

Part 1 General

1.1 GENERAL

- .1 This Section covers items common to all Sections of Division 23 and 25.
- .2 Coordinate location and installation of all equipment with all trades to ensure the equipment with all trades to ensure the equipment is serviceable.
- .3 Prime mechanical contractor shall be responsible to ensure that all requirements of Division 23 and 25 are met and comply with all other divisions and contract documents.
- .4 The word “provide” shall mean “supply, install, test and commission”.

1.2 RELATED REQUIREMENTS

- .1 Section 23 05 05 - Pipework
- .2 Section 23 05 17 - Pipe Welding
- .3 Section 23 05 23 - Valves
- .4 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .5 Section 23 31 13 - Metal Ducts
- .6 Section 23 32 48 - Silencers
- .7 Section 23 37 20 – Louvres
- .8 Section 25 90 01 EMCS Site Requirements, Of Applications & Systems Sequences Operation
- .9 Section 28 31 00 – Fire Detection and Alarm

1.3 EQUIPMENT LIST

- .1 Complete a list of equipment and materials to be used on this project and forming part of tender documents by adding Manufacturer’s name, model number and details of materials, and submit for approval.
- .2 Any costs associated with deviations of mechanical equipment electrical ratings affecting electrical Division 26 shall be carried by this contract.

1.4 EQUIPMENT INSTALLATION

- .1 Unions, flanges, and/or couplings: provide for ease of maintