectors, adapters, etc.

C. Continuous removable cover secured with screws and keyhole slots. Hinged cover where installed above suspended ceiling.

D. Provide wire retainers at not greater than 30 cm on center. Outlet, Junction, and Pull Boxes

E. Cast Type Boxes: NEMA FB1

1. Ferrous alloy box with inside threaded hubs for rigid steel conduit.
2. Aluminum box with inside threaded hubs for rigid aluminum conduit.
3. Ferrous alloy box with compression or inside threaded hubs with adapter for electrical metallic tubing.
4. Cast raised cover, size matched to contour of box.
5. Tapered threads for hubs.

F. Galvanized Pressed Steel Type Boxes: NEMA OS 1

1. General:

   a. Pressed steel, galvanized or cadmium-plated, 10 cm minimum octagonal or square with galvanized cover or extension ring as required.

2. Lighting Fixture Box:

   a. 10 cm minimum octagon.
   b. Where fixtures are mounted on or in an accessible type ceiling and a modular wiring system is not used, provide a junction box and extend flexible steel conduit to each fixture.

3. Provide 10 mm bolt fixture studs where required.

G. Sheet Steel Boxes: NEMA OS 1:

1. No. 12 gauge sheet steel for boxes with maximum side less than 1 meter, and maximum area not exceeding 6,500 square cm; riveted or welded 20 mm flanges at exterior corners.
2. No. 10 gauge sheet steel for boxes with maximum side 1 meter to 1.5 meters, and maximum area 6,500 to 10,000 square cm; riveted or welded 20 mm flanges at exterior corners.
3. No. 10 gauge sheet steel riveted or welded to 40 mm x 40 mm x 6 mm welded angle iron framework for boxes with maximum side exceeding 1.5 meter and more than 10,000 square cm in area.
4. Covers:

   a. Same gauge steel as box.
   b. Subdivided single covers so no section of cover exceeds 23 kg.
   c. Machine bolts or machine screws threaded into tapped holes.

5. Paint:

a. Rust inhibiting primer, powder coated RAL 7032 Wrinkled.

1122.3 EXECUTION

1122.3.1 General

A. Provide raceways for all systems. Complete runs before pulling in cables or wires. Provide insulated grounding conductor in metallic or nonmetallic raceways. Minimum conduit size shall be 25 mm. Wiring of each type and system shall be installed in separate raceways.

B. Protect metallic raceway in earth or fill from corrosion with two coats of corrosion resistant z or tape wrap.

C. Elbows for the connection of an exposed steel conduit above grade to the conduit installed below grade or embedded within floor slabs shall be rigid steel conduit with two coats of corrosion resistant paint or tape wrap.

D. Branch circuit conduits or wiring device conduits for miscellaneous systems shall not be installed below slab on grade or embedded within floor slabs in tenant areas.

E. Locate raceways so that the integrity of structural members is not affected and they do not conflict with the services of other trades. Draw up couplings and fittings full and tight. Protect threads from corrosion after installation with zinc chromate or equivalent protection.

F. Conceal raceways except at surface mounted cabinets and freestanding equipment. Provide flashing and counter-flashing for waterproofing of raceways which penetrate the roof. Route exposed raceways and raceways above suspended ceilings parallel or perpendicular to building lines with right angle turns and symmetrical bends. Provide sleeves in concrete walls, floor slabs and partitions. Waterproof sleeved raceways where required.

G. Provide raceway expansion joints for exposed and concealed raceways at expansion joints and between structures to compensate for differential movement. Provide bonding conductor.

H. Provide one empty 20 mm inch raceway for each three spare unused poles or spaces of flush-mounted panelboards. Terminate conduit in an accessible location for future extension.

I. Provide raceways with appropriate seal-offs, explosion-proof fittings, etc. in special occupancy areas as required. Provide conduit seal-offs

where portions of an interior raceway system pass through walls, ceiling or floors which separate adjacent rooms having substantially different maintained temperatures, refrigeration, or cold storage rooms.

J. Provide pull cord in empty raceways. Tag both ends noting destination.

K. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. Use ball mandrel (diameter approximately 85% of conduit inside diameter) followed by close fitting wire brush and wad of felt or similar material. This assembly may be pulled with, but ahead of cable being installed. Clean empty raceways similarly. Clear or replace any raceway which rejects ball mandrel.

L. Secure raceway clamps or supports to masonry materials with toggle bolts, expansion bolts, or steel inserts. Install raceway on steel construction with approved clamps which do not depend on friction or set-screw pressure alone.

M. Install exterior underground conduits 60 cm minimum below finished grade. Do not penetrate waterproof membranes unless proper seal is provided.

N. Raceways above Suspended Ceilings:

1. Single runs of 15 mm or 20 mm raceways may be supported from ceiling support wires where permitted by the rating of the ceiling system.
2. Provide independent support of raceways larger than 20 mm. Provide independent support of multiple raceways (more than one). Provide unistrut support and threaded rod to structure above. Attachment to ceiling support wires is not permitted.
3. Provide independent support of raceways installed above fire rated ceilings. Attachment to ceiling support wires is not permitted.
4. Install conduit 30 cm minimum above top of ceiling.

O. Conduit connected to rotating or vibrating equipment shall be flexible metal conduit or liquid tight flexible conduit.

P. Raceways Embedded in Floor Slabs:

1. Raceways shall not be installed in slab without the approval of the Structural Engineer.
2. Raceways shall not interfere with placement of floor slab reinforcement components.

3. Install raceways between the upper and the lower layers of reinforcing steel.

   Space raceways not less than 200mm on centers except where

they converge at panels or junction boxes.

4. Raceways running parallel to slabs supports, such as beams, columns and structural walls, shall be installed not less than 300mm from such supporting elements.

Q. Non-Metallic Raceway Installations:

1. Joints shall be made using the material recommended by the raceway manufacturer. Components shall be cleaned prior to assembly.
2. Raceway cutoffs shall be square and shall not deform conduit. Ream rough surfaces.
3. Provide male box adapters to terminate raceways.
4. Where separable terminations are required, provide PVC threaded adapters with locknuts or bushings. Provide "O" rings for watertight installations.
5. Bends shall be made by methods that do not deform or damage the conduit.
6. Provide expansion fittings where required.
7. Raceway supports shall be installed to allow the non-metallic conduit to slide through the supports.
8. Non-metallic raceway is not permitted within the building.

R. Conductors serving electric fire pumps shall be either in conduit encased in a minimum of 75 mm of concrete (concrete encasement is not required within fire pump room and electrical room where service originates), in conduit run beneath the slab on grade, or fire rated cable.

S. Raceways and fittings installed in hazardous (classified locations shall conform to local electrical code requirements for the associated Class and Division.

1122.3.2 Wireways and Auxiliary Gutters

A. Install wireways above suspended ceilings such that cover will hinge upward from side.

B. Provide 30 mm clear from wireway cover when in open position.

1122.3.3 Outlet, Junction, and Pull Boxes

A. Provide outlet, junction, and pull boxes as indicated and as required for a complete installation and to facilitate proper pulling of wires and cables. Boxes shall be sized per electrical code as minimum. Plug open knock outs.

B. The exact location of outlets and equipment is governed by field conditions. Where necessary, relocate outlets so that fixtures and equipment are symmetrically located in accordance with the room layout and will not interfere with other work or equipment. Verify final location of outlets, fixtures, and equipment with Architect.

C. Back-to-back outlets in the same wall, or "through-wall" type boxes are not permitted. Provide 30 mm minimum spacing for outlets shown on opposite sides of a common wall. Provide acoustical potting compound on outlet boxes installed in private offices and conference rooms.

D. Fit outlet boxes in finished ceilings or wall with appropriate covers, set flush with the finished surface. Where more than one switch or device is located at one point, use multiple gang boxes and covers. Provide tile box or a 10-mm square box with tile ring in masonry walls not plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of type and size suitable for the specific application. Provide barriers where required for voltage or systems separation.

E. Provide pull boxes so that an individual run of conduit does not contain more than the equivalent of two (2) 90 degree angle.

F. All boxes and conduit accessories shall be fully weather-proof when used in outdoor locations, weatherproof boxes and conduit accessories shall also be used in locations other than outdoors when so specified on the Drawings.

G. Provide nameplate/identification

1122.3.4 Application of Raceways

A. Intermediate Metal Conduit

1. Where exposed to physical damage.
2. Indoors where exposed to moisture.
3. Where required by code.
4. Exposed indoor installations within 3000mm above finished floor.
5. Exposed outdoor installations.
6. Systems higher than 600 volts.
7. General purpose feeders, power and lighting branch circuits, auxiliary systems, telephone system except where another conduit type is specifically required.

B. Electrical Metallic Tubing:

1. General purpose feeders and branch circuits, except where another conduit type is specifically required.

C. Flexible Steel Conduit:

1. Dry locations only.
2. Connections for wiring feed to furniture wiring management system.
3. Connections to lighting fixtures in suspended ceilings.
4. Connections to equipment installed suspended ceilings.
5. Transformer connections.
6. Connections to equipment where vibration isolation is needed.
7. Maximum length shall be 1000mm.
8. Busway plug in units.

D. Liquid Tight Flexible Steel Conduit:

1. Same as flexible steel conduit in damp or wet locations.
2. Motor connections.

E. Wireways and Auxiliary Gutters:

1. Where indicated
2. Above and below panelboards, lighting relay cabinets, and terminal cabinets to accommodate large concentrations of wires.

F. Polyvinylchloride (PVC) Conduit

1. Underground duct banks
2. Below slab on grade
3. Embedded in floor slabs

1122.3.5 Application of Boxes Outlet, Junction and Pull Boxes

A. Cast Type Boxes:

1. Where connected to rigid steel, intermediate metal, rigid aluminum conduit and liquid tight flexible conduit, 30 mm and smaller.
2. Exposed conduit installations within 3 meters above finished floor.
3. Where exposed to moisture and outdoors.

B. Galvanized Pressed Steel Type Boxes:

1. Where connected to electrical metallic tubing and flexible steel conduit, 30 mm and smaller.
2. Dry locations.
3. Where concealed in walls and above suspended ceilings.

C. Sheet Steel Boxes:

1. Where connected to conduit larger than 32 mm Ø.

1122.3.6 Sleeves

A. Sleeves shall be 10 cm rigid steel nipples. Extend floor sleeves a minimum of 10 cm above and below finished floor. Extend wall sleeves a minimum of 10 cm on either side of wall. Sleeve ends shall be threaded.

B. Provide sleeves between floors of telecommunication closets as in quantities and locations shown on the Drawings.

C. Fire seal floor sleeves and sleeves in fire rated walls to maintain fire rating of wall after telephone cables are installed.

ITEM 1123 FIRE DETECTION AND ALARM SYSTEM (FDAS)

1123.1 GENERAL

1123.1.1 Description

A. Provide fire detection and alarm system in accordance with the Contract Documents.

B. The fire detection and alarm system shall be controlled and monitored in each station control, and also be monitored at the central command center together with other control systems for the MRT 7 project. Each station shall have an automatic dial-up feature to the nearest Bureau of Fire Station.

C. Related work specified for MRT 7 project in other trades of these specifications:

1. Monitor modules for Sprinkler water flow and tamper switches.
2. Integration on Elevator Recall at Ground level.
3. Integration of Evacuation system/emergency announcement.
4. Integration with Magnetic door holder and electric door locking hardware.
5. Control modules for Damper and air flow switches.
6. Control modules for motorized smoke curtain exclusively only for stations with tunnel ventilations.
7. Installation of fire alarm horn with strobe-light and fireman's telephone jack.
8. Monitor modules for pre-action system, fire water tank level, fire and jockey pump.
9. Monitor modules for rooms protected by Gas suppression system.

1123.1.2 Related Documents

A. All work specified in this Section is subject to the provisions of Item 1116 – General Electronics Provisions.

B. Refer to the following Sections of related work in connection with the Fire Detection and Alarm System:

Item 1117 – Equipment Connections and Coordination
Item 1118 – Hangers and Supports for Electronics System
Item 1119 – Fire Stopping Materials for Electronics Works
Item 1120 – Basic Materials and Methods
Item 1121 – Control Communications Cable
Item 1723 – Raceway and Boxes
Item 1124 – Access Control System
Item 1105 – Grounding System (Electrical)

1123.1.3 Quality Assurance

A. Fire Department approval of fire detection and alarm system.

B. Manufacturer and equipment supplier shall have a minimum of ten years' experience as Contractor of fire detection and alarm system and shall have at least five completed or on-going FDAS installation in the Philippines.

C. Equipment supplier shall have 24-hour parts and labor service available with a maximum 4-hour response time.

D. Prior to making required submittals, system supplier shall meet with the Fire Department and make an informal presentation of the fire alarm and detection system. Meeting minutes shall be issued and comments incorporated into the required submittals.

E. Engineer in-charge supervising the work shall be a duly Registered Electronics Engineer with at least 2 years actual experience on this field of work, and supervised by a Professional Electronics Engineer with 5 years professional experience on this field required by R.A. 9292 and revised National Building Code.

1123.1.4 Standards

A. Bureau of Fire Department Requirements

B. National Building Code of the Philippines (Latest)

C. National Fire Protection Association (NFPA 72, 101, 130, 5000)

D. Underwriters' Laboratories, Inc. (UL):

- UL 268 – Smoke Detectors for Fire Alarm System 7th Edition
- UL 268A – Smoke Detectors for Duct Application
- UL 521 – Heat Detectors for Fire protective Signaling Systems
- UL 1481 – Power Supplies for Fire Protective Signaling Systems
- UL 1778 – Uninterruptible Power Systems
- UL 864 – Control Units and Accessories for Fire Alarm Systems
- UL 62368-1 – Information Technology Equipment – Safety Part 1: General Requirements
- UL 62368-1 – Information and Communication Technology Equipment - Part 1: Safety Requirements

E. The Fire Code of the Philippines, or Republic Act No. 9514

F. Philippine Electronics Code, Book 2

1123.1.5 Abbreviations

A. FACP Fire Alarm Control Panel

B. FTS Firefighters Telephone System

C. ISD Interactive Screen Display

1123.1.6 Submittals

A. Minutes of system supplier's meeting with the Bureau of Fire Department this should be done per stations.

B. Manufacturer's product data sheets for equipment including Fire Marshal listing numbers.

C. Riser diagram showing devices, equipment, and interconnecting conduit and wire. Indicate points of connection to other equipment such as motor control centers, damper actuators, fire pump controllers, dry pipe sprinkler systems, elevator machine rooms and shafts, electric door locking hardware, and magnetic door holders per stations of MRT 7.

D. Scaled detail drawings of FACP per stations.

E. Wiring diagram for each device per stations.

F. Wiring diagrams for smoke control sequence per stations.

G. Voltage drops calculations per stations (to be given by FDAS Contractor).

H. Battery sizing calculations per stations (to be given by FDAS Contractor).

I. Visual alarm power supply sizing calculations per stations (to be given by FDAS Contractor).

J. Power supply calculations and interface installation shop drawing for magnetic door holders, and electric door locking hardware per stations (in coordination between FDAS and Access control contractors).

K. List of all devices with address identification per stations (to be given by FDAS Contractor).

L. Seismic restraint calculations per stations (to be given by FDAS Contractor).

1123.1.7 Field Testing

A. Wiring shall be inspected and tested for continuity and short circuits.

B. Field Test Reports:

1. Certification that equipment has been properly installed and is in satisfactory operating condition for MRT 7 project. This field test report shall be done per stations.
2. Sensitivity settings for smoke detectors.
3. Detailed operational test report in matrix form indicating each initiating device, each signaling device, each communication device, and each control and indicating light on each piece of equipment. Report shall certify the following:

    a. Successful operation of each alarm and supervisory initiating device.
    b. Successful operation of each signaling device.
    c. Successful operation of automatic smoke control sequences including the smoke curtain ventilation exclusively for station with tunnels.
    d. Successful operation of FACP
    e. Successful operation of FTS
    f. Successful operation of elevator recall sequence.
    g. Successful operation of line supervision devices.
    h. Successful operation of off-site alarm monitoring system connection (by Rotem).
    i. Successful operation of unlocking electronically locked doors.

1123.1.8 Identification

A. Provide an identification nameplate for each equipment cabinet and pullboxes per stations.

1123.1.9 Sequence of Operation

A. A computerized intelligent fully-addressable, non-coded, two stage evacuation system complete with integrated emergency voice evacuation and two-way communication system will be provided. The system will be designed using RA. 9514 Revised Fire Code of the Philippines and National Building Code of the Philippines (latest) and other related standards such as NFPA as reference to be applied for every station.

B. The main design principle of the proposed system is to provide localized microprocessor based intelligent Fire Alarm Control Panel, FACP with Emergency Voice Evacuation System. Detectors and system device are able to identify maintenance points, malfunctioning and line discontinuity on each station.

C. The primary means of detection/suppression will be a system of smoke detectors integrated with the automatic sprinkler system. Smoke detectors will be provided in all areas of each station to comply with local codes,

and will be supplemented by the following types of early warning detection.

D. All detectors and zone control and monitor modules on every station shall be connected on an addressable loop and each will possess a unique address to allow specific identification in the case of alarm or malfunction and environmental sensitivity adjustment.

E. Upon activation of any alarm on every station, initiating devices the system will sends signal to:

1. Transmit an evacuation broadcast to the fire level, level above and level below.
2. Transmit an alert broadcast to the remainder of the station levels and the below grade level, IF;

    a. Fire alarm within the level, if the system is not reset during the alarm investigation phase, notification signals in accordance with the building evacuation or relocation plan and remote signals shall be automatically and immediately actuated.
    b. Manual pull station is activated within the fire alarm door.
    c. Sprinkler flow switch/supervisory switch is activated.
    d. Another detector is triggered/activated within the level.

3. Automatically return all elevators to the ground level sequentially.
4. Automatically stop all station levels recirculating air handling systems.
5. Automatically start all smoke removal and open/close appropriate dampers.
6. Activate all fire smoke curtains exclusively only for tunnel stations.
7. Release all secure door magnetic locks.
8. Annunciate all functions at the Fire Alarm Control Panel located in the SCCR Room.
9. Should the initial alarm not be acknowledged, within the time specified in NFPA 72 2019, under positive alarm sequence, an evacuation broadcast will be transmitted to the entire level of the station.
10. Transmit signal to the local fire department.
11. A hard copy printout to be initiated at the printer.

F. A selective paging system will be integrated with the public address (PA) system to allow authorized announcements.

G. An integrated UL listed dedicated two-way fire fighter's telephone system will be provided at each exit stair entry and plantrooms to allow direct communication between the fire fighters and the Station Command Control Room (SCCR) of each station.

H. The main control panel will consist of a central processing unit, printer and color LCD unit annunciator with a complete graphics package identifying all fire zone status.

I. The printer shall be as an event and status printer, it shall be LaserJet type with a minimum speed of 200 characters per second at 10 characters per inch.

J. The interactive firefighters' display shall support fire alarm, supervisory, and security events from the fire alarm control panel(s). The interface shall display building floor plans with respective active fire alarm devices, water supplies, evacuation routes, access routes and structural hazards in the building.

K. This system shall be via high level interface of either LonWorks, Bacnet Protocol, TCP/IP Protocol provided guarantee of interoperability with other electronic systems.

L. The Main FACP shall be capable of either LonWorks, BACnet or TCP/IP Protocol and hardwire connection thru dry contact wiring.

1123.1.10 System Zoning

A. Firefighter's Telephone System:

1. Plug in jacks: On each stairwell and plantrooms shall be a separate, individual zone.
2. Emergency telephones: Located inside of each station control room (SCCR) per stations.

1123.1.11 Training

A. The Contractor shall provide appropriate training for the operation and maintenance of the fire detection and alarm system.

1123.2 PRODUCT

1123.2.1 Acceptable Manufacturers

A. Fire Alarm and Detection System components shall be of the same manufacturer, unless otherwise noted.

B. Acceptable manufacturers: Honeywell/Notifier, Siemens, Integlex/Nohmi Bosai, Tyco/Simplex, Cooper/Eaton, Edwards, Siemens/Cerberus, Hochiki, Nittan, Bosch (UL only).

C. Contractor must have at least 10 years of experience and existence.

1123.2.2 Line Supervision

A. All system equipment and wiring shall be supervised to be applied on every station.

B. Class X wiring shall be arranged so that the system shall not be affected by a single open, short, or ground condition. Report trouble condition and automatically switch over to alternate wiring path.

C. Class B wiring shall utilize end of line resistors.

D. Addressable Channel Wiring: Class A.

E. Multiplex Channel Wiring: Style 7.

F. Non-Addressable Initiating Device Wiring: Class X.

G. VCS and FTS Device Wiring: Class B.

1123.2.3 Battery and Charger

A. Battery:

Maintenance-free sealed lead acid type, 24-volt nominal with sufficient capacity to power the fire alarm system shall have sufficient capacity to operate the system under normal non-alarm condition for a minimum of 24 hours, and at the end of the period, capable of operating all alarm notification appliances and emergency communications systems for a period of 5 minutes.

B. Charger:

Automatic with constant potential charger maintaining the battery fully charged under all service conditions. Charger will operate at 230-volt, 60 Hz source.

1123.2.4 Fire Alarm Control Panel (FACP)

A. Solid state, microprocessor based, modular design, fully supervised and intelligent addressable. Steel enclosure in standard finish, with hinged, locking door. Integral power supply, standby batteries, and battery charger. Wall mounted inside of each station control room (SCR) per stations.

B. Provide power on LED, power failure LED, system trouble LED, system reset switch, alarm silence switch, trouble silence switch, manual evacuation switch, alarm acknowledge switch, trouble acknowledge switch, supervisory service acknowledge switch, lamp test button, tone alert, battery supervision LED, auxiliary relays, and other system

indicators and controls necessary for processing alarm and signaling functions. Indicating lamps shall be LED type.

C. Provide appropriate permanent identification labeling of control and indicating functions.

D. Annunciation:

Serial annunciator with back lit, alphanumeric, 80-character liquid crystal display indicating clear language information as to the type of alarm (device type), point status (alarm or trouble), number of alarms on the system, and a custom location label. Ability to scroll back through prior system actions.

E. System shall utilize analog type smoke detection with alarm verification, self-test feature, individual sensor automatic timed sensitivity adjustment, individual smoke sensor field adjustable sensitivity set from FACP, and automatic maintenance alarm feature.

F. With LonWorks, Bacnet or TCP/IP interface provided guarantee of seamless interoperability with other high-level interface.

G. Provide at least one (1) spare loop for maintenance purposes.

H. Provision for the FACP to be readily network capable, such that all stations and depot shall be interconnected for overall monitoring of fire alarm.

I. Shall have an interface connection on EVAC Panel thru Public Address (PA) System.

J. With voice and telephone features. Built-in Firefighter telephone option.

1123.2.5 Fire Alarm Initiating Devices

A. General:

1. Intelligent Addressable type.
2. Provide auxiliary relays where required to satisfy system operational requirements.
3. Smoke detectors shall be intelligent addressable type.

B. Manual Pull Stations:

1. Furnish and install where indicated on plan.
2. All manual pull station shall be double action non-coded break glass type.
3. Manual station shall be constructed of Die Cast Metal with clearly visible operating instruction.

4. Station shall be suitable for surface mounting on matching back box.
5. Pulling the alarm handle shall activate the toggle switch which shall cause the station in alarm position.
6. Push button type manual station shall not be acceptable.

C. Smoke and Heat Detectors:

1. Photoelectric smoke detector:

   a. LED light source, silicon photodiode receiving element. Line filter and time delay circuitry to prevent transient false alarms.
   b. 360^{o} smoke entry, locking tamper screw, pulsating on power LED indicator, UL 268 7th Edition.
   c. Adjustable obscuration/smoke detection levels.
   d. Provides maintenance identification alarm.
   e. Provides two LED function/working indication.
   f. Base sounders shall have sound output not less than 75dBA at pillow level.

2. Heat Detector:

   a. Combination fixed temperature and rate of rise heat detector
   b. Locking tamper screw, UL 521.
   c. Provides maintenance identification alarm.
   d. Provides two LED function/working indication.

3. Duct Smoke Detector

   a. Photoelectric or ionization sensing technology to detect smoke or fire particles within duct air.
   b. Designed to operate within duct airflow velocities (typically 100 to 4000 feet per minute).
   c. Operating Temperature Range: -4°F to 158°F (-20°C to 70°C) and humidity (0% - 95% non-condensing).
   d. Operates on either 24V AC/DC or 120V AC, depending on model specifications
   e. Typically includes a mounting bracket for installation on the outside of the duct, with sampling tubes extending into the duct
   f. Listings and Approvals:
      - UL: S635, S3705
      - ULC: S635
      - CSFM: 3240-1653:0209
      - FM approved

D. Device Monitoring Module

1. The device monitoring module shall permit the use of conventional detecting devices including sprinkler flow switches and supervisory switches on the addressable system. The module can be mounted together in the fire alarm cabinet or be in the standard outlet boxes located near the device being monitored.

E. Control Module

1. Interfaces a controlled device to the addressable system. This enables the fire alarm panel to direct an instruction only to the intended device by addressing to its control module.

E. Fire Alarm Horn with Strobe Light

1. Fire lights shall be a xenon-strobe type or equivalent. It shall be low-voltage (24 VDC).

   - The maximum pulse duration shall be 2/10ths of one second (0.2 second with a maximum duty cycle of 40%). A pulse duration is defined as the time interval between initial and final points of 10% of maximum signal.
   - The intensity shall be minimum of 75 candelas.
   - The flash rate shall be minimum of 1 Hz and a maximum of 3 Hz.

2. The color shall be clear or nominal white (i.e. unfiltered or clear filtered white light).
3. Electric, utilizing solid state electronic technology operating on a nominal 24 VDC, with a nominal rating of 82 dBA at 3m.

F. Linear Beam Detector and Reflector

1. Operating Voltage: 20 - 40 V DC
2. Current Consumption:
   Standby: < 8 mA
   Alarm: < 15 mA
3. Detection Range: 5 to 100 meters (16 to 328 feet)
4. Alignment Angle: Horizontal: ±10°, Vertical: ·5°
5. Alarm Response Time: 2 to 30 seconds (adjustable)
6. Operating Temperature Range: -20°C to +55°C (-4°F to +131°F)
7. Relative Humidity: 0 to 95% non-condensing
8. Output: Addressable signal for integration with the fire alarm control panel (FACP)
9. Construction Material: High-impact ABS and polycarbonate
10. Ingress Protection Rating: IP54

11. Approvals: UL Listed, CE Marked, EN 54-12 Compliant

1123 Linear Heat Detector Cable

1. Digital Linear Heat Detector

a. The sensor cable is comprised of two steel conductors individually insulated with a heat sensitive polymer.
b. The insulated conductors are twisted together to impose a spring pressure between them, then wrapped with a protective tape and finished with an outer jacket suitable for the environment in which the detector will be installed.
c. At the rated temperature, the heat sensitive polymer insulation yields to the pressure upon it, permitting the inner conductors to move into contact with each other thereby initiating an alarm signal.
d. When used with the appropriate control equipment, the detector will activate a display, showing the location of an overheat or fire condition anywhere along its length.
e. The detector must be installed in continuous runs without taps or branches in accordance with applicable sections of NFPA 70 National Electrical Code, NFPA 72 National Fire Alarm Code, or as determined by the local "authority having jurisdiction."
f. Copper wire, of an approved type, with a minimum conductor size of 18 AWG, shall be installed from the control panel out to the hazard area where it is then connected to the beginning of the LHD portion of the circuit.
g. Jacketing Materials:
- EPC (Extruded Polyvinyl Chloride) – is a durable flame-retardant vinyl outer jacket designed for interior commercial and industrial applications. Features of this jacket include low moisture absorption, resistance to many common chemicals, and excellent flexibility at low temperatures.
- XCR (Extreme Corrosion Resistance) – is a high-performance fluoropolymer jacket designed for both interior and exterior environments. Features of this jacket include excellent chemical resistance, abrasion resistance, weather resistance, and high-temperature performance. XCR is the only heat detector that is FM-approved for corrosive environments.
- LSZH (Low Smoke Zero Halogen) – is a durable outer jacket designed for interior commercial and industrial applications requiring low smoke zero halogen performance. Features of this jacket include low moisture absorption, resistance to many common

chemicals, and excellent flexibility at low temperatures.

- XLT (Extreme Low Temperature) – is an outer jacket specifically selected for cold storage and freezers. Features of this jacket include low moisture absorption and excellent performance in extremely low temperatures. This detector has been UL and FM tested to –60°F (–51°C)
- EPR (Extruded Polypropylene Rubber) – is an outer jacket designed for both interior and exterior environments. Features of this jacket include good abrasion resistance, chemical resistance, and weather resistance over a wide temperature range.

h. Specifications:

Maximum Voltage Rating:	30 VAC, 42 VDC
Minimum Bending Radius:	2.5 inches (6.4cm)
Diameter:	Nominal 5/32 inch (4mm)

i. Complying with standards:

- UL 521 listed.
- FM approved for special application use only.

2. Fiber Optic Sensor Cables

a. A fast-responding sensor cable with a tight buffered fiber. Compact dimensions, high flexibility and good bending behavior. High tensile strengths due to the Aramid yarns. These cables have a halogen-free and flame-retardant cable sheath.

b. Sensor cables are completely passive and available in a variety of different compositions and configurations including metal-tubing, metal-free, tube-in-tube or armored stainless steel. Metal-free cable reduces the risk of induced voltages and are usually flexible, while metal armored cables have high rodent protection, are robust and the right choice for harsh environment. Additionally, a wide range of appropriate sheathings are available, for example flame retardant non-corrosive (FRNC) sheathings, water-tight high-dense polyethylene (HDPE) or others.

c. Sensor cables are available with multimode (MM) and single mode (SM) fibers or a combination of both. For MM fibers, typically a core of 50 µm or 62.5 µm diameter is chosen, which enables significantly lighter to travel in the core than in SM fibers.

d. Typically, MM fibers are used for Distributed Temperature Sensing (DTS) and for most high-bandwidth fiber optic communication links. MM fibers have substantially greater cross-sections that enable a higher volume of light, which can be coupled into and

then internally reflected in the core. Compared to the core of a SM fiber, MM fiber minimizes the core alignment mismatch, so less light gets lost at splices and mechanical connectors. This results in a better signal-to-noise ratio (SNR) and resolution performance for DTS systems.

e. Key features:
- Precise localization of events
- Temperature, strain, vibration and acoustic measurement
- Immune to electromagnetic interference (EMI)
- Maintenance-free (essential for inaccessible areas)
- Suitable for use in explosive hazard areas
- Small, flexible and purely passive sensor element
- Available for temperatures from -180 °C to + 300 °C

f. Complying with standards:
- IEC 60331-25; IEC 60332-1/-2/-3-24; IEC 60754-1/-2; IEC 60793; IEC 60794-1-2; IEC 61034-2; EN 187000; VdS approved.
- UL 521 and CAN/ULC S530 listed.
- FM 3210 approved.

1123.2.6 Firefighter's Telephone System (FTS)

A. Solid state, microprocessor based, modular design, fully supervised. Steel enclosure in standard finish, with hinged, locking door. Integral power supply, standby batteries, and battery charger. Wall mount inside Station control room (SCCR) on every station.

B. Two-way voice communication between the SCCR firefighter's phone jacks and emergency telephones. Selective zone paging to all or any combination of telephone zones. Provide sound powered type system where required by the Fire Department, otherwise, provide electrical type system.

C. Each telephone zone shall have a manual selection switch, red LED to indicate active zone, and yellow LED to indicate speaker zone trouble.

D. Acknowledge switch, system trouble, reset, and lamp test switch.

E. Red telephone handset.

F. Provide a remote handset in a lockable recessed cabinet.

G. Auxiliary Devices:

1. Firefighter's phone jack: Recessed wall mounted telephone jack,

stainless steel faceplate engraved FIRE EMERGENCY PHONE.

2. Emergency telephone: Recessed wall mounted cabinet, hinged locking door engraved LOCAL FIRE EMERGENCY PHONE, permanent handset with armored cable, and bread red glass.
3. Telephone handset cabinet: Surface mounted cabinet in SCCR. Provide plug in type phones with coil cord and jack, quantity as required by the Fire Department.

H. Provide a dedicated telephone outlet with a direct line for fireman connection.

I. The fire Fighters telephone system shall be at least built-in with the Fire Alarm Control Panel.

1123.2.7 Emergency Voice Evacuation Panel (EVAC) Panel

A. A fully automatic combination voice communication and fire fighter's intercom system which provides automatic and alarm signaling as per NFPA 72. Which applies in all stations for MRT 7.

B. One or two-way communications system for relocation/evacuation of building personnel and assisting fire-fighting efforts in controlling smoke and fire.

C. "ALL-CALL" tone and Voice Signaling.

D. Selective Tone and Voice Signaling with Redundant tone generators.

E. Module removal supervision

F. Service Diagnostic Center.

G. "ALARM/RESOUND/RESTORE" Feature

H. Short Circuit Speaker Disconnect

I. "On/Normal/Off" Auxiliary controls

J. Local annunciation with Time-out of selective alarm signal to general alarm "ALL-CALL"

K. Fully integrable with any Public Address system, connection thru dry contact hard wiring.

1123.2.8 Operator Workstation

One (1) Fire alarm control panel shall be located inside of each Station Control Room (SCCR) per station connected with a printer, evacuation panel and integration on life safety requirements with other trades.

The Fire alarm control panel shall be capable of supporting simultaneous operator workstation connections using a TCP/IP local area network (LAN).

A. Provide HP LaserJet Color Printer

1123.2.9 L2 (Layer 2) Switch with SFP (Small Form-Factor Pluggable) Ports

A. General

1. Switching Capacity: 48 Gbps – 176 Gbps
2. Forwarding Rate: 35.7 Mpps – 41.7 Mpps

B. Ports

1. Ethernet Ports: 24-48 x 10/100/1000 Mbps RJ-45 ports
2. SFP Ports: 4 x SFP (1/10GbE) ports for fiber uplinks

C. Performance

1. MAC Address Table: 8K entries
2. VLANs: Supports up to 256 VLANs
3. Link Aggregation: Supports up to 8 groups, 8 ports per group
4. STP: IEEE 802.1D STP, IEEE 802.1w RSTP, IEEE 802.1s MSTP
5. QoS: 802.1p QoS, DSCP, 8 priority queues

D. Security

1. Port Security: MAC-based port security, Dynamic Host Configuration Protocol (DHCP) snooping, and Dynamic ARP protection.
2. ACLs: L2/L3/L4 ACLs,
3. 802.1X: Port-based authentication, MAC-based authentication

E. Management

1. Interface: Web GUI, CLI, SNMP v1/v2c/v3
2. Remote Management: Telnet, SSH, HTTP/HTTPS
3. Firmware Upgrades: TFTP/FTP/HTTP

F. Physical and Environmental

1. Form Factor: 1U rack-mountable
2. Power Supply: Internal power supply, optional PoE

3. Operating Temperature: 0°C to 50°C
4. Dimensions: 440 x 220 x 44 mm
5. Weight: 3.2-3.65 kg

G. UL Listing (for reliability and safety)

1. UL 864: Applies to equipment used in fire alarm and signaling systems. If a Layer 2 switch is critical to fire protective signaling (e.g., connected to fire alarm control panels or public address systems), it may need UL 864 certification to meet fire protection standards
2. UL 60950-1 or UL 62368-1: Safety standards for IT and telecommunications equipment. For general network reliability, UL 60950-1 or UL 62368-1 listings are often sought for switches used in data infrastructure, although they do not necessarily cover fire protective signaling.

1123.2.10 Uninterruptible Power Supply (UPS)

The Contractor shall provide the following:

A. The UPS final capacity shall be proposed and calculated by the Contractor when all systems equipment loading is known and multiple by 20%. The Contractors shall supply, install and test complete sets of UPS with chargers, batteries, cabinet, etc.

B. The UPS shall consist of maintenance free standby batteries and adequate chargers.

C. The UPS shall have maintenance free batteries equipped with battery charger. The battery shall be sealed lead acid type and shall be suitable for continuous standby duty. Cable lugs shall be soldered on to cables, crimping shall not be permitted.

D. All flux residues shall be thoroughly cleaned from the termination and cables. Anticorrosion coatings shall be applied to the terminals and lugs.

E. The battery charger shall be capable of restoring the battery from a fully discharged state, to a fully charged state, within a period of twelve hours after restoring of supply. It should also be equipped with trickle charge.

F. The main supply shall be monitored from the output of the chargers but isolated from the battery. It shall also be fail-safe.

G. The UPS shall have the cabinet to house the battery charger and the batteries. It shall be well ventilated.

H. For NFPA 72 compliance, the UPS should have a UL listing that indicates it is suitable for use in fire alarm systems. Specifically, the relevant UL listing would be:

1. UL 1778: This is the standard for Uninterruptible Power Systems. A UPS with this listing ensures it meets the necessary safety standards for electrical equipment but may not specifically address fire alarm system compatibility.
2. UL 1481: This listing is particularly for fire protective signaling UPS systems. UL 1481-certified UPS units ensure that they can continuously supply power to fire alarm control panels and emergency signaling systems as per National Fire Protection Association (NFPA) requirements.

I. The UPS shall have the following features and characteristics:

1. Rating: As required based on tender specifications
2. Type: True Online on voltage, frequency and phase angel. Undetected by computer, modem, network loads, etc. There shall be no break in the supply upon main failure
3. Battery Backup: 10 minutes' backup on full load or as specified
4. Voltage: 230V A.C., 5%; single phase
5. Frequency: 50-60 Hz, 1%
6. Power factor: unity to 0.7 lagging
7. Static Transfer Switch: transfer time 100ms, detection time 4.2ms max.
8. Efficiency: >95% under normal conditions.
9. Input Protection: circuit breaker and fuse
10. Output Protection: Automatic current and over voltage protection.
11. Control: To provide control of UPS for the following:
    a. UPS/bypass transfer/re-transfer switch.
    b. Emergency shutdown push button
    c. Self-Diagnostic Test: To provide diagnostic aids to facilitate test and troubleshooting.

1123.2.11 Printer

Printer shall be of the automatic type with code, time, date, location, category and condition. System printer shall be of high a reliability digital input device, UL approved, for fire alarm applications. The printer will operate at a minimum speed of 30 characters per second.

1123.2.12 System Software

A. Automatic detector addressing and status indication.

B. Secure signal transmission on shielded twisted cables.

C. Interfaces to LonWorks, BACnet, or TCP/IP.

D. Intelligence distributed across the detectors and the fire control panel.

E. Drag and drop graphics and GUI interface.

F. Graphic screens are created with a built-in drawing utility of the protected area and are linked to fire alarm devices.

G. Should a device got to alarm, the appropriate graphic floor plan is displayed along with operator instructions.

H. History manager which tracks and stores events.

I. Must be able to control and monitor the system.

J. Must be able to connect to other networks using TCP/IP Local Area Network (LAN).

1123.2.13 Graphical Annunciator Panel

The Graphical Annunciator Panel shall be a graphic representation of the facility. It shall depict the circulation elements and the means by which fire fighters can reach the area indicating a fire condition. The display shall show the area in which the fire or smoke has been triggered indicated by a LED light. With the Graphic annunciator, the Fireman does not have to scroll through touchscreens to find the device that has gone into an alarm. The graphic annunciator design shall reflect building structure and tagging should be floor level not by zone, and will be subjected for approval by the authority having jurisdiction. The Graphical Annunciator Panel must be made from stainless steel (304 grad), front plate must be 1.5mm thick (if flat panel) and back boxes are 0.8mm.

1123.2.14 Interactive Firefighters' Display

A. An interactive screen display shall be installed in accordance to the project specifications and drawings.

B. The interactive screen display system shall include, but not be limited to a touch screen interface, network communications media, power supplies, an embedded gateway, and wire/fiber optic media as shown on the drawings and specified herein.

C. The interactive screen display shall support fire alarm, supervisory, and security events from the fire alarm control panel(s).

D. The interface shall display building floor plans with respective active fire alarm devices, water supplies, evacuation routes, access routes, gas, power and HVAC shutoffs, chemical hazards and structural hazards in the building.

E. The system shall include an easy one-touch method of viewing building, emergency contact, facility site plan, active event information, MSDS information, and have the ability to print floor-plans.

F. A supervised interface to fire alarm control panels shall be made available and displayed.

G. The system shall be electrically supervised and monitor the integrity of all conductors.

H. The system shall have the ability to connect to multiple gateways and accommodate floor plans for multiple buildings.

I. The system shall have a configuration audio tone with a silence button and configurable door activation.

J. The system shall have the ability to store and access MSDS safety sheet from Hazmat buttons placed on the screen.

K. The user shall be able to download system log files from the unit by connecting to USB device.

1123.3 EXECUTION

1123.3.1 General

A. All equipment shall be installed and connected in accordance with the manufacturer's recommendations. Following the required specifications indicated here.

B. Wiring shall be color coded, and in accordance with the manufacturer's recommendations and Fire Department requirements. Install wiring in an independent, dedicated metallic raceway system.

C. Connections to devices installed in accessible tile ceilings shall be in flexible conduit. Device back boxes shall be securely attached to framing members.

D. Provide wireways above and/or below equipment cabinets to accommodate large concentrations of wiring. Conductors within equipment cabinets shall be carefully formed and harnessed.

E. Connect equipment to emergency power system.

F. Provide power supply wiring to electric damper actuators used for smoke control that are not controlled by the temperature control system.

G. Furnish a fire alarm horn and a firefighter's plug in jack for each elevator. Coordinate installation with elevator equipment supplier.

H. FCIP and smoke control sequence wiring shall be dedicated and independent from other systems.

I. Provide a 25 mm empty conduit from the FACP to the nearest telecom terminal backboard.

J. Manual pull station shall be provided all throughout the buildings to initiate a signal that a fire is happening.

K. Fire Alarm Horn with Strobe Light circuits on individual level are to be wired in alternate pattern e.g. ‘a’-‘b’-‘a’-‘b’-‘a’.

1123.3.2 Testing and Commissioning

A. Provide the service of a competent factory-trained engineer or technical authorized by the manufacturer of the fire detection and alarm system equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the Project Manager.

B. When the system has been completed, and prior to the final inspection, furnish testing equipment and perform the following tests in the presence of the Engineer and the Local authority having jurisdiction.

1. Check installation, supervision and operation to ascertain that they will function as specified.
2. When any defects are detected, make repairs or install replacement components, and repeat the test.

C. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall perform the required test. In addition, the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of the Owner’s Representative, Project Manager, Consultant and the local authority having jurisdiction.

ITEM 1124 ACCESS CONTROL SYSTEM

1124.1 GENERAL

1124.1.1 Description of Work

A. Furnish all labor, materials, supplies, equipment, devices, appliances and perform all operations necessary for the installation of the complete IP based/capable Access Control System on each station for MRT 7.

B. The Access Control System shall conform to high level LonWorks, or BACnet or TCP/IP integration to be applied on every station.

C. Any equipment not specifically mentioned in the Specifications or not shown on the Contract Drawings, but deemed necessary for the satisfactory operation of the system, shall be provided.

D. The Contractor shall be responsible for coordination having properly assessed the fire alarm, elevator control and other specified interfacing requirements on each station and the conduit and wiring requirements relevant to their full compliance with this Specifications.

E. The system shall provide Access Control capable of allowing the on-duty guards to monitor and keep under surveillance, the specific doors, rooms and areas of the building with a minimum effort but with maximum efficiency. This shall be applied on every station.

F. The system shall be microprocessor based capable of providing the Security System Administrator advanced database entry, controllers' configurations, systems graphics, reports, events/alarms management facilities.

G. The system shall be capable to provide complete integration of door access, elevator control, and alarm monitoring per stations.

H. A card access control sub-system shall be provided with a high level of flexibility and comprehensive system management and database reporting facilities.

I. All circuit wiring shall be continuously supervised for open or short circuit and connection to earth and the system shall be able to detect tampering.

J. All wiring and roughing-ins work for power and signal circuits of access control system per stations shall be by the Specialty Contractor.

K. Separate wiring and conduiting for power and signal system shall be provided by the Specialty Contractor to be applied on every station.

L. During bid stage, the Contractor shall adequately and accurately describe the proposed system at the time of bidding per stations.

M. The Contractor shall provide written statements of Year 2017 compliance for the equipment offered, from the equipment manufacturer.

N. System is easily expandable to accommodate future expansion shall be applied on every station.

1124.1.2 Related Documents

A. All work specified in this Section is subject to the provisions of Item 1116 – Electronics General Provision.

B. Refer to the following Sections of related work in connection with the Security System:

Item 1117 – Equipment Connections and Coordination
Item 1118 – Hangers and Supports for Electronics System
Item 1119 – Fire Stopping Materials
Item 1120 – Basic Materials and Methods
Item 1121 – Control Communications Cable
Item 1122 – Raceways and Boxes
Item 1123 – Fire Detection and Alarm System
Item 1105 – Grounding System

1124.1.3 Quality Assurance

A. The entire security system installation shall be carried out in accordance with the PEC. The Fire Code of the Philippines & Regulations, NFPA, latest National Building Code and applicable local ordinances of the city.

B. The Contractor shall have 10 years minimum experience and with 24 hours service department.

C. Engineer in-charge supervising the work shall be a duly Registered Electronics Engineer under the supervision of a Professional Electronics Engineer as required by R.A. 9292 and the revised National Building Code.

1124.1.4 Submittals

A. Make submittals for the security system in accordance with the requirements of Item 1116 – Electronics General Provisions.

B. The Contractor shall supply a full set of drawings, specifications and catalogue sheets describing the various components belonging to the offered system.

C. The following list of equipment does not require samples but shall have specification sheets and catalogues, with sufficient details of mounting in control consoles, submitted before installation. Logo of UL listings shall be clearly indicated.

1. Equipment cabinets and panels / Control Consoles
2. Field Devices (Card Reader Module, Card Reader, Door Contact, Electromagnetic Lock, Door Alarms)
3. Security computers (Workstation and Server)
4. Level 2 Switch (with SFP ports)
5. Uninterruptible Power Supply (UPS)

D. The following shop drawings are required as minimum:

1. System Block Diagram
2. Cabling & Wiring Diagrams
3. Connection Diagrams
4. Floor level Plans & Sectional installation details including control console
5. Function Diagrams for all functions of the System and for the interfaces to Systems provided by others.

E. Submit O&M manuals, including test results.

1124.1.5 Approved Manufacturers

A. The complete security system shall be from one of the following manufacturers. No approved equal

1. Access Control – Honeywell, UTC/GE, Siemens, Tyco, Hirsch, Sensormatic, DSC, HID

1124.1.6 Training

A. The Contractor shall provide appropriate training for the operation and maintenance of the security system, in accordance with the requirements of Item 1116 – Electronics General Provisions.

1124.2 PRODUCTS

1124.2.1 General Product Requirements

A. All materials, equipment, components and devices shall be new and unused, of current manufacture and first quality. All equipment shall be previously tried and tested successfully in the field. The manufacturer shall be subject to the approval of the Consultant where this has not been specified.

B. All materials, equipment, components and devices shall be clearly marked and suitable for the electrical power supply system to which it will be connected.

C. Provision for LonWorks, BACnet or TCP/IP Interface with guarantee of seamless interoperability.

1124.2.2 Access Control System

A. General requirements are as follows:

1. Magnetic door contacts shall be provided on selected doors (e.g. Highly-secured areas, fire exit stairs, mechanical penthouse level, computer rooms etc.)
2. Alarm contacts of door detector shall be closed under normal conditions and open on alarm.
3. The access control panel shall be able to differentiate between open line conditions and alarms, and shall display a trouble condition in case of wire breaks.
4. Activation of the detection device shall alarm in the security control panel and display the respective zone or point.
5. Proximity card system shall be required as second level of security for higher security-areas as indicated in the plans.
6. All devices, equipment and enclosure shall be UL listed or approved equal.
7. The system shall be Open Database Connectivity (ODBC) complaint. ODBC is widely used in data-driven applications, reporting tools, and business intelligence systems due to its ability to provide a standardized approach to database connectivity. This shall facilitate enterprise-wide data transfer with third party applications such as interfacing with time keeping system and accounting system software with required data base input of Point dBF (data base file) and Text file.
8. The system shall be designed to maintain access control through two levels of degradation. The intelligent terminal controller shall continue to provide, using its local database, a full level of access control. Upon loss of communications with the intelligent terminal controller, the readers shall continue to control access using verification of the facility in the card.
9. The system shall be able to designate certain readers to control only entry or exit, and shall require a cardholder using a card at entry reader to subsequently use it at as exit reader before again entering the secured area. This shall prevent 'passing back' a card to an unauthorized second user.

B. Magnetic door detectors shall be recessed type suitable for mounting on all types of doors and on any part of the door. The switch mechanism shall have dust-tight housing, which shall be connected to a terminal box

with tamper proof cover. The magnetic switch contacts shall be closed by a magnetic repelling action.

C. The Electro-Magnetic lock shall be durable, easy installation to any type of door (swing or slide, singles or pairs, manual or automatic, hollow metal, wood, aluminum or herculite) and no maintenance required. Holding force shall be field adjustable from 100lbs. to 1500lbs. with no residual magnetism. The Electro-Magnetic lock shall be positive fail-safe type, protected against power surge and shall have battery power capability. All wiring to the unit shall be self-contained. Electro-Magnetic lock shall be UL listed.

D. The intelligent access controller shall comply with the following requirements.

1. The central access controller shall communicate with the smart terminal units of the system. When a card is read, the card number and issue level are sent to the controller. The controller shall be programmed to control access and record the transaction, including date, time and location. The option of having the transaction printed as they occur shall also be provided.
2. If access is granted, the controller shall send a signal to the appropriate reader to activate the door lock. If access is denied, the transaction will be recorded and/or printed identifying the reason.
3. Access Controllers shall provide stand-alone operation of up to 8 doors on a standard controller. Each controller shall store the personnel records for up to 1500 card (or PIN) holders. In addition, each access controller contains inputs for monitoring door contacts, motion detectors and other supervised security input devices.
4. Control programs shall be stored in battery backed-up RAM and EPROM. Each controller shall have the intelligence to perform all access control strategies, without communication to other controllers, for control functions not requiring data from other controllers.
5. Each controller shall be able to have its program edited and/or modified either locally through a laptop service tool or through a dumb terminal or workstation connected to a Master Security Controller. Each access controller shall complete its internal scan in less than one second. Each scan shall consist of updating of readers and keypads supervised inputs, importing of data from other controllers, performing mathematical calculations and sequencing appropriate outputs for local control of doors, elevators and other related devices. The maximum time for door opening from the proper presentation of a card shall be under 1 second.

6. Local access controllers shall have a minimum of 256K RAM, 512K ROM, and 1K EEPROM.
7. Access controllers shall provide communication to the field bus. In addition, a port shall be provided for connection to a laptop service tool to support local programming and parameter changes. It shall be possible from this port to access and program any controller on the field bus and Master Security Controller on the high-speed LAN.
8. The controller shall provide an interface, which permits data to be stored on a tape cartridge, although this is not to be provided initially. In the event of a power loss, a backup battery, with minimum life of 5 years, shall provide full controller operation for up to eight hours, and memory retention up to 24 hours.
9. Cards shall be programmed into the controller individually, with additions, deletions, and changes able to be completed quickly and simply.
10. The intelligent terminal controller shall provide an output for annunciation of alarms.

E. Input/Output requirements are as follows:

1. The input section of the access controllers shall provide a minimum of 4 card reader channels or optionally keypads. It shall be possible to expand the number of card readers per controller to a total of 8 readers. In addition, there shall be 32 supervised inputs on the base controller for request to exit, door status and general digital monitoring.

Card Readers	-	The card reader inputs shall accept proximity readers and optionally Wiegand, swipe, magnetic stripe, and biometrics. Proximity readers may require an external 12 VDC source.
Supervised Inputs	-	Each supervised input shall be able to distinguish among normal operation, a short, open circuit, or a fault.
Tamper Switch	-	A normally open momentary switch shall be used for external tamper detection. The on-board switch will detect whenever the cabinet of the access controller has been opened.

2. Output types shall be digital for control of door strikes. In addition to the 2 door strike outputs, the controller shall contain one auxiliary output for ON/OFF control of annunciators, lights, etc. Outputs shall be available with built-in override switches.

Card Readers	-	The digital outputs shall be rated for 24V AC/DC operation at 5 amps maximum. Each output shall have a corresponding LED for visual indication of its state.
Supervised Inputs	-	A board-mounted switch shall be provided for each output allowing local overrides. The position of the switch shall be detectable in software and available for alarm annunciation.

F. Access cards shall comply with the following requirements:

1. Individual cards may be programmed for special privileges to override access level and time zone parameters. Smart cards shall be customized to have ID card, access, accounting and time keeping card in one.
2. The access cards shall be of laminated plastic, coded with a combination of facility code and with an individual identification number included in the encoded information. The access cards shall be durable and difficult to duplicate without facilities of the type used in manufacture. Any access card technology, which allows field encoding of the cards shall not be acceptable.
3. The facility code shall be unique to the Clients premises. The Security System Contractor shall guarantee this facility code is not used for any other building or installation.
4. Credit card sized access cards shall permit direct color printing, including photographic information, on both sides of the card (100% edge-to-edge on the front and up to 80% on the back). Their operation shall be unaffected by metallic coins, mechanical keys and other electronic access cards, nor shall they affect bank magnetic stripe credit cards in a wallet.
5. All credit card sized access cards shall be delivered pre-punched to accept a clip for attachment to the clothing of the cardholder. The location of the hole (i.e.: for horizontal or vertical format cards) shall be confirmed by the Client prior to the card being offered.
6. Laminating punches shall be available as an option, at additional cost if required by the Client.
7. One thousand (1000) passive smart card shall be supplied under this Contract for employees, 200 prox. Cards for visitors and guests. (As applicable)
8. Access cards, which can incorporate multiple compatible technologies (e.g. proximity/Wiegand, proximity/magnetic strips, etc.) shall be preferred.

G. The card reader and intelligent interface shall comply with the following requirements:

1. The card readers shall consist of an intelligent terminal interface with initially a smart card reader type.
2. The intelligent terminal interface shall control the electric door lock, visual access indicators, access and shunt timers, and an auxiliary access input.
3. The intelligent terminal interface shall monitor door status via a door or lock contact. An alarm shall be reported when the door is not closed and locked, and when the door is forced open.
4. Readers shall be surface or flush mounted.

1124.2.3 Wiring

A. All wiring for the security system shall be supervised. Wiring shall be 0.75 mm^2 (#16 or #18 AWG) STP wire, or per manufacturer's requirement and shall be in intermediate metallic conduit (IMC) with a minimum of 25 mm dia. electrical trade size.

B. Each cable type shall run in a separate conduit. Sharing of conduit shall be allowed only to cables of the same type and function. Use IMC conduit unless indicated otherwise on the drawings.

1124.2.4 Access Control Room Console

A. The access control system Contractor shall design, document, manufacture, supply, cable, and install the security console located in the Communications Room. They shall also install all equipment associated with these consoles.

B. The console design shall incorporate the following:

1. Sound ergonomic principles
2. Robust design, suitable for continuous usage over a minimum ten (10) year period, with minimal maintenance.
3. Good quality screen-based equipment design for mounting and installing security equipment in the Contract.
4. Equipment manufacturer requirements for ventilating and cooling, including any forced ventilation required.
5. Space requirements for installing cable ducts, wiring harnesses, 220vAC power outlets, etc. and servicing and maintaining the equipment.

C. The access control console shall be located at depot and designed as a centralized desk serving all stations unit for keyboards, function buttons, intercoms, telephones and the like which are required within the operator's reach. The only monitor on this console shall be the computer screen.

D. The console desk shall be low profile to ensure the desk-mounted equipment does not obstruct the operator's view of the monitors. The VDT shall be recessed into the desk top.

E. A separate printer stand shall be provided for each printer. Printers shall not be located on the console desk.

1124.2.5 Interface with other Systems

A. Fire Alarm System interface

1. The Access Control System Contractor shall provide a complete security/fire interface between the Access Control System and the main fire indication panel provided by the FDAS Contractor in the Communications Room to comply with the full requirements in this Specification.
2. On receipt of the general fire alarm signal, the Access Control System shall, in accordance with pre-programmed database operations, release any electric locks on all emergency evacuation procedures are maintained in accordance with the building codes applicable. The doors shall remain unlocked until the fire alarm is reset.
3. When a fire system test mode signal is initiated, all the events received during the test and any fire event-initiated outputs, (e.g. unlock prescribed doors), shall be suppressed as pre-programmed by the Client Administrator, until the test mode is reset. This shall ensure that testing of a fire system shall not compromise the security of the premises nor distract the guard from his normal duties.
4. The interface between the Access Control Evacuation System thru PA and the Fire System shall be at "high level", any other accessories contained within interface panels, to comply with the full requirements of these Specifications and safe operations.
5. The tunnel ventilation system contractor shall provide a complete fire interface between tunnel ventilation system and main fire alarm control panel communication language via TCP/IP protocol at Station control room provided by the FDAS contractor to comply with the full requirements in this specification for Stations 2, 3 and 14.

B. Automatic Fare Collection (AFC) System

1. The Access Control System Contractor shall provide complete interface with the AFC gates to ensure security of the stations.
2. In case of intruder alert, the Access Control System shall be able to control and monitor operation of the AFC Gates.
3. In case of general fire alarm, the Access Control System shall be responsible to send signal initiating the release of gates.

Likewise, all other activities relating to Fire Alarm and Detection System shall be communicated via the Access Control System.

1124.2.6 Operator Workstation

A. The Contractor shall provide one (1) Security Management System Workstation at the Operation Control Center and the system shall be capable of supporting up to 5 simultaneous Operator Workstation connections using a TCP/IP Local Area Network (LAN) subject to hardware capacity on the server computer. The Network connection must allow a limitless number of casual users access to the 5 connections on a first-come-first-served basis.

B. The Operator Workstation shall comprise the following minimum hardware:

- A Core i7 (provide an equivalent version during the time of installation) at 3 GHz clock, 64 bit, 24MB cache
- 4 GB RAM
- A Super VGA graphics card capable of 1080x720 pixel resolution and 65K colors, non-interlaced (70 Hz or better vertical refresh rate).)
- A 2 TB Hard disk drive
- 500 GB SSD hard drive (for operating system faster operation)
- A 12 function-key keyboard
- A mouse pointing device
- An Adapter for Ethernet Networking compatible with TCP/IP network protocols
- Minimum of 2 ports type A USB
- 32” Colored LED Monitor

1124.2.7 L2 (Layer 2) Switch with SFP (Small Form-Factor Pluggable) Ports

A. General

1. Switching Capacity: 48 Gbps – 176 Gbps
2. Forwarding Rate: 35.7 Mpps – 41.7 Mpps

B. Ports

1. Ethernet Ports: 24-48 x 10/100/1000 Mbps RJ-45 ports
2. SFP Ports: 4 x SFP (1/10GbE) ports for fiber uplinks

C. Performance

1. MAC Address Table: 8K entries
2. VLANs: Supports up to 256 VLANs
3. Link Aggregation: Supports up to 8 groups, 8 ports per group
4. STP: IEEE 802.1D STP, IEEE 802.1w RSTP, IEEE 802.1s MSTP

5. QoS: 802.1p QoS, DSCP, 8 priority queues

D. Security

1. Port Security: MAC-based port security, Dynamic Host Configuration Protocol (DHCP) snooping, and Dynamic ARP protection.
2. ACLs: L2/L3/L4 ACLs,
3. 802.1X: Port-based authentication, MAC-based authentication

E. Management

1. Interface: Web GUI, CLI, SNMP v1/v2c/v3
2. Remote Management: Telnet, SSH, HTTP/HTTPS
3. Firmware Upgrades: TFTP/FTP/HTTP

F. Physical and Environmental

1. Form Factor: 1U rack-mountable
2. Power Supply: Internal power supply, optional PoE
3. Operating Temperature: 0°C to 50°C
4. Dimensions: 440 x 220 x 44 mm
5. Weight: 3.2-3.65 kg

G. UL Listing (for reliability and safety)

1. UL 864: Applies to equipment used in fire alarm and signaling systems. If a Layer 2 switch is critical to fire protective signaling (e.g., connected to fire alarm control panels or public address systems), it may need UL 864 certification to meet fire protection standards
2. UL 60950-1 or UL 62368-1: Safety standards for IT and telecommunications equipment. For general network reliability, UL 60950-1 or UL 62368-1 listings are often sought for switches used in data infrastructure, although they do not necessarily cover fire protective signaling.

1124.2.8 Uninterruptible Power Supply (UPS)

The Contractor shall provide the following:

A. The UPS final capacity shall be proposed and calculated by the Contractor when all systems equipment loading is known and multiple by 20%. The Contractors shall supply, install and test complete sets of UPS with chargers, batteries, cabinet, etc.

B. The UPS shall consist of maintenance free standby batteries and adequate chargers.

C. The UPS shall have maintenance free batteries equipped with battery charger. The battery shall be sealed lead acid type and shall be suitable for continuous standby duty. Cable lugs shall be soldered on to cables, crimping shall not be permitted.

D. All flux residues shall be thoroughly cleaned from the termination and cables. Anticorrosion coatings shall be applied to the terminals and lugs.

E. The battery charger shall be capable of restoring the battery from a fully discharged state, to a fully charged state, within a period of twelve hours after restoring of supply. It should also be equipped with trickle charge.

F. The main supply shall be monitored from the output of the chargers but isolated from the battery. It shall also be fail-safe.

G. The UPS shall have the cabinet to house the battery charger and the batteries. It shall be well ventilated.

H. For NFPA 72 compliance, the UPS should have a UL listing that indicates it is suitable for use in fire alarm systems. Specifically, the relevant UL listing would be:

1. UL 1778: This is the standard for Uninterruptible Power Systems. A UPS with this listing ensures it meets the necessary safety standards for electrical equipment but may not specifically address fire alarm system compatibility.
2. UL 1481: This listing is particularly for fire protective signaling UPS systems. UL 1481-certified UPS units ensure that they can continuously supply power to fire alarm control panels and emergency signaling systems as per National Fire Protection Association (NFPA) requirements

I. The UPS shall have the following features and characteristics:

1. Rating: As required based on tender specifications
2. Type: True Online on voltage, frequency and phase angel. Undetected by computer, modem, network loads, etc. There shall be no break in the supply upon main failure
3. Battery Backup: 10 minutes' backup on full load or as specified
4. Voltage: 230V A.C., 5%; single phase
5. Frequency: 50-60 Hz, 1%
6. Power factor: unity to 0.7 lagging
7. Static Transfer Switch: transfer time 100ms, detection time 4.2 ms max.
8. Efficiency: >95% under normal conditions.
9. Input Protection: circuit breaker and fuse
10. Output Protection: Automatic current and over voltage protection.
11. Control: To provide control of UPS for the following:

a. UPS/bypass transfer/re-transfer switch.
b. Emergency shutdown push button
c. Self-Diagnostic Test: To provide diagnostic aids to facilitate test and troubleshooting.

1124.2.9 Server Computer

A. The system server computer shall comprise of the following minimum hardware:

- A XEON Processor (provide an equivalent version during the time of installation) at 55 MB cache, 22 cores, 44 threads, 145.0w Max TDP, 2.40 GHz clock speed and 3.60 GHz max turbo frequency
- 8 GB of RAM
- A Super VGA graphics card capable of 1080x720 pixel resolution and 65K colors, non-interlaced (70 Hz or better vertical refresh rate).)
- A 12 function-key keyboard
- Mouse pointing device
- A 2 TB Hard disk drive
- 500 GB SSD (for operating system faster operation)
- A SCSI CD/DVD rewritable
- An 8-line serial communications adapter
- An Adapter for Ethernet Networking compatible with TCP/IP network protocols
- Minimum of 2 ports type A USB
- 21” Colored LED Monitor

1124.2.10 Product Delivery and Storage

A. Deliver and store security system equipment in undamaged factory packaging according to the requirements of Item 1116.

B. Store security system equipment on elevated platforms in a clean, dry location. Protect from dirt, water, construction debris, and traffic.

1124.2.11 Badge Printer

Printing Method	Color Dye Sublimation / Monochrome Thermal Transfer
Resolution	300 dpi x 300 dpi
Display	LCM control panel
Memory	32MB ; 1MB Flash (Minimum)
Printing Speed	Speed Mode: 25 sec per YMCKO single side Premium photo mode: 32 sec per YMCKO printing (Minimum)

Accepted Card Specification	Size: CR-80 86mm(L) x 54mm(W) / 3.375"(L) x 2.125"(W) Thickness : 0.3 mm* to 1.0 mm / 10 mil* to 40 mil * 0.3mm (10mil) only supports single side printing
Card Input Capacity	100 Cards (0.76 mm / 30 mil thickness)
Card Out Capacity	100 Cards (0.76 mm / 30 mil thickness)
Software Driver	Current Windows softtware sold by Microsoft during the time of activation
Communication Interface	USB 1.1 / USB 2.0 full speed, USB 3.0 and above
System Requirement	Current Windows software sold by Microsoft during the time of activation Computer with 128MB of RAM or higher, 100 MB free hard disk space or higher
Power Supply	100 ~ 240 VAC; 50Hz ~ 60Hz
Operating Condition	10° ~ 32° C / 59° to 89.6°F; 20 ~ 75% non-condensing
Ribbon Options	YMCKO (200 prints) Resin K (1,000 prints) KO (500 prints) YMCKOK (170 prints)
Optional Encoding Modules (SDK upon request)	ISO Magnetic stripe card encoder, Dual high- and low-coactivity, Track 1, 2 and 3. Contact Smart Card Encoding Module Contactless Smart Card Encoding Module (Mifare ISO 14443 type A available)

1124.2.12 System Software

A. System Software: Based on 64-bit, Microsoft Windows central-station and workstation operating system and application software. Software shall have the following features:

1. Multiuser multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
2. Graphical user interface to show pull-down menus and a menu tree format.
3. Capability for future additions within the indicated system size limits.
4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
5. Password-protected operator login and access.

B. Peer Computer Control Software: Shall detect a failure of a central computer, and shall cause the other central computer to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.

C. Application Software: Interface between the alarm annunciation and entry-control Controllers, to monitor sensors and DTS links, operate displays, report alarms, generate reports, and help train system operators. Software shall have the following functions:

1. Resides at the Central Station, workstations, and Controllers as required to perform specified functions.
2. Operate and manage peripheral devices.
3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
4. Import custom icons into graphics views to represent alarms and I/O devices.
5. Globally link I/O so that any I/O can link to any other I/O within the same Location, without requiring interaction with the host PC. This operation shall be at the Controller.
6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host PC. This operation shall be at the Controller.
7. Messages from PC to Controllers and Controllers to Controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
8. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other PC-to-Controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
9. Automatic and encrypted backups for database and history backups shall be automatically stored at the central control PC and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
10. Operator audit trail for recording and reporting all changes made to database and system software.

D. Workstation Software:

1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is

unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

E. Controller Software:

1. Controllers shall operate as an autonomous intelligent processing unit. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door locking schedules for its operation, independent of other system components. Controllers shall be part of a fully distributed processing control network. The portion of the database associated with a Controller and consisting of parameters, constraints, and the latest value or status of points connected to that Controller, shall be maintained in the Controller.
2. Functions: The following functions shall be fully implemented and operational within each Controller:

    a. Monitoring inputs.
    b. Controlling outputs.
    c. Automatically reporting alarms to the Central Station.
    d. Reporting of sensor and output status to Central Station on request.
    e. Maintaining real time, automatically updated by the Central Station at least once a day.
    f. Communicating with the Central Station.
    g. Executing Controller resident programs.
    h. Diagnosing.
    i. Downloading and uploading data to and from the Central Station.

3. Controller Operations at a Location:

    a. Location: Up to 64 Controllers connected to RS-485 communications loop. Globally operating I/O linking and anti-passback functions between Controllers within the same Location without central-station or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the Central Station or workstations are off line.
    b. In the event of communications failure between the Central Station and a Location, there shall be no degradation in operations at the Controllers at that Location. The Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
    c. Buffered events shall be handled in a first-in-first-out mode of operation.

4. Individual Controller Operation:

   a. Controllers shall transmit alarms, status changes, and other data to the Central Station when communications circuits are operable. If communications are not available, Controllers shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the Central Station, shall be stored for later transmission to the Central Station. Storage capacity for the latest 1024 events shall be provided at each Controller.
   b. Card-reader ports of a Controller shall be custom configurable for at least 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different Controllers or within the same Controller.
   c. Controllers shall provide a response to card-readers or keypad entries in less than 0.25 seconds, regardless of system size.
   d. Controllers that are reset, or powered up from a non-powered state, shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
   e. Initial Startup: When Controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each Controller.
   f. Failure Mode: On failure for any reason, Controllers shall perform an orderly shutdown and force Controller outputs to a predetermined failure mode state, consistent with the failure modes shown and the associated control device.
   g. Startup After Power Failure: After power is restored, startup software shall initiate self-test diagnostic routines, after which Controllers shall resume normal operation.
   h. Startup After Controller Failure: On failure, if the database and application software are no longer resident, Controllers shall not restart, but shall remain in the failure mode until repaired. If database and application programs are resident, Controllers shall immediately resume operation. If not, software shall be restored automatically from the Central Station.

5. Communications Monitoring:

   a. System shall monitor and report status of RS-485 communications loop of each Location.

b. Communication status window shall display which Controllers are currently communicating, a total count of missed polls since midnight, and which Controller last missed a poll.
c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM memory for each Controller.

6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the Central Station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

F. PC-to-Controller Communications:

1. Central-station or workstation communications shall use the following:

a. Direct connection using serial ports of the PC.
b. TCP/IP LAN network interface cards.
c. Dial-up modems for connections to Locations.

2. Serial Port Configuration: Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only"; or as an ASCII output port.
3. Multiport Communications Board: Use if more than two serial ports are needed.

a. Expandable and modular design. Use a 4-, 8-, or 16-serial port configuration that is expandable to 32 or 64 serial ports.
b. Connect the first board to an internal PCI bus adapter card.

4. Direct serial, TCP/IP, and dial-up communications shall be alike in the monitoring or control of system, except for the connection that must first be made to a dial-up Location.
5. TCP/IP network interface card shall have an option to set the poll frequency and message response time-out settings.
6. PC-to-Controller and Controller-to-Controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications shall be verified and buffered and retransmitted if not acknowledged.

G. Direct Serial or TCP/IP PC-to-Controller Communications:

1. Communication software on the PC shall supervise the PC-to-Controller communications link.
2. Loss of communications to any Controller shall result in an alarm at all PCs running the communications software.
3. When communications are restored, all buffered events shall automatically upload to the PC, and any database changes shall be automatically sent to the Controller.

H. Controller-to-Controller Communications:

1. Controller-to-Controller Communications: RS-485, 4-wire, point-to-point, regenerative (repeater) communications network methodology.
2. RS-485 communications signal shall be regenerated at each Controller.

I. Database Downloads:

1. All data transmissions from PCs to a Location, and between Controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
2. If a Controller is reset for any reason, it shall automatically request and receive a database download from the PC. The download shall restore data stored at the Controller to their normal working state and shall take place with no operator intervention.

J. Operator Interface:

1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.

6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:

    a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
    b. Maps to provide real-time display animation and allow for control of points assigned to them.
    c. System to allow inputs, outputs, and override groups to be placed on different maps.
    d. Software to allow changing the order or priority in which maps will be displayed.

7. Override Groups Containing I/Os:

    a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
    b. Icon shall change automatically to show the live summary status of points in that group.
    c. Override group icon shall provide a method to manually control or set to time zone points in the group.
    d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.

8. Schedule Overrides of I/Os and Override Groups:

    a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
    b. Each schedule shall be composed of a minimum of two dates with separate times for each date.
    c. The first time and date shall be assigned the override state that the point shall advance to, when the time and date become current.
    d. The second time and date shall be assigned the state that the point shall return to, when the time and date become current.

9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.

K. Operator Access Control:

1. Control operator access to system controls through three password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
3. A minimum of 32 passwords shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
4. The password shall not be displayed or printed.
5. Each password shall be definable and assignable for the following:

    a. Commands usable.
    b. Access to system software.
    c. Access to application software.
    d. Individual zones that are to be accessed.
    e. Access to database.

L. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged and processing shall start in not less than 1 second(s).
3. Tasks that are executed by operator's commands shall include the following:

    a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
    b. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
    c. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.
    d. System Test: Allows the operator to initiate a system-wide operational test.
    e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
    f. Print reports.
    g. Change Operator: Used for changing operators.

h. Security Lighting Controls: Allows the operator to remotely turn on/off security lights.

i. Display Graphics: Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.

j. Run system tests.

k. Generate and format reports.

l. Request help with the system operation.

1) Include in main menus.
2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
3) Provide navigation to specific topic from within the first help window.
4) Help shall be accessible outside the applications program.

m. Entry-Control Commands:

1) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.
2) Arm or disarm each monitored input up to four times a day through time-zone programming.
3) Enable or disable readers or keypads up to twice a day through time-zone programming.
4) Enable or disable cards or codes up to four times per day per entry point through access-level programming.

4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:

a. Command entered is incorrect or incomplete.
b. Operator is restricted from using that command.
c. Command addresses a point that is disabled or out of service.
d. Command addresses a point that does not exist.
e. Command is outside the system's capacity.

M. Alarms:

1. System Setup:

   a. Assign manual and automatic responses to incoming point status change or alarms.
   b. Automatically respond to input with a link to other inputs, outputs, operator-response plans, unique sound with use of WAV files, and maps or images that graphically represent the point location.
   c. 60-character message field for each alarm.
   d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages.
   e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
   f. Allow 25 secondary messages with a field of 4 lines of 60 characters each.
   g. Store the most recent 1000 alarms for recall by the operator using the report generator.

2. Software Tamper:

   a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
   b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond their authorization level.
   c. Maintain a transcript file of the last 5000 commands entered at each Central Station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
   d. Allow only acknowledgment of software tamper alarms.

3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
5. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.

6. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
7. Alarm Automation Interface: High-level interface to Central Station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in same manner as burglar alarms, using an RS-232 ASCII interface.

N. Alarm Monitoring: Monitor sensors, Controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.

1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
3. Maps shall automatically display the alarm condition for each input assigned to that map, if that option is selected for that input location.
4. Alarms initiate a status of "pending" and require the following two handling steps by operators:

    a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
    b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.

5. Each workstation shall display the total pending alarms and total unresolved alarms.
6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
7. Alarms shall transmit to Central Station in real time.
8. Alarms shall be displayed and managed from a minimum of four different windows.

    a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.

b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.

9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
12. Identical alarms from same alarm point shall be acknowledged at same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
13. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and Controllers.
14. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

O. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.

1. Color Code:

a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
c. YELLOW: Advises operator that a zone is in access.
d. GREEN: Indicates that a zone is secure and that power is on.

2. Graphics:

a. Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from

another drawing or graphics program.

b. Allow I/O to be placed on graphic maps by the drag-and-drop method.

c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on graphic map.

d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic map associated with inputs or outputs.

e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.

f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.

g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

P. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.

1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.

Q. Report Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest priority activity. Report generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.

1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of period; and the default printer.
2. Printing on Requests: An operator may request a printout of any report.
3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm such as door alarm, intrusion alarm, tamper alarm, etc. the type of sensor, the location, the time, and the action taken.
4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.

5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
10. Who Is In (Muster) Report:

    a. Emergency Muster Report: One click operation on toolbar launches report.
    b. Cardholder Report. Contain a count of persons that are "In" at a selected Location and a count with detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.

11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that they are available on-site at all times.
12. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events or alarms only.
13. History Reports: Custom reports that allows the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.

    a. Initially store history on the hard disk of the host PC.
    b. Permit viewing of the history on workstations or print history to any system printer.
    c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
    d. Each report shall depict the date, time, event type, event description, device, or I/O name, cardholder group assignment, and cardholder name or code number.
    e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
    f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.

14. Reports shall have the following four options:

    a. View on screen.
    b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to system.
    c. "Save to File" with full path statement.
    d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

15. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:

    a. Active, inactive, or future activate or deactivate.
    b. Code number, name, or imprinted card number.
    c. Group, Location, access levels.
    d. Start and stop code range.
    e. Codes that have not been used since a selectable number of days.
    f. In, out, or either status.
    g. Codes with trace designation.

16. The reports of system database shall allow options so that every data field may be printed.
17. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.

R. Anti-Passback:

1. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.
2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.
3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.
4. Timed Anti-Passback: A Controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.

5. Provide four separate zones per Location that can operate without requiring interaction with the host PC (done at Controller). Each reader shall be assignable to one or all four anti-passback zones. In addition, each anti-passback reader can be further designated as "Hard," "Soft," or "Timed" in each of the four anti-passback zones. The four anti-passback zones shall operate independently.
6. The anti-passback schemes shall be definable for each individual door.
7. The Master Access Level shall override anti-passback.
8. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential holder population anti-passback status to a neutral status.

S. Visitor Assignment:

1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only access levels that have been designated as approved for visitors.
2. Provide an automated log of visitor name, time and doors accessed, and whom visitor contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. Security access system shall be able to restrict the access levels that may be assigned to credentials that are issued to visitors.
5. Allow operator to recall visitors' credential holder file, once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

T. Time and Attendance:

1. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
2. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
3. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.

    a. Reports shall show in and out times for each day, total in time for each day, and a total in time for period specified by the user.

b. Allow the operator to view and print the reports, or save the report to a file.

c. Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.

U. Training Software: Enables operators to practice system operation including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

V. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. The enrollment station shall not have alarm response or acknowledgment functions.
2. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
3. The program shall provide means to disable the enrollment station when it is unattended to prevent unauthorized use.
4. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
5. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
   a. MASK: Determines a specific format that data must comply with.
   b. REQUIRED: Operator is required to enter data into field before saving.
   c. UNIQUE: Data entered must be unique.
   d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
   e. NAME ID: Data entered will be considered a unique ID for the cardholder.

6. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
7. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
8. Batch card printing.
9. Default card data can be programmed to speed data entry for sites where most card data are similar.
10. Enhanced ACSII File Import Utility: Allows the importing of cardholder data and images.
11. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

1124.2.13 System Database

A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.

B. Database Operations:

1. System data management shall be in a hierarchical menu tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
2. Navigational Aids:

    a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
    b. Point and click feature to facilitate data manipulation.
    c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
    d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.

3. All data entry shall be automatically checked for duplicate and illegal data and shall verify that data are in a valid format.
4. Provide a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose the item was entered for, reasons for changes that were made, and the like.

C. File Management:

1. Provide database backup and restoration system, allowing

selection of storage media, including 3.5-inch floppy disk, Zip and Jaz drives, and designated network resources.

2. Provide manual and automatic mode of backup operations. The number of automatic sequential backups before the oldest backup becomes overwritten; FIFO mode shall be operator selectable.
3. Backup program shall provide manual operation from any PC on the LAN and shall operate while system remains operational.

D. Operator Passwords:

1. Software shall support up to 32,000 individual system operators, each with a unique password.
2. Operator Password: Alphanumeric Characters
3. Allow passwords to be case sensitive.
4. Passwords shall not be displayed when entered.
5. Provide each password with a unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:

    a. Allow for at least 32,000 operator password profiles.
    b. Predetermine the highest-level password profile for access to all functions and areas of program.
    c. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
    d. Restrict which doors an operator can assign access to.

6. Operators shall use a user name and password to log on to system.

    a. This user name and password is used to access database areas and programs as determined by the associated profile.

7. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.

E. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).

1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.

2. Use data-entry windows to view, edit, and issue access levels. Access authorization entry management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.
6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
8. Visitor Access: Issue a visitor badge, without assigning that person a card or code, for data tracking or photo ID purposes.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visual annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Allow each cardholder to be given either an unlimited number of uses or a number from 1 to 9998 that regulates the number of times the card can be used before it is automatically deactivated.
11. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

F. Security Access Integration:

1. Photo ID badging and photo verification shall use same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
2. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
3. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

G. Key control and tracking shall be an integrated function of cardholder data.

1. Provide the ability to store information about which conventional metal keys are issued and to whom, along with key construction information.
2. Reports shall be designed to list everyone that has possession of a specified key.

H. Facility Codes: System shall accommodate up to 2048 facility codes per Location, with the option of allowing facility codes to work at all doors or only particular doors.

I. Operator Comments:

1. With the press of one appropriate button on toolbar, the user shall be permitted to make operator comments into history at anytime.
2. Automatic prompting of operator comment shall occur before the resolution of each alarm.
3. Operator comments shall be recorded by time, date, and operator number.
4. Comments shall be sorted and viewed through reports and history.
5. The operator may enter comments in two ways; either or both may be used:

    a. Manually entered through keyboard data entry (typed), up to 65,000 characters per alarm.
    b. Predefined and stored in database for retrieval on request.

6. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

J. Group:

1. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
2. System software shall have the capacity to assign 1 of 32,000 group names to an access authorization.
3. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
4. Allow sorting of history reports and code list printouts by group name.

K. Time Zones:

1. Each zone consists of a start and stop time for 7 days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.

3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
4. System shall have the capacity for 2048 time zones for each Location.
5. System clock shall be synchronized from a stable world time server.

L. Holidays:

1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time zone schedule for that 24-hour period.
2. System shall have the capacity for 32,000 holidays.
3. Three separate holiday schedules may be applied to a time zone.
4. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in system and will not be purged.
5. Holidays not designated to occur each year shall be automatically purged from database after the date expires.

M. Access Levels:

1. System shall allow for the creation up to 32,000 access levels.
2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
3. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
4. System shall be able to create multiple door and time zone combinations under same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same Controller.

N. User-Defined Fields:

1. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
2. System shall accommodate a title for each field; field length shall be 20 characters.
3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.

4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include search for a character string.
8. System shall have the ability to print cardholders based on and organized by the user-defined fields.

O. Code Tracing:

1. System shall perform code tracing selectable by cardholder and by reader.
2. Any code may be designated as a "traced code" with no limit to how many codes can be traced.
3. Any reader may be designated as a "trace reader" with no limit to which or how many readers can be used for code tracing.
4. When a traced code is used at a trace reader, the access-granted message that usually appears on the monitor window of the Central Station shall be highlighted with a different color than regular messages. A short singular beep shall occur at the same time the highlighted message is displayed on the window.
5. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.

1124.3 EXECUTION

1124.3.1 Installation

A. All wiring shall be in a complete conduit system separate from other building wiring. Wiring color code shall be maintained throughout the scope of the work.

B. Installation equipment and services that pertain to other work in the Contract shall be closely coordinated with the appropriate Contractors.

C. Space provision for camera mounting and wiring facilities shall be by the Lift Contractor, and the Security System Contractor shall ensure that all details are coordinated with the Lift Contractor.

D. Coordinate with Builder to ensure that:

1. All required building penetrations are provided, otherwise provide details (eg: drawings)
2. Trimming shall be provided for all ceilings and walls where security detection devices and cables are required provide details.
3. Interfaces between motorized doors and the Security System are fully compatible, fully commissioned and tested, and provide all the control, monitoring signals and information required by the Security System.

E. Coordinate with the Elevator Contractor to ensure that:

1. Low level elevator interfaces provided for communications between the elevator systems and Security System are fully compatible, fully commissioned and tested, and provide all the control, monitoring signals and information required by the Security System.
2. Adequate and suitable provision is made for the mounting of the equipment in each elevator car.
3. Inter-system cabling is properly labeled and terminated in an agreed fashion and fully documented to a level satisfactory to both Contractors.
4. All cabling run in riser shafts, on cable trays, in ducts, conduits, etc., from the elevator motor room to the security/elevator demarcation junction boxes are done in an orderly and neat fashion and which allows clear identification and segregation of the cable looms.
5. Location of intercom within the Security Control Room (on console) and associated installation is in accordance with the Security Control Room design.
6. The systems are tested and commissioned successfully.

F. Coordinate with the Electronics Contractor to ensure that:

1. No conflict occurs between cable conduit or cable tray routes for the two services.
2. Sufficient essential supply is supplied and installed to meet the requirements of the Security System Contractor.
3. The cabling is terminated in an agreed fashion and documented to a level satisfactory to both Contractors.
4. All cabling are done in an orderly and neat fashion and which allows clear identification and segregation of the cabling looms.
5. The systems are tested and commissioned successfully.
6. All interfaces are fully documented to the satisfaction of the Security System and Electronics Contractors.

G. Coordinate with the Fire Alarm Contractor to ensure that:

1. Interfacing compatibility between the Security and Fire System is achieved.
2. The Security and Fire Systems are fully operational and have been tested and commissioned fully and meets the requirements of this Specification.
3. Inter-system cabling is terminated in an agreed fashion and documented to a level satisfactory to both Contractors.
4. Junction boxes, properly labeled termination strips, conduits, cables are suitably located for the Security-Fire system interface.
5. Location of intercom within the Security Control Room (on console) and associated installation is in accordance with the Security Control Room design.
6. All Fire-Security interfaces are fully documented to the satisfaction of the Security System and Fire Contractors.

H. The manufacturer's authorized representative shall provide all on-site software modifications and supervision of installation of the complete Security System installation, perform a complete functional test of the system, and submit a written report to the Project Manager attesting to the proper operation of the complete system.

I. Unless specified otherwise, the manufacturer's recommendations shall be followed with regard to workmanship and associated materials, equipment, components and devices, whether or not the particular manufacturer has been specified.

J. Where equipment and materials enter in environmental condition e. g. temperature, humidity, rain, fog, steam, etc., all said materials, equipment, components and devices which could be affected by such shall be selected and installed to ensure satisfactory operation.

K. The layout, dimensions and positions of equipment shown on the Drawings are diagrammatic and indicative only and exact positions shall be determined on site.

L. Variations of positions shall be affected without cost variation if the change is advised before the equipment is cabled and it is not more than ten (10) meters distant.

M. All equipment and/or appliances provided under this Specification shall be designed so that no interference shall cause to any radio or other electronic transmitting or receiving equipment in the same locality. In the event of the inherent characteristics of the electrical installation being such that interference is possible efficient devices capable of eliminating such interference shall be provided by the Security System Contractor.

N. Equipment supplied and installed shall be such that interference from outside sources (magnetic, electrical or EMI noise distortion, etc.) shall not be accepted as reasons for non-operational equipment or systems.

ITEM 1125 EQUIPMENT MONITORING AND CONTROL SYSTEM (CONTROLLERS AND SOFTWARE)

1125.1 GENERAL

1125.1.1 Work Included

Provide an Equipment Monitoring and Control System (EMCS) in accordance with the Contract Documents.

1125.1.2 General System Architecture

A. The Equipment Monitoring and Control System (EMCS) shall comprise of the monitoring, control and operator interfaces to perform supervision or direct digital control of specified equipment.

B. The Equipment Monitoring and Control System Contractor shall provide a totally integrated Equipment Monitoring and Control system.

C. The function of the EMCS shall include monitoring and control of the system as specified in this document.

D. The work covered by this specification includes the design, supply, installation, testing and commissioning of the complete operational integrated Equipment Monitoring and Control system.

E. The Equipment Monitoring and Control System Contractor shall furnish all labor, materials, equipment and devices necessary to complete the EMCS system installation.

F. The intent of this specification is to provide a complete distributed direct digital control (DDC) system. The network controllers and individual local controllers shall be selected so that each mechanical system operation is completely standalone. Each system operation, such as VRF fan coil units, air condensing control unit, air handling units, fans, etc. will be controlled by a single standalone DDC controller.

G. The EMCS shall consist of modular microcomputer controllers providing distributed processing capability, and allowing future expansion of both input/output points and processing control functions. The system shall have capabilities to expand and control a 10% increase in points without any degrading of system performance.

H. In no circumstance shall multiple application controllers be employed to control a single piece of equipment.

I. Provide network interface modules or connections to third party controllers which are supplied as part of their equipment to achieve the level of interface specified in the control diagrams on the drawings.

Provide interface software, coordinated with the third-party protocols, to achieve the specified interface communication across the full EMCS.

J. It is intended that the Central Control Centre have access to all systems and information in the entire complex through the System Access Control (see Article 2.3) using a level of authority which will be established to accomplish this.

K. The EMCS shall effectively manage the facility and its activities to optimize the operation of HVAC systems to minimize energy consumption and extend equipment life during variations in occupancy, loads, schedules and weather conditions.

L. The EMCS shall operate on a management by exception concept, enabling automatic operation and requiring minimal manual intervention and supervision.

M. The modular design of the system software and hardware shall ensure easy maintenance and repairability. Self-diagnostic programs shall report errors without the need for operator interrogation. Maintenance on one module shall not affect the operation of other system components.

N. Coordinate with other trades for the actual location of main equipment and sequence of operation.

O. Server Hot Backup

1. This facility shall enable the system server to operate in a high availability architecture with no single point of failure. To achieve this, the facility must provide specific features.
2. The system must be capable of running a pair of similarly configured computers in a hot backup configuration where at any point in time, one is the acting Primary and the other the acting as the Hot Backup. An on-line database duplication mechanism must be supported.
3. Simply scanning I/O on two separate systems and processing independently is not acceptable. The database duplication must be performed on a per-transaction basis for two reasons:

    - To ensure that the duplicated Backup database is consistent at all times with the Primary database
    - To avoid unnecessary loading of field devices caused by duplicate polling

4. It must be possible to remove one of the redundant systems for maintenance without interrupting operation, and upon its reinstatement, re-synchronize the databases, again without interruption to system operation. A method of manually

initiating a failover must be provided to assist with such maintenance operations.

5. Failure of either system must be announced audibly and visually via the alarming subsystem.

   To accommodate recoverable faults, the failed system must be able to reboot automatically after non-fatal errors and assume the role of acting as Hot Backup automatically.

P. Communications Redundancy

The system must be capable of supporting fully duplicated communications links to Operator Workstations and field devices that support this type of connection.

Capabilities must exist to interface to devices via:

- Direct Serial Connection (or modem)
- Serial Connection via Ethernet connected terminal servers. Using back-to-back terminal servers will be deemed unacceptable. The system must be able to directly communicate with the Terminal servers via Ethernet.

The system and its associated Operator Workstations must be capable of connecting to two fully independent Ethernets run in parallel. No repeater or bridge connection between the Ethernets is acceptable as a means of achieving this function.

Operator Workstations must be capable of switching automatically between the two server computers in the event of a failover, and switching between two Ethernets automatically in the event of an Ethernet failure.

Q. Distributed System Servers

A method shall be provided for monitoring and control of points on remote EMCS servers. Specifically, real-time and history values in any EMCS server must be available to any other server for monitoring and control. Features supported must include:

- **Access**: Access to data shall be global, such that users at Operator Workstations on one server can access data, history, point detail displays, etc. for points on any other server. It shall not be necessary to configure more than one point for each data value or signal, regardless of the number of servers accessing the data.
- **Security/Filtering**: It shall be possible to nominate sets of points to be accessed on a server by server and user by user basis. The mechanism shall be the same as the mechanism to control individual operator and workstation access to data for single server systems.

- **Alarms / Messages**: Operators and workstations at any server must be able to see from any other server. It shall not be necessary to configure alarms more than once, regardless of the number of servers accessing the data.
- **Trending**: It shall be possible to configure real time and historical trends that combine data from any connected server on a single trend. It shall not be necessary to configure more than one point for each data value or signal, regardless of the number of servers accessing the data.
- **Graphics / Reports / Applications**: All graphics, reports, and applications at a server shall have the same distributed access to data on other servers as described above for operators and workstations. It shall not be necessary to configure more than one point for each data value or signal, regardless of the number of servers accessing the data.

  The engineering effort to configure points in a distributed server system shall be the same as for a single server system.

  Connections between servers can be made through local Ethernet connections, the plant's LAN, or the corporate WAN. Connections must be optionally redundant. Both redundant and non-redundant servers must be supported, and the same engineering effort (i.e., none) must be required to connect both kinds of servers.

R. Network

The Server Computer and Operator Workstation hardware shall be capable of interfacing to an IEEE 802.3 Standard Local Area Network (LAN).

The LAN shall use standard network cables. Acceptable cable types are:

- Ethernet
- Fiber
- Twisted Pair

S. The EMCS shall be provided with Uninterruptible Power Supply (UPS) system.

1125.1.3 Quality Assurance

A. EMCS work shall be performed by one firm specializing in the manufacture and installation of control system for building environmental control. The EMCS Contractor shall have minimum of 10 years' experience in the Equipment Monitoring and Control system installation and shall have at least 10 completed and ongoing EMCS project in the Philippines.

B. Products referenced under this section establish the minimum acceptable standards of products quality, features and performance.

1. Codes:

a. Philippine Electrical Code (PEC 2000 Edition)
b. National Electrical Code (NEC 1999 Edition)
c. Philippine Fire Code (PFC Revised Edition) (IRR No. RA9514)
d. Philippine Society of Mechanical Engineers Code (PSME)
e. National Fire Protection Code (NFPC)
f. Uniform Plumbing Code (UPC 1991)
g. National Plumbing Code of the Philippines (NDCP)
h. Applicable Local Ordinances
i. Revised National Building Code and its IRR
j. Philippine Electronics Code (PECE)

2. Standards

a. Underwriters Laboratories (UL)
b. American Society for Testing and Materials (ASTM)
c. National Electrical Manufacturers Association (NEMA)
d. National Fire Protection Association (NFPA)
e. Institute of Electrical and Electronics Engineers (IEEE)
f. American National Standards Institute (ANSI)
g. American National Standards Institute (ANSI)
h. International Electro-Technical Commission (IEC)
i. American Society of Mechanical Engineers (ASME)
j. Factory Mutual Engineering Corps (FMEC)
k. International Standard Organization (ISO 9001)
l. Other Internationally Accepted Standards

C. The equipment and software provided by the supplier shall be the latest version currently in the manufacture. No custom product shall be allowed.

D. Static, transient, and short circuit protection on all inputs and outputs.

E. Communication lines protected against in-correct wiring, static transient and induced magnetic interference.

F. Bus connected devices shall be A.C. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.

G. All controllers (DDC's) shall have real time clocks and data file ram to be battery-backed for a minimum of 72 hours.

H. Acceptable UL listed (Bears Logo) products and manufacturers are the following manufacturers listed at Section 17007.

I. Engineer in-charge supervising the work shall be a duly Registered Electronics Engineer under the supervision of a Professional Electronics Engineer as required by R.A. 9292 and revised National Building Code.

1125.1.4 Submittals

A. The Contractor shall make the following submittals.

1. Shop drawings
2. Samples of controlling devices including technical brochures.
3. Input/Output Summary form that include:

   a. Description of all points.
   b. Listing of binary and analog hardware required to interface to the equipment for each function.
   c. Listing of all applicable programs associated with each piece of equipment.

4. Software Package

   a. Graphic flow diagram for each software program proposed.

B. Project Specific Manual

Reference manuals for the system shall include the following categories: User's Manual, Engineering Handbook and software documentation. Project Specific Manuals shall include detailed information describing the specific installation at this project.

C. Submit 5 sets of final as-built documentation including the above items and complete with troubleshooting procedures.

D. Provide final documentation to serve the diverse needs of personnel concerns with instruction, operation, procurement, installation and maintenance.

E. Shop drawing and final documentation will be reviewed to ensure that such documents are in keeping with the intent of this specification and fully meet the requirements in terms of content and format. Make all required changes to this documentation at no additional cost.

F. Delivery of the final approved documentation, in hardcore 5 mg binders with index page and index tabs, is required before the certificate of submittals completion will be issued.

G. Maintain a complete and current copy of all reviewed shop drawings at the job site.

1125.2 PRODUCTS

1125.2.1 Server Computer

A. The system server computer shall comprise of the following minimum hardware:

- A XEON Processor (provide an equivalent version during the time of installation) at 55 MB cache, 22 cores, 44 threads, 145.0w Max TDP, 2.40 GHz clock speed and 3.60 GHz max turbo frequency
- 8 GB of RAM
- A Super VGA graphics card capable of 1024x768 pixel resolution and 65K colors, non-interlaced (70 Hz or better vertical refresh rate).)
- A 12 function-key keyboard: Qwerty, 105 keys in ergonomic shape
- Mouse pointing device: Three button optical
- A 2 TB Hard disk drive
- 500 GB SSD (for operating system faster operation)
- A SCSI CD/DVD rewritable
- An 8-line serial communications adapter
- An Adapter for Ethernet Networking compatible with TCP/IP network protocols
- 32” Colored LED monitor

1125.2.2 OPERATOR WORKSTATION

A. The system shall be capable of supporting up to 40 simultaneous Operator Workstation connections using a TCP/IP Local Area Network (LAN) subject to hardware capacity on the server computer. The Network connection must allow a limitless number of casual users access to the 40 connections on a first-come-first-served basis.

B. The Operator Workstation shall comprise the following minimum hardware:

- A Core i7 (provide an equivalent version during the time of installation) at 3 GHz clock, 64 bit, 24MB cache
- 4 GB RAM
- A Super VGA graphics card capable of 1024x768 pixel resolution and 65K colors, non-interlaced (70 Hz or better vertical refresh rate).)
- A 2 TB Hard disk drive
- 500 GB SSD hard drive (for operating system faster operation)
- A 12 function-key keyboard
- A mouse pointing device

- An Adapter for Ethernet Networking compatible with TCP/IP network protocols
- Minimum of 2 ports type A U
- 32" colored LED monitor

1123.2.3 L2 (Layer 2) Switch with SFP (Small Form-Factor Pluggable) Ports

A. General

1. Switching Capacity: 48 Gbps – 176 Gbps
2. Forwarding Rate: 35.7 Mpps – 41.7 Mpps

B. Ports

1. Ethernet Ports: 24-48 x 10/100/1000 Mbps RJ-45 ports
2. SFP Ports: 4 x SFP (1/10GbE) ports for fiber uplinks

C. Performance

1. MAC Address Table: 8K entries
2. VLANs: Supports up to 256 VLANs
3. Link Aggregation: Supports up to 8 groups, 8 ports per group
4. STP: IEEE 802.1D STP, IEEE 802.1w RSTP, IEEE 802.1s MSTP
5. QoS: 802.1p QoS, DSCP, 8 priority queues

D. Security

1. Port Security: MAC-based port security, Dynamic Host Configuration Protocol (DHCP) snooping, and Dynamic ARP protection.
2. ACLs: L2/L3/L4 ACLs,
3. 802.1X: Port-based authentication, MAC-based authentication

E. Management

1. Interface: Web GUI, CLI, SNMP v1/v2c/v3
2. Remote Management: Telnet, SSH, HTTP/HTTPS
3. Firmware Upgrades: TFTP/FTP/HTTP

F. Physical and Environmental

1. Form Factor: 1U rack-mountable
2. Power Supply: Internal power supply, optional PoE
3. Operating Temperature: 0°C to 50°C
4. Dimensions: 440 x 220 x 44 mm
5. Weight: 3.2-3.65 kg

H. UL Listing (for reliability and safety)

1. UL 864: Applies to equipment used in fire alarm and signaling systems. If a Layer 2 switch is critical to fire protective signaling (e.g., connected to fire alarm control panels or public address systems), it may need UL 864 certification to meet fire protection standards
2. UL 60950-1 or UL 62368-1: Safety standards for IT and telecommunications equipment. For general network reliability, UL 60950-1 or UL 62368-1 listings are often sought for switches used in data infrastructure, although they do not necessarily cover fire protective signaling.

1123.2.4 Uninterruptible Power Supply (UPS)

The Contractor shall provide the following:

A. The UPS final capacity shall be proposed and calculated by the Contractor when all systems equipment loading is known and multiple by 20%. The Contractors shall supply, install and test complete sets of UPS with chargers, batteries, cabinet, etc.

B. The UPS shall consist of maintenance free standby batteries and adequate chargers.

C. The UPS shall have maintenance free batteries equipped with battery charger. The battery shall be sealed lead acid type and shall be suitable for continuous standby duty. Cable lugs shall be soldered on to cables, crimping shall not be permitted.

D. All flux residues shall be thoroughly cleaned from the termination and cables. Anticorrosion coatings shall be applied to the terminals and lugs.

E. The battery charger shall be capable of restoring the battery from a fully discharged state, to a fully charged state, within a period of twelve hours after restoring of supply. It should also be equipped with trickle charge.

F. The main supply shall be monitored from the output of the chargers but isolated from the battery. It shall also be fail-safe.

G. The UPS shall have the cabinet to house the battery charger and the batteries. It shall be well ventilated.

H. For NFPA 72 compliance, the UPS should have a UL listing that indicates it is suitable for use in fire alarm systems. Specifically, the relevant UL listing would be:

1. UL 1778: This is the standard for Uninterruptible Power Systems. A UPS with this listing ensures it meets the necessary

safety standards for electrical equipment but may not specifically address fire alarm system compatibility.

2. UL 1481: This listing is particularly for fire protective signaling UPS systems. UL 1481-certified UPS units ensure that they can continuously supply power to fire alarm control panels and emergency signaling systems as per National Fire Protection Association (NFPA) requirements

I. The UPS shall have the following features and characteristics:

1. Rating: As required based on tender specifications
2. Type: True Online on voltage, frequency and phase angel. Undetected by computer, modem, network loads, etc. There shall be no break in the supply upon main failure
3. Battery Backup: 10 minutes' backup on full load or as specified
4. Voltage: 230V A.C., 5%; single phase
5. Frequency: 50-60 Hz, 1%
6. Power factor: unity to 0.7 lagging
7. Static Transfer Switch: transfer time 100ms, detection time 4.2ms max.
8. Efficiency: >95% under normal conditions.
9. Input Protection: circuit breaker and fuse
10. Output Protection: Automatic current and over voltage protection.
11. Control: To provide control of UPS for the following:
    a. UPS/bypass transfer/re-transfer switch.
    b. Emergency shutdown push button
    c. Self-Diagnostic Test: To provide diagnostic aids to facilitate test and troubleshooting.

1125.2.5 Printer

A. Black-and-White, Laser-jet type as follows:

- Print Head: 1200 x 1200 dpi resolution
- Paper Handling: Minimum of 250 sheet trays
- Print Speed: Minimum of 120 characters per second

B. Color Ink-jet type as follows:

- Print Head: 4800 x 1200 dpi optimized color resolution
- Paper Handling: Minimum of 100 sheets
- Print Speed: Minimum of 17ppm in black and 12ppm in color

1125.2.6 Diagnostic Terminal Unit

Portable notebook-style, PC-based microcomputer terminal capable of

accessing system data by connecting to system network with minimum configuration as follows:

A. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

B. Processor: Intel Core i7, 3.0 GHz.

C. Random-Access Memory: 2 GB.

D. Graphics: Video adapter, minimum 1024 x 768 pixels, 256-MB video memory.

E. Monitor: 19 inches (480 mm), LED color.

F. Keyboard: QWERTY 105 keys in ergonomic shape.

G. Hard-Disk Drive: 1 TB.

H. DVD-ROM Read/Write Drive: 48x24x48.

I. Pointing Device: Touch pad or mouse.

1125.2.7 Control Units

Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    1. Global communications.
    2. Discrete/digital, analog, and pulse I/O.
    3. Monitoring, controlling, or addressing data points.

C. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

D. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

E. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using ANSI/EIA/CEA 709.1 datalink/physical layer protocol.

1125.2.8 Local Control Units

Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

A. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.

B. Stand-alone mode control functions operate regardless of network status. Functions include the following:

1. Global communications.
2. Discrete/digital, analog, and pulse I/O.
3. Monitoring, controlling, or addressing data points.

C. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

D. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

E. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using ANSI/EIA/CEA 709.1 datalink/physical layer protocol.

F. Controller/Control unit shall be capable of BACnet and LonWorks Protocol. All controllers and devices shall be BTL and/or LonMark Certified.

1125.2.9 I/O Interface

Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

A. Binary Inputs: Allow monitoring of on-off signals without external power.

B. Pulse Accumulation Inputs: Accept up to 10 pulses per second.

C. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

D. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

E. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

F. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

G. Universal I/Os: Provide software selectable binary or analog outputs.

1125.2.10 Power Supplies

Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

A. Output ripple of 5.0 mV maximum peak to peak.

B. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

C. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

1125.2.11 Power Line Filtering

Internal or external transient voltage and surge suppression for workstations or controllers with the following:

A. Minimum dielectric strength of 1000 V.

B. Maximum response time of 10 nanoseconds.

C. Minimum transverse-mode noise attenuation of 65 dB.

D. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

1125.2.12 Unitary Controllers

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to

terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. LonWorks Compliance: Communicate using ANSI/EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
5. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
6. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

1125.2.13 Direct Digital Controllers (DDC)

A. The DDC shall have 32-bit Intel microprocessors running at 8 MHz or better, each dedicated to either CPU or communications.

B. The CPU memory available for DDC processing shall consist of a minimum of 2x128 kbytes of RAM and 2x512 kbytes of flash eprom.

C. Each AHU, packaged cooling unit, VAV box, fan powered VAV box or fan coil unit shall have a DDC controller ranging from a unitary up to a modular DDC as per spec requirement.

D. Each DDC can act as master located anywhere in the same network. As such, every DDC shall be able to modify parameters of any controller in the same network.

E. Provide modular designed DDC with UL listing and software facilities to:

1. Receive signals from system sensors, meters, transmitters and other pertinent equipment.
2. Accept, process and execute commands from other input devices.
3. Transmit output signals to control system end devices or other pertinent equipment.
4. Use peer-to-peer communication to transmit to, receive from and check the integrity of data and other information received from other DDCs.
5. Record, evaluate and report changes of state and/or values.

6. Provide power fail safe, automatic restart facilities.
7. Act as standalone with internal clock.

F. The DDC shall be capable of performing its assigned local loop control and other functions as a standalone unit. The DDC shall be capable of having data loaded from a desktop workstation or a portable terminal workstation. It shall perform all specified control functions without interaction to other field panels or to a workstation. Systems that rely only upon processing control functions in a workstation will not be acceptable.

G. The DDC shall have the capability to communicate with a remote workstation and allow monitoring of every sensing point and controlled point data indicated on the drawings and/or input/output schedules.

H. The DDC application software shall reside in non-volatile memory and save in a flash memory.

I. Failure of DDC shall not prevent other DDC on the same network from communicating with each other.

J. In the event of a total memory loss of the DDC, or the expiration of back-up power, or on start-up of the unit the necessary database shall be downloaded from the DDC itself automatically and without user instruction. Controllers requiring a manual intervention for the re-loading of applications software are not accessible.

K. Each DDC shall consist of a microcomputer-based controller modular input/output modules a fully intelligent type and capable of performing all Energy Management Control.

L. Provide DDC as specified above. Provide additional DDC if required to support the control loops specified, the sequence of operations, number of monitoring points or other criteria to permit the field panel capacity to meet the specified functional requirements of the project.

M. Each DDC shall be capable of operation as a completely independent unit and as a part of a facility wide control system. All DDC are to be equipped to enable transmission of all input and output information to a workstation.

N. Each DDC shall be capable of receiving signals from industrial grade and industry standard sensors and transducers. Each DDC shall have the capability to monitor the types of inputs and outputs as below:

1. Analog Inputs - 0 to 20 mA or 4 to 20 mA, 0 to 10 volts DC and resistance (PT-1000, N1-1000, NTC thermistor and potentiometer). It shall be possible to carry out signal type declarations from the workstation, or locally via a portable

terminal. Normalization and linearization routines shall exist for all supported inputs.

2. Binary Inputs - from volt free contacts normally open or normally closed, including pulsed contacts at a rate of 20 pulses per second minimum.
3. Analog Outputs - true analog ie. 0 to 10 volts DC or 2 to 10 volts DC. Pulse width modulation is acceptable only for VAV box DDCs.
4. Binary Outputs - momentary or maintained direct form the DDC using triac outputs or volt free contacts.

O. Each control loop is to be of the PID type, although initially most loops will be of the PI type. Adding the derivative function or modifying loop parameters should not require further programming of algorithms, but only entering the desired changes via the workstation or portable terminal.

P. Printed circuit boards shall be able to be removed without having to disconnect any field wiring.

Q. Any analog input becoming short circuited shall not prevent any other analog inputs from working.

R. Digital outputs shall be galvanically isolated from each other as well as from the internal electronics of the DDC.

S. To prevent serious damage to the DDC from surges, RFI, electrically induced spikes, etc., protection in the following form shall be provided, as a minimum:

1. Digital outputs singularly or collectively shall be galvanically isolated from the main DDC processor.
2. Analog outputs shall have noise and surge suppressers fitted to prevent damage or malfunction due to induced voltages in series or common mode.
3. Digital and analog inputs shall have noise and surge suppressers fitted to prevent damage or malfunction due to induced voltages in series or common mode.

T. DDC application programs are usually to be entered by downline loading from a workstation. Limited program changes eg. control parameters, setpoints, time delays, etc. may be carried out via a portable terminal plugged into the DDC.

U. For each DDC it shall be possible to declare alarms on every input, digital as well as analog. Alarming of points shall be operator definable on a per point basis and shall comprise of at minimum:

1. High/low limits

2. High/low differential from setpoint limits
3. Eng. units and timed deadbands
4. Special and interlocked alarms

V. After a power failure, the DDC is to refer to its various time programs and provide start signals in an orderly and predefined manner.

W. For each VAV box, the controller shall include an air velocity sensor pickup, velocity controller, damper actuator, electric heating coil SCR control (where indicated) and temperature sensor.

1. Damper Motor - Provide a damper motor compatible with the velocity controller and suitable for the damper to be controlled. Where indicated, provide fail safe motors, which fail to normally open or normally closed. To allow flexibility e.g. to change actuator to fail safe type, it is preferred the actuator be separate to the velocity controller. Bidders are to state if their actuator is not separate.
2. The controller shall control the damper and heating (if required) (either on/off or SCR as scheduled) in sequence. Setpoint, P-band and I-time shall be separately programmable for cooling and heating.

X. For each fan powered VAV box, in addition to the control components specified above, the controller shall provide for AHU. See the sequence of operation shown on the control diagrams on the drawing.

Y. For each fan coil unit, the controller shall include for the sequence of operation as shown in the control diagrams on the drawing.

Z. Zone Temperature Sensors - The sensing element shall be influenced both by the surrounding air temperature and by the radiant heat in the zone. Each zone temperature sensor shall have a modular jack for connection of a portable terminal (PT). The PT via the jack shall be able to communicate to the controller which the sensor is connected to or any other controller or DDC within the system.

AA. Outdoor Direct Digital Controller (DDC) shall be weather-proofed.

AB. Final locations of all DDC shall be included during detailed design stage. All points shall also be indicated in the EMCS Points List once all trades equipment and devices will be pinpointed.

1125.2.14 Communications

A. The EMCS system shall provide BACnet and LonWorks communications protocol over a variety of physical media topology's as follows:

- RS-232
- RS-422
- Ethernet
- RS485

B. The system shall be capable of supporting greater than ninety separate communications links to networks of control devices. Each connection shall operate independently of the others and facilities shall be provided by system displays to individually place these links in service or out of service.

C. Where supported by the controller, it shall be possible for serial connections to the EMCS Server to be routed via a terminal server and the LAN as an alternate to connecting directly to the host computer. TCP/IP based Terminal Servers are suitable and must be Ethernet connected to the EMCS server directly.

D. Given the sufficient level of system privilege, it shall be possible to view, manipulate and analyse all data in the system from any Operator Workstation in the system, including those operating remotely via modem links.

E. Once a control device is configured and placed in service, the system shall automatically begin background diagnostic scanning of the device to ensure that communications are monitored independently of any monitoring scanning.

F. The system shall perform checks on data integrity of all data acquired from the device. If an invalid or time out response is received, the data shall be ignored and the system will record the transaction as an error. Statistics shall be kept and displayed by the system on errors encountered in communication by means of a communications barometer. The barometer shall increment for every failed call and decrement for each successful call. In addition, the system shall alarm separate *marginal* and *failure* conditions based on user defined limits to advise the operator of the device and link that has failed. Communications statistics shall be displayed as standard on the system and shall also be available as part of the reporting system or custom displays.

1125.2.15 System Software

A. The EMCS system server shall be based around the Microsoft Windows (or any of the latest windows software compatible with the system) 64-bit multi-tasking environment. The EMCS system shall be a true 64-bit application to take advantage of Microsoft Windows 10 (or any of the latest windows software compatible with the system) enabling technologies. Any 16-bit system running on the Microsoft NT 2000

platform (such as those originally based on MS-DOS and Microsoft Windows 3.x) shall not be acceptable.

B. Standard services supported by the server computer operating system will include the following:

- Multi-tasking Multi-user support
- TCP/IP Network Support
- Graphic Display Building Editor
- Application software

C. Software at the Operator Workstation shall comprise of:

- Windows 10, (or any of the latest windows software compatible with the system)
- Graphic Display Building Editor
- Application software
- TCP/IP Networking

C.1 ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 Protocol and Communicate using ISO 8802-3 (Ethernet 1 data link/physical layer protocol.

C.2 LONWORKS Compliance: Control units shall use Lontalk Protocol Communicate using ANSI/EIA/CEA 709 data link/physical layer protocol.

D. The networking software shall use the industry standard TCP/IP LAN protocol.

E. The server computer or an alternative network connected computer shall be capable of acting as a File Server for graphic displays and cardholder photo images. All LAN connected Operator Workstations shall be able to view custom displays and photo images from the server computer.

F. All system peripherals shall be capable of being connected to the server computer via the LAN.

G. The EMCS system shall be integrated with the startup services of Microsoft Windows XP (or any of the latest windows software compatible with the system). Logon to Microsoft Windows XP (or any of the latest windows software compatible with the system) shall not be required for the EMCS system to startup and run. The Microsoft Windows XP (or any of the latest windows software compatible with the system) event viewer shall be available to view startup and shutdown of the EMCS system.

1125.2.16 Graphic Display Building Editor

A. It shall be possible to launch the Graphic Display Building editor from the operator interface on both the server computer and connected Operator Workstations. It shall allow one step online building of display static and dynamic objects. It shall be a WYSIWYG editor (what you see is what you get) allowing the displays drawn using the editor to appear exactly the same when viewed from an Operator Workstation.

B. Static objects created using the Graphic Display Building Editor shall include static text, rectangles, arcs and circles. However, it shall be possible to animate static objects to give the dynamic characteristics of the real-world object the point represents.

C. It shall be possible to link dynamic objects to the EMCS database. They shall allow information to be displayed from the database or to allow an operator to interact with them in order to make changes in the database and to perform control actions. Dynamic objects shall include dynamic text, push buttons, indicators, charts, check boxes, combo boxes and scroll bars.

D. It shall be possible to include static and dynamic display objects on the one display. The editor shall allow display objects to be manipulated by pointing, clicking and dragging. The editor shall allow display objects to be drawn, re-sized, copied, grouped, rotated, aligned and layered over each other. It shall be possible to copy and paste objects within and between displays.

E. The Graphic Display Building Editor shall support the following features:

- One step display building (both background and dynamic information)
- Point and click operation
- Paste to and from the Clipboard
- World co-ordinate object placement
- Ruler and grid
- Tool, color and line palettes
- Dialog boxes for definition of object details
- Shape and page building
- On-line help
- Import graphics from third party packages in the form of Windows Meta files, Bitmaps, TGA and JPEG formats.
- Standard library of EMCS industry objects
- Three dimensional effects including raised, lowered, ridge and groove line styles
- Live video element

- Multi-media element to allow links to web sites and ActiveX Documents to be incorporated onto displays
- Display Scripts

Display Scripting

It shall be possible to further animate display elements using Visual Basic Scripts. By attaching Visual Basic script programs to individual elements on the display, it shall be possible to perform a variety of animations, which include but are not limited to:

- move objects
- resize objects
- recolor objects
- pop up messages and dialog boxes etc.

Scripts may be activated on displays using the following events:

- On mouse click
- On mouse enter
- On mouse move
- On page callup
- On a timer
- On value or state change of a point on the display

A script editor shall be provided which allows scripts to be created and modified. This script editor shall be incorporated as part of the Graphic Display Building Editor. A proprietary scripting language or additional scripting and drawing package shall not be acceptable.

Live Video

Both the Graphic Display Building Editor and the Operator Interface shall have built in support for the creation and display of live video objects without the need for programming. The Microsoft Multimedia Control Interface (MCI) standard shall be used to facilitate support for a video overlay card (such as a Flashpoint 3D AGP). The video overlay card shall enable live video to be fully integrated into custom schematics. The size and position of the video object shall be configured on a per display basis.

Systems which show the live video object in a separate window from the operator interface, or on a separate monitor screen shall not be acceptable.

Web Browsers

The Graphic Display Builder Editor shall have the ability to imbed web browser objects into custom displays. This shall allow information from

intranets, the internet or ActiveX documents to appear in the operator interface along with other building data. It must be possible to restrict access to the World Wide Web, therefore launching an external browser application shall not be acceptable.

Launching External Applications

It shall be possible to launch applications (such as Microsoft Word, Excel, custom help files or any third-party applications) from a custom display. If supported by the application, it shall be possible to launch the application with a specified file opened within the launched application. Launching of such applications shall also be possible from the Operator Workstation pull down menus or from a push button on a custom display.

1125.2.17 Database Configuration Tool

A database configuration tool shall be provided with the EMCS system that shall allow configuration of all point records, printers, controllers, and Operator Workstation connections. This utility shall be in the form of a relational database and operate in a true 32-bit graphical environment such as Windows XP (or any of the latest windows software compatible with the system). The utility shall also have the ability to export information to and import information from Microsoft applications such as Microsoft Excel.

Users with sufficient security access shall be able to configure the database while the system is on-line. Configuration shall not require the need for any programming, compiling or linking and shall not require shutting down or restarting of the system. In addition, historical data collection shall not be interrupted for points not affected by configuration changes.

It shall be possible to launch the database configuration tool from the operator workstation interface. The utility shall have the ability to configure database changes and download them either from the EMCS server directly, or remotely via the network. The remote download is to provide password protection.

It shall be possible to modify a range of communications and other parameters for each device. The parameters of a particular device made available for modification shall be specific to the device or hardware item being configured - for example baud rate, parity, data and stop bit information in the case of serial devices. Hardware configuration utilities that rely solely on text-based configuration files shall not be acceptable.

All documentation for the configuration utility shall be provided on-line. The help facility shall operate using standard Microsoft features such as context sensitive help using the F1 function key.

The utility shall provide features that reduce configuration time of the EMCS system. These features shall include adding multiple points, controllers etc. at

once. The utility shall automatically increment names or numbers of any information that is required to be unique by the EMCS system (such as point names). The user shall be able to select multiple items (such as points) and then edit fields that are common to all selected items to assist in global changes. Standard copy and paste facilities are to be provided by the utility.

The utility shall also support free format text fields, which the user can use for additional information such as cabinet or wire numbers. These additional fields shall be simple extensions to existing items in the database such as EMCS points.

A filtering mechanism shall be provided with the utility so that the user need view only relevant information. The filter shall provide standard choices for the user to select, and also provide user defined filtering.

Database management reports shall be provided by the utility as standard. The utility shall also provide support for ad-hoc reporting facilities for engineering use.

1125.2.18 Internationalization

The EMCS Operator Interface shall be fully translatable into the local language. This includes languages which do not support the European character set e.g. Chinese. The process of translating a system shall be done by editing message files and by editing displays.

1125.2.19 Monitoring and Control

A. Monitoring

The system shall support acquisition of data using the following techniques:

- Periodic Scanning
- Report by Exception

The system shall support a range of scan intervals, ranging from less than 1 second up to 15 minutes.

In order to minimize communications traffic, the system shall automatically block data requests using contiguous addresses and the scan interval to generate scan packets, optimizing throughput for a given scanning load. The system shall also provide utilities to examine scan packet allocation for each scan interval, and compile aggregate statistics on communication link usage.

Where supported by the controlling device, Report by Exception (RBE) protocols shall be used to reduce the scanning load of the system while

improving system response. If necessary, periodic scanning may be used in conjunction with RBE to ensure data integrity.

B. Device Control

Control transactions issued by the operator shall be communicated to control devices using a write followed by read to ensure the integrity of the transaction. If the read following the write to the device indicates that the control action has failed, the operator shall be informed by means of a control failure alarm. The priority of the control failure alarm shall be configurable by the user.

It shall be possible to optionally assign a control confirmation message to individual points. This message shall request the operator confirm the requested supervisory control action prior to sending the entered value to the controller.

1125.2.20 System Database

The system shall provide a real-time database incorporating data from analog, logical or pulse inputs. The database shall be configurable by the end user without the need for any programming and shall be able to be modified on-line without interrupting operation of the system. In addition to point based information, the database shall also provide historization capabilities for analog, digital, pulse and event based information. This information shall be accessible by all facilities of the system such as custom displays, reports, trends, user written applications, etc.

A. Database Structure

The real-time database shall support collection of data and storage using the following structures:

- Access Point Structures
- Analog Point Structures
- Status Point Structures
- Accumulator Point Structures
- Historical Data Structures
- Event Data Structures
- User Defined Structures

Each of the Point database structures shall be comprised as a composite point with a number of associated parameters which may be referenced relative to a single tag name. Specifically, each of these parameters shall be accessible by various sub-systems such as the Graphical Operator Interface, Report Generation system and Application Program Interface in a simple POINT. PARAMETER format without the need to know any internal storage mechanism.

The system shall maintain portions of the database requiring frequent high-speed access as memory resident information and other less frequently accessed data as disk resident data. Memory resident data shall be checkpoint to disk every minute to minimize loss of data in the event of loss of power or other system failure.

Database backup shall be possible with the system on-line including backup of historical based data. The backup shall be possible via standard Microsoft Windows XP (or any of the latest Microsoft windows software compatible with the system) operating system utilities.

Point data shall be stored in a composite point database structure that provides a wide range of configurable information including but not limited to:

- Point name and description
- Multiple locations for data storage and device scanning addresses
- Scan period
- Multiple types and instances of alarms
- Multiple deadband or hysteresis settings (analog points)
- Monitoring and Control access restriction information
- Location of operator alarm handling instructions
- Location of ancillary information associated with the point.

B. Analog Points

Analog data

C. Status Points

Status (digital) information shall be stored in a Status Point type in the database. The status point shall be a composite point capable of processing from a single to a three-bit digital input, allowing up to eight possible states.

D. Accumulator Points

Data associated with pulsed inputs shall be stored in the system in a composite point database structure that shall provide automatic tracking of instrument rollover.

E. Grouping of Points

The EMCS system shall provide a means by which a number of alarm inputs, outputs and other related points can be grouped together for more convenient monitoring and control without the need for custom graphics.

F. History Management

Collection of historical point data shall be configurable as part of the point definition. Once configured, this data shall be collected automatically. Historical data collection shall be provided for both snapshots and averages with intervals ranging from 5 seconds to 24 hours.

Once assigned to history, point data shall be available by POINT.PARAMETER access used in conjunction with a history offset to locate the particular value of interest. The graphical operator interface, trend, report generation and application interfaces shall be able to access historical data.

Modifications to the history collection of a point shall be possible on-line without the loss of previously collected data for the point being changed or any other points in the system currently being historized.

G. Trending

The system shall provide flexible trending allowing real-time, historical or archived data to be trended in a variety of formats. In addition, trend data types shall be able to be combined to allow for comparisons between data e.g. current real-time data versus archived data.

Trend Capabilities

The system shall provide trending capability with the following functions:

- Real time trending
- Historical trending
- Archived History trending
- Trend Scrolling
- Trend Zoom
- Engineering Unit or Percent
- Cursor readout of trend data
- Trend comparisons between archived, real-time and historical data (for example, this year vs. last year). Comparisons between the same point offset in time, or different points must be possible.
- Trend Decluttering via per-pen enable/disable on multi-plot style trends
- Independent Y-axis per point on multi-plot style trends. It must be possible to display the Y-axis for any point on the trend by simply selecting the point using the mouse or keyboard
- copying the currently displayed trend data to the clipboard for pasting into spreadsheet or document

Configuration of trends shall only require the entry of the Point Name into the desired trend template to produce the trend. All trend configuration must be possible on-line without interruption to the system. Historization of data shall not be affected by changes to trend configuration. Systems that only provide trending via a third-party package will not be acceptable.

Trend Types

The system shall be able to present real-time, historical or archived data in a variety of formats, including single, dual and multiple value trends of up to 8 points. For each trend set display it shall be possible for operators to configure the number of historical samples and ranges displayed. Points configured in trend sets shall be changeable on-line.

Operators shall be able to zoom in on information displayed on trend sets for closer inspection by dragging out an area of interest with the mouse or other pointing device. From such a selection, it shall be possible to copy the underlying data to the Windows clipboard for subsequent pasting into a spreadsheet application such as Microsoft Excel. Scroll bars shall be available to move the Trend set backwards and forwards across the historical records. The trend sets shall automatically access archived history files without operator configuration.

It shall be possible to embed trend objects as part of custom displays. The following formats shall be available:

- Bar Trend
- Line Trend
- Numeric Trend
- Tuning Trend
- Pie Trend
- X-Y Plot

H. Event Management

It shall be possible to log an event such that it shall be journalized in the event file and optionally printed on the event printer. The journal shall contain the following event information:

- Alarms
- Alarm Acknowledgements
- Return to Normal
- Operator Control Actions
- Operator Login & Security Level Changes
- On-line database Modifications
- Communications Alarms

- System Restart Messages

Standard Displays shall be provided to show the current journal file with the most recent event at the top of the display. Subsequent page forward actions shall allow display of progressively older events. Sorting and filtering of the journal shall be possible via a standard report, which shall be configurable by filling-in-the-blanks. Coding or scripting of any kind shall not be required. If events are viewed on the screen, it shall be possible to pause the real time view and prevent events from scrolling off the screen as new events occur.

The Event database entries shall contain the following information:

- Time & Date Stamp
- Point Name
- Event Type
- Alarm Priority
- Point Description
- Point value or status at time of the event
- Engineering Units

The Event database must also be accessible from other sub-systems such as the Operator Interface, Report Generation and Application Programmers Interface.

It shall be possible to have an on-line event file as large as the disk capacity can accommodate. For example, given the appropriate disk space it shall be capable of storing up to 1,000,000 (one million) events on-line.

The event file shall store events in a current online buffer. When the buffer is full an alarm shall be raised advising the operator to save the file to an external media. The current online buffer contents shall then be transferred to an archive buffer to await archiving to an external media. The current online buffer shall, without interruption, continue to store current events.

Another file area shall be available to hold archived event files ready for playback. These are event files previously archived to external media.

Operators shall be able to restore previously archived files via the operator interface and a dedicated display.

The events file system shall be fully integrated with the standard reporting system. The system shall automatically reference the restored playback file if a Report is requested containing a time search window covered by the current playback file.

The operator shall be able to restore previously archived files and review or print them from the Operator Workstations.

I. Alarm Management

The EMCS shall support several different types of alarm, including:

- Two high-value alarms
- Two low-value alarms
- Two deviation alarms
- Rate of change alarm
- Unreasonable value alarm

Any four of these alarms shall be assignable to each Analog or Accumulator point on an individual point basis as part of the point configuration process.

Alarm Priorities

Each monitored point in the system shall be able to assigned one of four alarm priorities to individual states. The meaning of the priorities shall be as follows:

Journal

Changes of state shall be journalized to the Alarm/Event Log and optionally printed on the Alarm/Event printer.

Low

Change of state will generate a Low priority alarm, which will appear on the Alarm Summary. Optionally, the alarm may be printed on the Alarm/Event printer or generate an audible tone.

High

Change of state will generate a High priority alarm, which will appear on the Alarm Summary. Optionally, the alarm may be printed on the Alarm/Event printer or generate an audible tone.

Urgent

This is the highest priority. Change of state will generate an Urgent priority alarm which will appear on the Alarm Summary. Optionally, the alarm may be printed on the Alarm/Event printer or generate an audible tone.

Within each of the four alarm types there shall be 15 sub-priorities available.

It shall be possible to configure a time such that if a low priority alarm is not acknowledged within this time the alarm's priority is elevated to high priority. If a high priority alarm is not acknowledged within a configured time, its priority is elevated to urgent priority.

It shall be possible to associate additional messages to be logged into a message summary in the event of an alarm condition.

When an alarm is acknowledged, it shall be possible to automatically issue a reset to a controller to indicate the alarm is acknowledged and to attempt to reset the alarm point.

Alarm Enunciation

Alarms shall be enunciated by:

- Most recent, highest priority alarm message appearing on dedicated alarm banner on the operator interface.
- Alarm message appearing on alarm summary display.
- Available Tone - based on a "*.wav" or other sound file for each alarm priority
- Alarm message printed on the alarm printer
- Alarm indicator flashing on the operator interface

Alarms shall be enunciated at the Operator Workstation even if there is no operator currently signed-on. This feature shall be available on network connected Operator Workstations as long as the computer running the Operator Workstation software remains logically connected to the network. If the Operator Workstation is minimized in the Windows environment, then the Operator Workstation icon will indicate an alarm. An audible tone shall be able to be generated and this tone shall be specified by a "*.wav" or other sound file for each alarm priority.

Points shall be enunciated whilst in alarm. If a point is set to alarm inhibited the point shall no longer cause annunciation. If a point goes into an alarm state whilst inhibited and then is still in the alarm state when the point is set to alarm enabled, the point shall immediately cause annunciation.

Alarm Processing

Assigning an alarm to the point shall automatically cause the system to perform the following actions when an alarm occurs:

- The alarm shall be time stamped to the nearest second and logged in the Event database with the Point Name, Alarm type, Alarm Priority, Point Description, New value and Engineering Units

- The point value which is in alarm shall turn red and flash on any standard or custom display which uses that point
- An Unacknowledged alarm entry shall be made in the system alarm summary for Low, High and Urgent Alarms
- The audible alarm shall sound (if configured)
- The alarm annunciation indicator shall flash

In addition, the alarm banner of the Operator Interface must show the most recent (or optionally oldest), highest priority, unacknowledged alarm in the system.

Dedicated Alarm Banner and Alarm Indicator

A dedicated alarm banner shall appear on all displays showing either the most recent or oldest (configurable), highest priority, unacknowledged alarm in the system. This banner shall be clear when there are no unacknowledged alarms for the operator to process.

On occurrence of an alarm, the graphic display shall output the point identification, point type, and description on the banner. If multiple alarm/change of state conditions occur, subsequent messages shall overwrite the display if they are higher priority. As subsequent alarms are displayed, the previous alarm information shall move to an unacknowledged alarm list, awaiting acknowledgement by the operator.

An alarm indicator shall also appear on all displays. This indicator will flash red when there are any unacknowledged alarms pending in the system. This indicator will remain solid red if there are alarms, which have not returned to normal but which have all been acknowledged. The indicator will be clear if there are no points in an alarm condition.

Alarm Logging

As well as being logged on the printer, alarms shall be logged to an event file for future retrieval in alarm reports or archived to removable media.

Alarm Response Function Keys

The following dedicated function keys shall be provided on the keyboard for alarm action:

Acknowledge

After moving the cursor to the point in alarm on the screen and selecting the point the operator shall be able to acknowledge an alarm by pressing this key. This action shall be logged in the event file and on the printer showing the operator ID with the message.

Alarm Summary

By pressing a dedicated key at any time, the operator shall be able to view a display showing all currently active alarms. The alarm messages shall be color-coded showing priorities. The operator shall be able to view the alarms according to priority. It shall be possible to acknowledge alarms from this display and also go to the associated display defined for the point.

Associated Display

After moving the cursor to the point in alarm on the screen and selecting the point the operator shall be able to bring up the display applicable to that alarm by pressing this key. Just selecting the associated display key directly will bring up the associated display for the point currently on the alarm banner.

Alarm Acknowledgement

The system shall provide for efficient alarm acknowledgement in a number of ways as follows:

- Selection of any POINT.PARAMETER from a custom graphic and pressing the dedicated acknowledge push-button
- Selection of the alarm banner and pressing the dedicated acknowledge button
- Selection of the alarm in the alarm summary display and pressing the dedicated acknowledge button
- By performing a page acknowledge from the alarm summary display

On acknowledgement by the operator, the flashing indicator shall turn steady, and the point value shall remain red on any system or custom graphic. The acknowledgement shall also be logged in the Event database identifying the operator or station that acknowledged the alarm. If the point goes out of alarm before being acknowledged by the operator, the alarm shall be shown by a different indication and remain in the list until specifically acknowledged by the operator.

Alarm Filtering

The Alarm Summary shall be able to filter the alarms displayed to the operator. The filtering criteria shall include as a minimum:

- Individual Priorities (ie. Urgent, High, Low)
- Ranked Priorities (ie Urgent only, Urgent & High only, Urgent, High & Low)
- Unacknowledged Alarms only
- Individual Areas only

Additional Alarm Information

The EMCS system shall provide support for an additional message to be tagged to the alarm. This message shall provide the operator with additional information on the alarm but shall not clutter the alarm summary. It shall appear in a separate message summary at the same time as the alarm appears in the alarm summary. The messages can be pre-configured and then simply attached to individual points by means of a message ID.

Advanced alarm management

The EMCS shall be capable of advanced alarm management, which includes set stages of alarm handling.

The stages shall be:

- silence alarm condition
- acknowledge and action alarm condition
- respond to alarm condition by using pre-defined responses
- optionally reset alarm

All actions shall be recorded in the event file for retrieval and auditing purposes.

When an alarm is silenced, an instruction page for the alarm will be displayed. The alarm may then be acknowledged from this page and actioned.

Once the alarm is acknowledged and appropriate action has been taken, the operator may move to the response page to select from up to 100 user defined responses to be logged in the event file. Alternatively, the operator shall be able to enter their own response, which will also be logged in the event file. At the same time the alarm is removed from the alarm file.

It shall be possible to enable/disable this feature on a point by point basis given the appropriate system privilege level.

Reporting

The system shall support a flexible reporting package to allow easy generation of report data. The reports provided shall include pre-configured standard reports for common requirements such as Alarm Event reports and custom report generation facilities that are configurable by the user.

Standard Reports

The following pre-formatted reports shall be available on the system:

- Alarm/Event Report
- Operator Trail Report
- Point Trail Report
- Alarm Duration Report
- All Point Report
- After Hours Alarm Report
- Point Attribute Report

Configuration of these reports shall only require entry of the schedule information, and other parameters such as Point Name or wildcard, Filter information, time interval for search and destination printer to fully configure the report. Specifically, no programming or scripting shall be required.

Alarm/Event Report

A report shall be provided to produce a summary of all events of a specified type for nominated points occurring in a time period. The time period may be specified as an absolute start and end date and time, or as a period relative to the current time. This report shall also be able to produce a summary of all changes made by a specific operator.

Operator Trail Report

A report shall be provided to produce a summary of all operator actions relating to a specific operator in a specified period.

Point Trail Report

A report shall be provided to produce a summary of all events of a specified type occurring in a period on nominated points.

Alarm Duration Report

A report shall be provided which calculates the total amount of time a nominated point or group of points has been in an alarm condition over a given time period. The time period may be specified as an absolute start and end date and time, or as a period relative to the current time.

All Point Report

A report shall be provided to produce a list of point information, including point name, description, point type, engineering units, and

current values. Report configuration shall allow filtering based on a wide variety of criteria.

After Hours Alarms Report

A report shall be provided to produce of summary of all Alarms occurring during the period specified by the operator as “After Hours”

Point Attribute Report

A report shall be provided to points selected by one of the following attribute criteria:

- Out-of-service
- Alarm suppressed
- Abnormal input levels
- In Manual mode

Additional Custom Reports

In addition, configurable report generation facilities must be provided to allow custom reports to be produced. They shall be able to be configured at any time with the system online, and shall be able to access any database values. At least two methods of custom report generation shall be available, including the following:

Microsoft Excel

The EMCS shall provide the facility for the use of Microsoft Excel as a reporting tool allowing calculations such as summations, maxima, minima and standard deviations, and the production of graphs, charts and tables.

Data accessible for Excel reporting shall include alarms, events, and point parameter values.

ODBC

The EMCS shall be capable of providing selected data in an ODBC format for the purpose of extracting data and creating custom reports. It shall be possible to access tables of data from the EMCS through an ODBC compliant tool such as Crystal Reports.

Shall be possible to incorporate the activation of custom reports created through the ODBC compliant tool through the standard EMCS report subsystem. Example reports shall be provided to illustrate how to access the ODBC data in the EMCS.

A report detail display shall allow naming of reports, scheduling information and the destination of the report. The report destination shall be a printer, operator interface or internal file. The report output format shall be HTML (Hypertext Markup Language), Microsoft Word or RTF format.

Report Activation

Reports shall be activated in one or more of the following ways:

- Periodic activation at user specified intervals
- Operator Demanded
- Event Initiated e.g. Change in point value
- Application Initiated

K. User Definable Database

In order to support other types of data such as user entered or calculated data from application programs, the system shall also provide a User Definable database area that can be fully integrated into the system. Data contained in this database must be accessible by:

- Custom Graphics
- Custom Reports
- Application Programs
- Network Applications using a Network API

L. Point Initiated Programs (PIPS)

In addition to standard point processing functions, the system shall allow additional processing through the use of standard PIPS that may be attached to an analog, status or accumulator point. Typical functions to be provided by these PIPS are listed below:

- Arithmetic Calculation
- Boolean Calculation
- Maximum/Minimum Value
- Composite Alarms
- Integration
- Run Hours Totalization
- Group Alarm Inhibit
- Report Request by Point Change
- Application Program Request (By point value change or cyclic period)
- Alarm Transportation
- Value Transportation
- Door Activity Task Request
- Security Area Seal / Unseal

- Alarm or Point Value Change Graphic Call-up
- Value Change Group or Area Alarm Inhibit

M. Historical Data Archiving

The system shall support archiving of historical data to allow a continuous record of history to be built up over a period of time. Archived data may be stored on the hard disk of the system or a remote network drive or moved off-line to removable media such as floppy disk, cartridge tape, DAT tape, or optical disk. The number of archives maintained on the system before transferal to off-line media shall only be limited by the size of the hard disk or remote network drive. The system shall allow the user to define the specific intervals of history to be archived to avoid archiving of unnecessary data.

Archiving of historical data may be activated by one of the following methods:

- Operator Demand
- Periodic Schedule
- Event Initiated

Once archived, the data shall be available for re-trending through the system trend facilities in combination with the current on-line history or other archives. Providing the archived history is present on the EMCS Server's hard disk or remote network drive, the trend facilities must be able to access it transparently for display, when a user scrolls beyond current on-line history limits.

N. Time Schedules

A minimum of one thousand (1000) EMCS based time schedules shall be provided by the system.

The time schedule facility shall allow the scheduling control of points on both a periodic and one-off Basis by the EMCS. The time schedule facility shall execute every 60 seconds and it shall be possible to schedule Point controls on minute boundaries.

All time schedules shall be configurable via the Operator Workstation.

Each time schedule entry shall consist of:

- Date
- Time
- Point name
- Point parameter
- Target value
- Type of scheduling

The available time schedule type shall be as a minimum:

- One shot - to be executed only once then deleted
- Daily - to be executed every day
- Workday - to be executed Monday to Friday
- Weekend - to be executed on Saturday and Sunday
- Holiday - to be executed on holidays
- Individual days - to be executed on individual days (eg. Monday)

Where the control device supports an internal time schedule program, the EMCS shall be able to upload, display, modify and download the control device time schedules. Support for the control device time schedules shall be in addition to the EMCS time schedules.

1125.1.21 Open Systems Architecture Via BACnet/LonWorks Protocol

Protocol Standards shall be BACnet or LonWorks-ready for devices or systems.

1125.1.22 Data Exchange

The EMCS system shall have the capability to interface to the point database of other similar EMCS systems (i.e. nodes) on a TCP/IP network. This shall enable both the acquiring of point data and issuing control outputs to other EMCS systems.

A. Data Exchange with Microsoft Excel

The system must be capable of exporting bulk data to Microsoft Excel. Windows 3.x Dynamic Data Exchange (DDE) is not an acceptable method to use.

As a minimum the following shall be supported:

- allow retrieval of data either periodically or snapshot
- allow retrieval of data via POINT.PARAMETER requests
- allow retrieval of tag names, descriptions etc
- allow retrieval historical data
- writing of values from Excel back to the supervisory system

B. Web Browser Access to the EMCS

Web-page controls and a web server interface to the EMCS shall be optionally provided, which allow tenants or other users to monitor & control a variety of EMCS-supervised functions via a web page viewed from a standard web-browser.

It shall be possible to limit web browser access to EMCS facilities by means of standard web and networking techniques.

For example, it shall be possible for building tenants to be able to view floor graphics via a dedicated or existing building Intranet, and to be able to monitor and control floor lighting and ambient temperature information.

1125.1.23 Application Programming Interface

Two types of application programming interface (API) are required, the first is for applications written on the EMCS server and the second is for applications that are required to run on network-based clients (that are not necessarily Operator Workstations).

The EMCS system API's must have support for either Visual Basic or C++ or both. Proprietary programming languages are not acceptable.

The API on the EMCS server requires the following functions as a minimum:

- Read and write to points in the database
- Access to historical data
- Initiate supervisory control actions
- Access to the alarm/event subsystem
- Access to user-defined database
- Provide a prompt for operator input.

The API on the network-based clients requires the following functions as a minimum:

- Read and write to points in the database
- Access to historical data
- Initiate supervisory control actions
- Access to user-defined database

1125.1.24 Operation Interface

A. General

The operator interface provided by the system shall allow for efficient communication of operational data and abnormal conditions. It shall provide a consistent framework for viewing of information. Critical areas (such as alarm icons) shall be visible at all times. A predefined area on the screen shall provide operator messaging, and this area shall also be visible at all times. A set of standard displays for configuration, and navigation around the EMCS system are to be provided. These are to be independent of any custom (facility specific) display.

The operator interface software shall be capable of running in the Windows XP (or any of the latest windows software compatible with the system) environment.

The operator interface shall be interactive and totally graphics and/or icon based. Graphics shall be capable of supporting up to 256 colors at a minimum 1024 x 768-pixel resolution.

The operator interface shall be windows based and shall employ standard Windowing conventions so as to reduce required Operator training. In particular, standard tool bar icons and drop-down menus shall be available on all standard and custom displays to allow easy access to common functions.

Similarly, such functions shall also be available via a standard set of Function-Key based pushbuttons without requiring configuration.

The operator interface shall support the ability to "full screen lock" the window so users can not access other applications. If "full screen lock" is not enabled, support for copy and paste facilities shall be provided between the operator window and other Microsoft applications.

Support for customizable WinHELP files shall be provided for use as operator instructions and On-line HELP.

The number of displays specified in Appendix A shall be reserved for custom use. These users configured displays shall be constructed using the integrated display building functions available through the Operator Workstation.

B. Operator Interface Connection

The operator interface shall be flexible in its connection to the EMCS server. An Ethernet LAN connection shall be used between the Server and the Operator Workstations. The operator interface shall provide standard dial-up modem (or equivalent) support using Microsoft Remote Access Service (RAS). Using other packages such as Microsoft Terminal to make the modem connection shall not be acceptable.

The operator interface LAN connection shall also be flexible to support both permanent and casual access to the EMCS server. A large number of casual users shall be permitted without any additional licensing burden. Licensing shall be based on the number of simultaneous operator connections on a "First Come First Served" basis. Those users with casual access shall automatically disconnect from the EMCS server after an idle timeout period.

The operator interface shall support connection over poor quality, low bandwidth channels. This support shall include radio links, microwave and VSAT communications.

To minimize bandwidth on both serial and LAN links, it shall be possible for the operator interface to only require updated dynamic

information from the EMCS server. All static information (such as display backgrounds) can be stored locally.

C. Operator Interface Characteristics

The system shall provide a Windows operator interface with the following minimum capabilities as standard. No custom programming or scripting shall be necessary to produce these:

- Window re-size, Zoom in, Zoom out
- Dedicated icons and Pull Down Menus to perform the following:
    - Associated Display
    - Alarm Summary
    - Alarm Acknowledgement
    - Display Sequence Forward/Backward
    - Previous Display Recall (minimum of 8 displays)
    - Graphic Call-up
    - Trend Call-up
    - Point Detail
    - Card Holder Detail
    - Alarm Banner showing highest priority, most recent (or oldest) unacknowledged alarm
    - System Date and Time Zone
    - Current security Level
    - Workstation connection number
    - Alarm Annunciation
    - Communications Fail Annunciation
    - Operator Message Zone

D. Pointing and Input Devices

The operator interface shall be capable of being mouse driven and simultaneously support keyboard data input. Both fixed menus and configurable function keys shall be supported to aid novice and experienced operator respectively. The interface shall also be capable of supporting a touch-screen for pointing and command input.

The operator interface shall use a Tool Bar for common operator commands. The operator shall be able to request display of commonly used displays and activate system functions via Drop-Down menus

All operator interface input shall be possible using only the pointing device and QWERTY section of the keyboard.

E. Operator Functions

The following functions shall be performed through the operator interface:

- Display and control of field equipment
- Acknowledge alarms on a priority basis
- Initiate printing of reports
- Archive and retrieve event logs
- Change own password
- Monitoring of data communications channels
- Configure system parameters

F. Operator Security and Sign-on

Security

If necessary, each operator may be assigned a user profile that defines the following:

- Security and/or Control Level
- Operator Identifier
- Unique Password
- Area Assignment / Area Profile
- Start Graphic for that operator
- Timeout Value for that operator

Any actions initiated by the operator shall be logged in the Event database by operator identifier. In addition, any control actions to a given point shall only be allowed if the control level configured in the operator's profile exceeds the level assigned to the controlled point.

Utilities shall be provided to allow administration of the operator passwords.

Security Levels

The system shall support at least 6 levels of operator security. The functions allowed from each security level shall be as follows:

Level 1: Signed Off mode - View start-up display only.

Level 2: View only - Permit all Level 1 functions and in addition the operator shall be able to view displays. Typically used for an inexperienced operator.

Level 3: Permit all Level 1 and 2 functions and in addition the building operator shall be permitted to control points

such as start/stop, disable/enable, etc. and acknowledge alarms as they occur.

Level 4: Permit all Level 1 through Level 3 functions in addition to accessing master time schedules, system peripherals allocation, change point engineering parameters, build reports and use most standard system configuration displays. This level shall typically be reserved for the building engineer.

Level 5: Permit all Level 1 through Level 4 functions in addition to accessing the engineering functions such as building and linking displays, allocating keyboard push button assignments, etc. Reserved for the building supervisor.

Level 6: This is the highest level of station security and shall allow the user unlimited access to all station functions. Typically reserved for the building manager.

Sign-On/Sign-Off

The operator shall be permitted to sign on to the system if the correct Operator Identity (up to 4 characters) and the Operator Password (up to 6 characters) have been entered. This password shall be encrypted.

After a series of three (3) unsuccessful attempts to sign-on the Operator Workstation interface shall be locked for a configurable period of time. The lock-out period shall be set via system configuration displays. During Operator Workstation lock-out the other Windows functions of the computer running the Operator Workstation software shall not be affected.

It shall be possible to assign operators either single or multi-user passwords. Single user passwords enable the operator to sign-on to only a single Operator Workstation thus preventing simultaneous sign-on be the same operator. The multi-user password would typically be used by operators with the highest sign-on security level who may require simultaneous access to more than one Operator Workstation.

Each operator shall be assigned a password and a set of authorised areas. The operator may sign-off at any time by issuing a sign-off command.

A keyboard time-out feature shall be provided such that the operator shall be automatically signed off after a defined period of keyboard inactivity. It shall optionally be possible to configure automatic callup of a "logged-out" display when this occurs to hide restricted information for example.

Area Assignment / Area Profile

Each operator shall be assigned one or more specific areas of the building with the appropriate monitoring and control responsibility. An area shall be defined in this context as a logical entity comprising of a set of points in the system. This in turn may represent a physical space in the building.

It shall be possible to define individual tenant access by means of area assignment. Likewise, an operator's ability to control or monitor certain parts of a facility can be controlled by means of area assignment.

The system shall provide the facility to create area profiles, which combine areas and time periods, and which can be assigned to operators with the same area access requirements. By using area profiles in this way, area access can be specified to apply during certain time periods, allowing different areas of access at different times of the day or week.

Password Authentication

Each password shall be an alphanumeric character string programmable up to a maximum of six (6) characters in length. The system shall not accept a password of less than five (5) characters in length nor shall the system force an operator to enter a password of more than five (5) characters in length.

The system shall provide a facility to allow all operators to change their own passwords at any time.

When a password is changed, the system shall not permit the new password to be the same as any of the last ten (10) passwords used in the past three (3) months. This shall be configurable with the appropriate level of security. All passwords stored in the system shall be encrypted.

Duress

It shall be possible for an operator to indicate that they are signing on under duress. The system shall recognize that the operator is signing on under duress and it shall then be able to issue a control to alert appropriate assistance.

Command Partitioning

It shall be possible to assign to each operator a set of allowed commands for each assigned area, where an area is a group of points. These commands can be mapped against the output state of any given digital point in the respective area to determine whether a control command is allowed for the particular operator.

With this feature, it shall for example be possible to configure an operator to set a digital point to ON, but to disallow the same operator from setting the same digital point to OFF.

G. Standard System Displays

The following displays shall be included as part of the system:

- Alarm Summary Display
- Event Summary Display
- Point Detail Template Displays (for each point in the database)
- Trend Set Template Displays
- Group Control and Group Trend Template Displays
- Communications Status Displays
- System Status Displays
- Operator Scratch-pad Display

In the case of the Trend and Group displays, configuration of these displays shall only require entry of a point name to completely configure the display.
The Alarm Summary, Event Summary, Point Detail, Communications Status, System Status shall not require any configuration.

Systems where standard graphical displays, showing all parameters for each system Point, do not exist, shall not be acceptable.

Status Displays

System status displays shall be available on the main Operator Workstation. They shall display the following information:

- Points in alarm condition pending ACKNOWLEDGE command
- Points which remain in an alarm state but which have been acknowledged
- Communication failures
- Printer status
- Operator Workstations status
- Communication links status
- Controller status

Administration Displays

The system shall provide the following full screen displays:

- Master system menu
- Report summary
- Alarm summary
- Event summary

- Display summary
- System parameters configuration
- Operator Workstation configuration
- Area assignment
- Schedule assignment
- Holiday assignment
- History assignment
- Push-button assignment
- Operator definition
- Operator message board
- Events archive and retrieval
- Time Period summary and configuration
- Point Detail for every configured Point

Applications launcher

It shall be possible to launch any Windows application from within the Operator Interface. For example, a button or menu item shall be able to be created in the EMCS to launch an application such as Microsoft Word.

Operator interface as a web browser

It shall be possible to use the standard operator interface as a browser for viewing information in HTML format. This allows the operator to view information on the Internet or an Intranet without having to activate an external browser application. This enables the operator to view information in HTML while still monitoring and responding to alarms. The operator interface shall provide a mechanism to restrict access to all or particular URL addresses in order to prevent the viewing of undesirable information. The linking of operator displays to particular URL addresses shall be achieved using the Graphical Display Building Tool.

Active Document support

It shall be possible to display Active Documents (such as Microsoft Word or Microsoft Excel documents) through the operator interface by incorporating these documents directly onto displays. The linking of displays to Active Documents shall be achieved using the Graphical Display Building Tool.

Point Collection summary

There shall be an online display of selected points and their current states. It shall be possible to group points together based on common states, areas, controllers or links and place them in a collection. The total number of all points in a collection shall be displayed along with the

number of points in each possible state. An overall summary display shall be provided which shows this information about each point collection.

It shall be possible to simultaneously control points, or subsets of points in the collection.

1125.3 EXECUTION

1125.3.1 Installation

A. Install all equipment, accessories, conduit and interconnecting wiring in a neat and protected manner by skilled and qualified work persons using the latest standard practices of the industry.

B. Unless otherwise specified, meet manufacturers latest printed instructions for materials, planned maintenance and installation methods.

C. Notify Construction Manager in writing of any conflict between these Specifications and manufacturer's instructions. Within 2 weeks of submission of Tender, Contract award may be determined by these deviations. No deviations will be considered after this time period.

D. Coordinate with other Division 15 work and provide the necessary relays, auxiliary contacts and transformers required to interconnect equipment. Retain original equipment suppliers to provide contacts as required.

G. All equipment installed shall be mechanically stable and fixed to wall or floor.

F. Install equipment so as to allow for easy maintenance access and such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.

G. Install equipment in locations providing acceptable ambient conditions for its specified functioning, allowing for adequate ventilation and with no condensation traps.

H. Meet Division 17 installation and materials requirements.

I. Shield and ground communication trunk wiring at a single end.

J. Do not splice trunk cables.

K. Provide complete installation, testing, debugging and interfacing of specified software.

L. Meet & coordinate with Division 17970 EMCS Instrumentation work and provide necessary equipment & interfacing.

1125.3.2 Identification

A. Provide all pieces of supplied equipment with a minimum 25 mm x 75 mm black and white limacoid nameplate with, at minimum, 6 mm high bold lettering and affix to control device or on panel front. Identify in accordance with the shop drawing descriptions. Except where specifically noted otherwise, permanently attach using self-tapping screws or bead chain.

B. Within each field panel provide a complete listing of points connected, system schematic diagrams, calculated point codes and other information useful to assist an operator using a PT for diagnostic purposes. Fasten information to inside of front door using adhesive backed paper, or mount information in sealed plastic covers and secure to field cabinet.

C. Identify all field wiring terminations with labels corresponding to Shop Drawing identifications.

1125.3.3 Power

A. Provide single phase, dedicated ground, nominal 220V/1Ø/60Hz power to the field panels from emergency panels in locations identified to Division. Provide suitably sized breaker compatible with existing power panels, provide wiring from breaker to all equipment unless specifically indicated otherwise.

B. Provide class II 24VAC transformers where required.

C. Under normal conditions, no single power supply shall be operated at more than 75% of its rated maximum continuous load.

1125.3.4 Wiring

A. Provide all wiring required for Instrumentation. Install in IMC conduit or use plenum rated cable, and otherwise comply with Division 17 requirements. Approved plenum cable wire may be used where allowed by code.

B. Provide power wiring from nearest 220-volt emergency powered panel to each field device as required.

C. Provide necessary relays required to interconnect equipment.

D. Install wiring parallel and perpendicular to building planes.

1125.3.5 Training

A. Provide practical training for the owners designated representatives. Direct training towards the requirements of the following user groups:

1. Supervisors: Control, Monitoring including Offsite Monitoring, Report Generation, Data Base Management
2. Operators: Control, Monitoring including Offsite Monitoring and Maintenance

B. Provide training at the site at locations specified by the client. These groups of sessions will be scheduled according to the project schedule and the groups may be held weeks or months apart. Allow 4 full 8-hour days of training for each group (total 16 days) to cover the three user categories above and allow for these days to be staggered to meet the owners schedule. Training sessions will be scheduled during normal working days and during normal working hours, excluding holidays.

C. Training shall cover the complete operation of the EMCS. Supervision training shall include for the software procedures to allow for the appropriate operators or supervisors to add, or modify points, programs, reports or graphics.

D. Provide training specifically directed to controller programming with the Program Editor Module provided.

E. Submit to the Construction Manager, check lists for each system or piece of equipment indicating that all components have been checked and are complete prior to instruction period.

F. Provide all equipment and supplies, as required by the Contractor in order to execute the training program.

G. Submit a complete record of instructions given to the owner's user groups. For each instruction period, supply the following data:

1. Date
2. Duration
3. Agenda: system or equipment involved
4. Names of persons giving instructions
5. Names of persons being instructed
6. Other persons present

H. At least 4 complete sets of approved Draft Final Documentation must be provided before training can begin.

I. Verification of completed training shall be submitted to the Construction Manager prior to final release of holdback.

J. Selected client's representatives shall be sufficiently trained so as to be qualified to perform emergency maintenance during the warranty period, without affecting, in any way, the warranty coverage provided. At the end of such training, provide qualification certificate.

1125.3.6 Warranty and Warranty Service

A. Warrant in writing, all provided equipment, accessories, installations, software and firmware against defects in workmanship and materials for a period of one year commencing from the date of issue of the Certificate of Completion. Include emergency 24-hour service.

B. In addition to the above, provide a supplier onsite warranty for two (2) years minimum to cover all parts, materials and labour for the desktop and portable workstation computers, including monitors.

C. These warranties shall take precedence over any other warranties.

D. Maintain the affected parts operational during repair of defective equipment covered by the warranty.

E. All warranty repairs shall be carried out on site or a replacement component shall be issued to the facility at no charge.

F. During the warranty, all components described above shall be routinely inspected and serviced by trained EMCS technicians with written reports to the owner regarding condition, adjustments or changes made to any equipment following each inspection. Change consumable items such as printer ribbons as required at these inspections.

G. Provide all service at no additional cost during the warranty period, with the specified exception of the supply of consumable items as defined above.

H. Perform a final inspection in conjunction with the client, Construction Manager and Lead Consultant, 60 days prior to the termination of the warranty period. Submit a full report, to the client at least 30 days prior to the termination of the warranty period.

I. During the warranty period, replace or repair all supplied equipment, documentation and software, at no additional cost. All defective equipment and software shall be replaced or repaired as soon as is reasonably possible after it is considered to be defective.

J. Maintain an inventory of sufficient normal replacement parts, components, materials, tools, equipment and testing devices such that repair or replacement can commence within 8 hours of notification of an inoperable condition.

K. At the end of the warranty period, update software such that all software will be the most recent product.

1125.3.7 After Warranty Service Maintenance Contract

A. Submit a Separate Price to provide complete routine and emergency maintenance services on the EMCS for a period of one year following the completion of the warranty period. Base the price upon work being executed during normal working hours. Include separate emergency call out provisions. Prices submitted should be based upon current price lists and labour rates, details of which shall be included within this bid.

B. The maintenance Contract may be renewed annually, at the option of the client, for up to a term of 10years. The price shall be negotiated annually, 3 months in advance of the contract expiry. The price shall be a mutual agreement of both parties, with variations reflecting only changes in material and labour costs that can be substantiated by the Contractor and agreed to by the Owner.

C. It shall be understood that the maintenance Contract shall not commence in any event before the termination of the warranty period.

D. The maintenance contract services shall, at minimum include:

1. Checking the performance of all equipment and components provided under this contract on a regular scheduled basis. Performance checking shall involve diagnostic tests, examination, cleaning, lubrication, adjustment and calibration, as appropriate, together with other functions to maintain the EMCS fully operational and in compliance with these Specifications.
2. Provide labour and material for the repair and replacement of worn or defective equipment and components where such items were initially provided as part of this contract or the EMCS preventive maintenance contract. Replacement items shall be of the same quality as the parts that are replaced.
3. Update all applicable software, as required to meet the intent of this Specification, at maximum, annually, if the client so wishes, such that all EMCS software will be the most recent product.

E. Maintain an inventory of sufficient normal replacement parts, components, materials, tools, equipment and testing devices such that repairs or parts replacement can commence within 8 hours of notification that the EMCS is malfunctioning or inoperable. Major replacement components shall be available within 8 hours of component malfunction.

F. Undertake maintenance with qualified EMCS technicians.

ITEM 1126 EMCS INSTRUMENTATION

1126.1 GENERAL

A. Comply with Division 17, General Requirements and all documents referred to therein.

B. Provide all labor, materials, products, equipment and services to supply, install, wire, calibrate and commission the electronic control and monitoring system instrumentation as specified in the point schedules, in this Specification and as required to make a complete and functional system.

C. The section includes control equipment for HVAC systems and components, including control components for terminal heating & cooling units not supplied with factory-wired controls.

D. Refer to Section 15900 “HVAC Instrumentation and Controls” and provide necessary equipment that relates to this section.

E. Coordinate with other Division 15 work and provide necessary equipment and requirements that relates to this section.

1126.1.1 Work Included

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. ASHRAE 135 (BACnet): Equipment Monitoring and Control System communications protocol developed by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), which enables devices to communicate and exchange information regardless of manufacturer.

E. MS/TP: Master Slave/Token Passing.

F. PC: Personal computer.

G. PID: Proportional plus integral plus derivative.

H. RTD: Resistance temperature detector.

1126.1.2 Definitions

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. ASHRAE 135 (BACnet): Equipment Monitoring and Control System communications protocol developed by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), which enables devices to communicate and exchange information regardless of manufacturer.

E. MS/TP: Master Slave/Token Passing.

F. PC: Personal computer.

G. PID: Proportional plus integral plus derivative.

H. RTD: Resistance temperature detector.

1126.1.3 System Performance

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).

b. Water Flow: Plus or minus 5 percent of full scale.
c. Water Pressure: Plus or minus 2 percent of full scale.
d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
i. Relative Humidity: Plus or minus 5 percent.
j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
l. Airflow (Terminal): Plus or minus 10 percent of full scale.
m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
o. Carbon Monoxide: Plus or minus 5 percent of reading.
p. Carbon Dioxide: Plus or minus 50 ppm.
q. Electrical: Plus or minus 5 percent of reading.

1126.1.4 Submittals

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.

E. Samples for Initial Selection: For each color required, of each type of thermostat [**or sensor**] cover with factory-applied color finishes.

F. Samples for Verification: For each color required, of each type of thermostat [**or sensor**] cover.

G. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

H. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

I. Qualification Data: Supply and Installs EMCS Equipment with minimum of 10 years documentary experience with 24 hours service and maintenance group.

J. Field quality-control test reports.

K. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1126.1.5 Quality Assurance

A. Instrumentation work shall be performed by one firm specializing in the installation of control systems for building environmental control or by the qualified EMCS installer.

B. Products referenced under this Section establish the minimum acceptable standards of product quality, features and performance. Products provided under this Section shall be provided by the same supplier as the EMCS system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with LonWorks and ASHRAE 135 for DDC system components.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Products referenced under this section establish the minimum acceptable standards of products quality, features and performance.

1. Codes

a. Philippine Electrical Code (PEC 2000 Edition)
b. Philippine Electronics Code (PECE)
c. Philippine Fire Code (IRR No. RA9514)
d. Philippine Society of Mechanical Engineers Code (PSME)
e. National Fire Protection Code (NFPA)
f. Applicable Local Ordinances
g. Revised National Building Code and its IRR

2. Standards

a. Underwriters Laboratories (UL)
b. American Society of Testing and Materials (ASTM)
c. National Electrical Manufacturers Association
d. National Fire Protection Association (NFPA)
e. Institute of Electrical and Electronics Engineers (IEEE)
f. American National Standards Institute (ANSI)
g. International Electro-Technical Commission (IEC)
h. American Society of Mechanical Engineers (ASME)
i. Factory Mutual Global – Building Insurer (FM Global)
j. International Standard Organization (ISO: 9000)
k. Other Internationally Accepted Standards

G. Engineer in-charge supervising the work shall be a duly Registered Electronics Engineer under the supervision of Professional Electronics Engineer as required by R.A. 9292 and revised National Building Code.

1126.1.6 Delivery, Storage and Handling

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1126.1.7 Coordination

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 16 Section "Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Division 17 Section 17720 Fire Detection and Alarm System" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

E. Coordinate equipment with Division 16 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

F. Coordinate equipment with Division 16 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

G. Coordinate equipment with Division 16 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

H. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements.

1126.2 PRODUCTS

1126.2.1 Related Work

A. Where the application of any special software package requires additional instrumentation to meet the requirements specified, provide the necessary instrumentation at no additional cost whether or not such instrumentation is identified.

B. Any required additional instrumentation shall meet the requirements of this Section. Submit details for review prior to installation.

C. Provide actuators and terminal unit controller for all VAV, constant volume controllers, fan coil units and other terminal devices. Where possible, have actuators and controls installed in the terminal unit manufacturer’s factory.

1126.2.2 Acceptable Manufacturers

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be

incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1126.2.3 Control System

A. Acceptable Manufacturers:

1. Honeywell
2. Siemens
3. Johnson Controls
4. Enye/ Innotech
5. Schneider
6. Easy I/O/Niagara
7. Delta
8. DEOS
9. Delta Dore
10. ALC

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

D. Control system shall include the following:

1. Building security system specified in Division 17 Section "Security Management System”
2. Building lighting control system specified in Division 16 Section "Lighting Controls."
3. Fire alarm system specified in Division 17 Section "Fire Detection and Alarm System."

1126.2.4 Electronics Sensors

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Acceptable Manufacturers:

    a. BEC Controls Corporation.
    b. Ebtron, Inc.
    c. Heat-Timer Corporation.
    d. I.T.M. Instruments Inc.
    e. MAMAC Systems, Inc.
    f. RDF Corporation.

2. Accuracy: Plus or minus 0.36 deg F (0.2 deg C) at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Exposed, Red-reading glass.
    d. Color: Qualify.
    e. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. RTDs and Transmitters:

1. Acceptable Manufacturers:

    a. BEC Controls Corporation.
    b. MAMAC Systems, Inc.
    c. RDF Corporation.

2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 18 inches (460 mm) long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.

6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Concealed
    b. Set-Point Indication: Concealed
    c. Thermometer: Concealed
    d. Color: Red
    e. Orientation: Vertical

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Acceptable Manufacturers:

    a. BEC Controls Corporation.
    b. General Eastern Instruments.
    c. MAMAC Systems, Inc.
    d. ROTRONIC Instrument Corp.
    e. TCS/Basys Controls.
    f. Vaisala.

2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Concealed
    b. Set-Point Indication: Exposed.
    c. Thermometer: Exposed Red-reading glass.
    d. Color: Qualify.
    e. Orientation: Vertical.

5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F (0 to 50 deg C).
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Acceptable Manufacturers:

a. BEC Controls Corporation.
b. General Eastern Instruments.
c. MAMAC Systems, Inc.
d. ROTRONIC Instrument Corp.
e. TCS/Basys Controls.
f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
b. Output: 4 to 20 mA.
c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 300-psig (2070-kPa) operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room Sensor Cover Construction: Manufacturer's standard locking covers.

a. Set-Point Adjustment: Exposed.
b. Set-Point Indication: Exposed.
c. Thermometer: Red-reading glass.
d. Color: Blue
e. Orientation: Vertical.

G. Room sensor accessories include the following:

a. Insulating Bases: For sensors located on exterior walls.
b. Guards: Locking; heavy-duty; transparent plastic; mounted on separate base
c. Adjusting Key: As required for calibration and cover screws.

1126.2.5 Pneumatic Sensors

A. Pneumatic Transmitters: Vibration and corrosion resistant.

1. Differential-Pressure Transmitters: One pipe, direct acting for gas, liquid, or steam service; pressure sensor and transmitter of linear-output type; with range of 0 to 50 psig (0 to 344 kPa), and 3- to 15-psig (21- to 103-kPa) output signal.
2. Differential-Air-Pressure Transmitters: One pipe, direct acting, double bell; unidirectional with suitable range for expected input; and temperature compensated.

   a. Accuracy: 5 percent of full range and 2 percent of full scale at midrange.
   b. Output Signal: 3 to 15 psig (21 to 103 kPa).

B. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to 0 to 20 psig (0 to 140 kPa).

1. Acceptable Manufacturers:

   a. BEC Controls Corporation.
   b. MAMAC Systems, Inc.

C. Pneumatic Valve/Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

1126.2.6 Status Sensors

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt

hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

1. Acceptable Manufacturers:

a. BEC Controls Corporation.
b. I.T.M. Instruments Inc.

1126.2.7 Gas Detection Equipment

A. Acceptable Manufacturers:

1. B. W. Technologies.
2. CEA Instruments, Inc.
3. Ebtron, Inc.
4. Gems Sensors Inc.
5. Greystone Energy Systems Inc.
6. Honeywell International Inc.; Home & Building Control.
7. INTEC Controls, Inc.
8. I.T.M. Instruments Inc.
9. MSA Canada Inc.
10. QEL/Quatrosense Environmental Limited.
11. Sauter Controls Corporation.
12. Sensidyne, Inc.
13. TSI Incorporated.
14. Vaisala.
15. Vulcain Inc.
16. Automation Components, Inc.

B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 35 and 200 ppm.

C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output, for wall mounting.

D. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

E. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

1126.2.8 Flow Measuring Stations

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Acceptable Manufacturers:

   a. Air Monitor Corporation.
   b. Wetmaster Co., Ltd.

2. Casing: Galvanized-steel frame.
3. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.
4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

1126.2.9 Thermostats

A. Acceptable Manufacturers:

1. Erie Controls.
2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
3. Heat-Timer Corporation.
4. Sauter Controls Corporation.
5. Tekmar Control Systems, Inc.
6. Theben AG - Lumilite Control Technology, Inc.
7. ACI

B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

1. Label switches "FAN HIGH-MED-LOW-OFF".
2. Mount on single electric switch box.

C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.

3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

    a. Time of day.
    b. Actual room temperature.
    c. Programmed temperature.
    d. Programmed time.
    e. Duration of timed override.
    f. Day of week.
    g. System mode indications include "heating," "off," "fan auto," and "fan on."

10. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

1126.2.10 Actuators

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 15 Section "Motors."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Acceptable Manufacturers:

   a. Siemens Building Technologies
   b. Honeywell
   c. Johnson Controls
   d. Enye/Innotech
   e. Schneider
   f. Easy I/O/Niagara
   g. Delta
   h. DEOS
   i. Delta Dore
   j. ALC

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
   e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 230-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).

11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
12. Run Time: 12 seconds open, 5 seconds closed.

1126.2.11 Control Valves

A. Acceptable Manufacturers:

2. Danfoss Inc.; Air Conditioning & Refrigeration Div.
3. Erie Controls.
4. Hayward Industrial Products, Inc.
5. Magnatrol Valve Corporation.
6. Neles-Jamesbury.
7. Parker Hannifin Corporation; Skinner Valve Division.
8. Pneuline Controls.
9. Sauter Controls Corporation.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 5-psig (21-kPa) maximum pressure drop at design flow rate or the following:

    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

1126.2.12 Dampers

A. Acceptable Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

1126.2.13 Control Cable

A. Electronic and fiber-optic cables for control wiring are specified in Division 17 Section "Control – Communication Cable."

1126.3 EXECUTION

1126.3.1 Examination

A. Verify that conditioned power supply is available to control units and operator workstation.

B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

1126.3.2 Installation

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Mount compressor and tank unit on elastomeric mounts Vibration isolators are specified in Division 15 Section “Mechanical Vibration and Seismic Control.” Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer’s written instructions and seismic-control requirements.
   1. Pipe manual and automatic drains to nearest floor drain.
   2. Supply instrument air from compressor units through filter, pressure-reducing valve and pressure relief valve, with pressure gauges and shutoff and bypass valves.

D. Verify location of thermostats, sensors, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.

   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards on thermostats in the following locations:

   1. Entrances.
   2. Public areas.
   3. Where indicated.

F. Install automatic dampers according to Division 15 Section "Duct Accessories."

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Division 15 Section "Mechanical Identification."

I. Install hydronic instrument wells, valves, and other accessories according to Division 15 Section "Hydronic Piping."

J. Install steam and condensate instrument wells, valves, and other accessories according to Division 15 Section "Steam and Condensate Piping."

K. Install refrigerant instrument wells, valves, and other accessories according to Division 15 Section "Refrigerant Piping."

L. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.

M. Install electronic and fiber-optic cables according to Division 17 Section "Control Communication Cable."

1126.3.3 Electrical Wiring and Connection Installation

A. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways and Boxes."

B. Install building wire and cable according to Division 16 Section "Conductors and Cables."

C. Install signal and communication cable according to Division 17 Section "Control Communication Cable."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

1126.3.4 Field Quality Control

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Pressure test control air piping at 30 psig (207 kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
5. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
7. Test each point through its full operating range to verify that safety and operating control set points are as required.
8. Test each control loop to verify stable mode of operation and compliance with sequence of operation.
9. Test each system for compliance with sequence of operation.
10. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

1126.3.5 Adjusting

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.

b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

1126.3.6 Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 1 Section "Demonstration and Training."

ITEM 1127 EMCS INSPECTION AND ACCEPTANCE TESTING

1127.1 GENERAL

1127.1.1 Work Included

A. Comply with Division 1, General Requirements and all documents referred to therein.

B. Provide all labor, materials, products, equipment and services to demonstrate to the Owner and the Consultant, that the equipment, networks, installations, programs and services supplied, installed and tested under this Contract meet the requirements of the Contract Documents in all respects.

C. Engineer in-charge supervising the work shall be a duly Registered Electronics Engineer under the supervision of a Professional Electronics Engineer as required by R.A. 9292 and revised National Building Code.

1127.1.2 Special Testing and Use of Equipment Prior to Acceptance Testing

A. The Owner/Consultant reserves the right to use any piece of equipment, device or material installed under this Contract for such reasonable lengths of time and at such times as they may require to make complete and thorough tests of same before undertaking the final acceptance testing. Do not construe such tests as evidence of acceptance of any part of the contract. No claim for damage will be made by the Contractor for any injury or breakage to any parts of the above due to the aforementioned tests where caused by weakness or inaccuracy of the parts or by defective materials or workmanship of any kind whatsoever.

B. Conduct such operation following prior agreement between the Owner/Consultant and the Contractor as to the format and scheduling of the tests.

C. Arrange work to enable the Owner to change over local air handler control systems to the new system for extended operating periods to ensure proper functioning of software and hardware.

D. Do not withhold consent to the execution of such operation when reasonably requested by the Owner/Consultant.

E. Make EMCS available for the use of the Owner once the individual work items are such that they can be used for their intended function(s) as detailed herein.

F. The warranty period shall not commence until the Owner's Certificate of Substantial Completion is issued.

G. The Owner and/or Consultant reserve the right to defer acceptance testing on any item until all work included in this Contract has been completed by the Contractor or can be fully tested.

H. Draft documentation must be provided before acceptance testing will commence.

1127.2 PRODUCTS

1127.2.1 Test Provisions

A. Provide all equipment, software, consumable items, personnel and facilities as required to reasonably execute any factory or site acceptance tests, including any signal simulation equipment.

1127.2.2 Documentation

A. Submit preliminary as-built drawings and documentation at least 4 weeks prior to the commencement of final acceptance testing. The intent is that this documentation may be used by the Owner and Consultant during the execution of the final acceptance testing.

B. Submit data relevant to point index, functions, limits, sequences, interlocks, software routines and associated parameters and other pertinent information for the operating system and data base.

C. Submit point log sheets to the Consultant at least 4 weeks prior to the test. Submit sample point log sheets for Consultant review prior to completion and final data entry.

D. Submit for acceptance by the Consultant, a total demonstration test plan before commencement of each test/inspection. All hardware and software system components and all other work items shall be fully tested/inspected during the demonstration.

1127.3 EXECUTION

1127.3.1 Site Acceptance Testing

A. Perform a complete demonstration of the EMCS real-time responsibilities of surveillance and command prior to online operation.

B. Advise the Consultant and Owner, in writing, at least 2 weeks in advance of readiness to perform tests.

C. Note deficiencies and correct before starting and continuing tests. Perform calibration and operational checks prior to the commencement of final acceptance testing for all relevant system parts.

D. Perform final acceptance testing at the following defined levels:

1. per point basis
2. per system basis
3. software functions and packages basis
4. per building basis
5. total EMCS basis

E. Make available on site for the duration of these tests, all installation, engineering, software, system and personnel, required to enable test completion.

F. Demonstrate the specified performance of the EMCS software and hardware, at all levels from individual end devices through to total system operation and the proper operation/undertaking of all other items of work performed under this Contract.

G. Specifically orient acceptance test procedures to demonstrate the satisfactory operation of aspects of the operator interface terminals.

H. Perform a complete and detailed calibration and operational check for each individual EMCS point and control function contained within the supplied system. Check to ensure that all equipment, software, network elements, modules and circuits provided are functioning to meet the Specification and record on log sheets.

I. Repeat acceptance testing until acceptable performance has been established.

1127.3.2 Factory Testing

A. Factory testing of hardware or software shall not replace, in whole or in part, site acceptance testing as detailed in this Section.

B. Submit for Consultant review, proposed format of factory tests.

ITEM 1128 TESTING AND COMMISSIONING OF ELECTRONICS SERVICES

1128.1 GENERAL

1128.1.1 Scope of Work

A. Provide any materials, equipment and labour required, and make such tests as specified in the various Electronics Systems and Communication Systems as specified herein, and as otherwise deemed necessary to show proper execution of the work in the presence of the Engineer.

B. Any defect or deficiencies discovered as result of such tests shall be corrected.

C. After the installation is completed and properly adjusted, operating tests shall be conducted. The various equipment and systems shall be demonstrated to operate in accordance with the requirements of the Contract Documents. Tests shall be performed in the presence of the Engineer. Provide electric power, instruments and personnel necessary for performing the various tests.

D. Procedures and tests outlined below are to be considered as in addition to normal visual and mechanical inspections which must be carried out prior to balancing equipment in service.

E. Procedures and test outline below are to be considered as in addition to tests called for under other sections of the electrical specifications.

F. Perform the following tests in the presence of the Engineer:

1. Voltage test shall be made at the last outlet on each circuit. If drop in potential is excessive, correct the condition and re-test the relevant circuit.
2. All cables, after being pulled in place and before being connected, shall be tested by Megger test to determine that conductor insulation resistance is not less than that recommended by cable manufacturer. Four copies of all test shall be furnished to the Architect. All cable failing insulation test shall be removed, replaced and re-tested.
3. All equipment shall pass similar tests and entire system tested after all final connections have been made.

1128.1.2 Testing, Special Requirements

A. The contractor shall take every precaution possible to assure the proper functioning of equipment or systems, and shall adhere to the following procedures.

1. Electronics equipment delivered to job-site during construction shall be protected in such a way that will prevent dirt, dust, water or any other foreign materials from entering or contaminating the working parts. This protection shall also be provided after installation as long as construction operations continue.
2. Before any equipment or system is energized, the following procedures and tests should be followed and/or performed.

    a. Clean all dirt, dust and moisture from equipment.
    b. Check for loose bus and cable connections.
    c. Check for missing insulation in equipment and on conductors.
    d. Check for any modifications, alternations, or the use of unapproved parts in the assembly of the equipment against the approved submittals.
    e. Ascertain that all circuit breaker short interrupting ratings are adequate.
    f. The equipment room or area should be free of moisture accumulations.

B. Ascertain that all equipment is rated for the available fault current.

1128.1.3 Submittals

A. The study result shall be submitted for review in the following form:

1. For the device coordination study, five (5) bound copies of the time current curves, together with a tabulation of relay identification, location and recommended settings. A commentary covering the basis for selection of settings, and suggestions for improvement of coordination and protection shall be included where applicable.

B. Provide system documentations, manuals, source code, back-up system software in 5 sets of DVD copies for future reference and for back-up system.

1128.1.4 Safety and Precautions

A. Safety practices shall be included but are not limited to the following requirements:

1. Local Authority and Insurance Company's Standards/Requirements.
2. Applicable National and Local Safety operating procedures.
3. Owner's safety practices.

B. All tests shall be performed with apparatus de-energized except where otherwise specifically required herein.

C. Power circuits shall have conductors shortened to earth by a hot line grounding device approved for the purpose.

D. In all cases, work shall not proceed until it has been determined that it is safe to do so.

E. The Contractor shall have available, sufficient protective barriers and warning signs to conduct specified tests safety.

1128.2 PRODUCTS

(Not Applicable)

1128.3 EXECUTION

1128.3.1 Testing, Adjusting and Verification

A. Confirm that all protective device schemes function properly. Conduct circuit breaker trip test. Apply correct voltage and current to protective device.

B. During the testing and verification procedure, conduct spot checks on selected devices with representative of the Owner and/or Engineer to adjust and to re-test prospective devices to that final settings will result in performance in accordance with approved issue.

C. Provide factory witness testing to suit delivery schedule of manufacturers. Provide hourly rates etc. to re-witness equipment if initial tests fail.

D. Provide all submission and final report as previously specified.

E. The final report and study shall include assurance for the following items:

1. That the protective devices on the main low voltage equipment is coordinate with the Utility Company protective devices.
2. That the protective devices within the parameters of the study conform to the results of the study.
3. That the equipment has been tested and performs as per the settings of approved coordination curves.
4. That the “as left” condition of the protective device correspond to the record documents.

Complete studies and reports shall be submitted simultaneously to the Engineer as well as part of the requirement of the Project Record Document.

1128.3.2 Commissioning

A. The Contractor shall be responsible for the coordination of all the previously described elements which comprise the whole installation.

B. In addition, the Contractor shall carry out final settings and adjustments and commissioning of the whole installation up to including the incoming circuit breakers of the main low voltage switchboards in accordance with the manufacturer's recommendations and recognized practice.

C. Details of proposed commissioning procedures shall accompany the Contractor's proposal Submission.

ITEM 1129 ALTERNATIVE EQUIPMENT AND SUPPLIERS

1129.1 GENERAL INFORMATION

A. Where a choice of equipment is given, indicate selection by submitting this Section.

B. Where modifications to the work of Other Trades are required as a result or part of the alternative offered, include the cost of said modifications in the alternative price offered.

C. Submit the following list of base bid and alternative suppliers in accordance with Bid requirements.

Spec. Reference Section	Equipment	Base Bid Manufacturer or Supplier	System Integrator
270526	Grounding Electrode	Erico Furse Kumwell	
	Vibration Insulators	Amber/Booth Dynamics Mason Industries Sausse (Vibrex) VOS	
	Flexible Connectors	Crouse-Hinds Honeywell	
270529	Hangers & Supports	Grinnell Gripple Hilti Obo Betterman Unistrut	
078413	Firestopping Materials	3M Hilti Metacaulk Rectoseal Roxtec Specseal Tremco	
271000	Conductors and Cables	Aurora (c/o Saturn) Columbia JJ-LAPP Phelps Dodge Philflex Alternative: Orion (For Megaworld Projects only)	

	Fire Rated Cable	Belden Prysmian Keystone LAPP Nexans Betaflam Sigma Phelps Dodge Far East Cable DOHA Cables Fire Rated Columbia	
	Electrical Tape	3M	
271000	Communications Horizontal Cabling	AMP Netconnect/Tyco Electronics/Krone/ Commscope Anixter Axess Belden/Nordx/CDT Clipsal Draka FIBER-REX General Cable/Carol/ ICSI Leviton LS Cables Nexans Panduit Premium Line Schneider/Actassi Seimon UniCabwire	
270539	Metallic Conduit & Tubing	Allied Matsushita/Panasonic Mcgill Smart Tube Royal Steel Sumitomo	
270539	Non-metallic conduit & Tubing	Atlanta Emerald Moldex Neltex Approved Alternative: Crown Asia	

270539	Wireways/Auxiliary Gutters	Asiaphil Fumaco Gentech GTech Solutions LJ Industrial Fabrication Obo Betterman Powerbox Tomelekt R. S. Thomas System Power Mark Total Versatrunk	
270539	Outlet, Junction, Pullboxes	Amco Amtec Crouse-Hind Fumaco HKK Steel City	
270539	Flexible Connectors	Amtec Crouse-Hinds Honeywell	
270539	Liquid Flexible Steel	Appleton Matsushita/Panasonic	
271000	Wiring Devices	Clipsal Hubbel Legrand / Bticino MK Electric National/Panasonic Toshiba	
272100	Switches and Routers	Allied Telesis Cisco Dell HP/Aruba Huawei Juniper Meraki Netgear TOMO TP Link	
271500	Communicating Horizontal Cabling	AMP Netconnect/Tyco Anixter Axess Belden/Nordx/CDT Clipsal Draka FIBER-REX Fiberhome General Cable/Carol ICSI Legrand / Bticino	AFLA ANSSII Digicom DTSI EC&M IBMS ISDN Lantro MCM Micro Genesis Mighty Lynx

		Leviton LS Cables Nexans Panduit Premium Line Schneider/Actassi Seimon Uni Cabwire Alternative: Alantek	Multi-line Pastels, Inc. Pronet Saturn Beta Solvento Stelsen Techspectrum TISSI TSI
280000	Conductors & Cables for Electronic Safety and Security	AMP Netconnect/Tyco Electronics/Krone/ Commscope Anixter Belden/Nordx/CDT Cavicel Clipsal Draka FIBER-REX General Cable/Carol/ ICSI Legrand / Bticino Leviton LS Cables Panduit Premium Line Schneider/Actassi Seimon Uni Cabwire Alternative: Alantek	
284600	Fire Detection and Alarm System **(FDAS)**	***Apollo*** ***Carrier*** Cooper Edwards/EST ***EATON*** ***Global Fire Equipment*** Hochiki Honeywell Integlex/Nohmi Bosai ***Kidde*** ***Kingfisher*** ***Maple*** ***Nittan*** Notifier/Morley/SS ***Securiton*** Siemens/Cerberus	***ANSSII*** Avesco ***Beta*** ***Calvelo*** ***Circuit Solutions*** CMRP Comfac Electro Systems ***Extinguished*** ***FlexNet*** FPI ***Geanaux*** ***ISR*** Loxon ***Mighty Lynx***

		Tyco/Simplex UTC/GE **Approved Alternative:** Bosch ***GST*** ***Mircom*** Panasonic (UL Certified devices only) Potter (UL Certified devices only) ***Protec***	Multi-line ***Mustard Seed*** ***OSP*** PID Prestige Pronet Pulser ***Stelsen*** ***System Hub*** TISSI ***UES*** Yek-Yeu
281000	Access Control System **(ACS)**	Amano Bosch Bostex/Niagara CEM DSC Entrypass Falco Gallagher Gallaqher GE/UTC ***Genetec*** HID ***HikVision*** Hirsch Hirsch Honeywell Igloohome Kantech ***Keri Systems*** Lenel Matrix Park Tronix Parktron Siemens Skidata Smart Park ***Suprema*** TAC by Schneider Samsung Tyco Sensormatic UTC/GE **Approved Alternative:** *HikVision* *Chiyu*	***8Technologies*** Adtel Avesco ***Calvelo*** ***Circuit Solutions*** Comfac Cylix DIgiflash Electro-Systems ENJ ESSCOR Explorelink Fairetech i3 Technologies IBMS ICSI ***Inewvation*** ***Intellismart*** ***IoT*** ISDN ***ISR*** ***Kempal*** MCM ***Mighty Lynx*** Multi-line Optimum Equipment Pronet TISSI ***UES*** Yek-Yeu

253000	Equipment Monitoring and Control System **(EMCS)**	***ABB*** ALC ***Alerton*** ***Azbil*** Delta Controls Delta Dore DEOS ***Diamond Controls*** ***Distech Controls*** Easy I/O/Niagara Enye Controls/Innotech Honeywell Johnson Controls ***Nenutec*** Schneider Siemens	Azbil Beta Calvelo CMRP Enye Controls ***FlexNet*** ***Ideal Controls*** ***IEEI*** ISDN Linkwise Lonworks ***Loxon*** Multi-line Optimum OSP P.T. Cerna PID Pronet Tratek Asia ***UES*** Uniwell Yek-Yeu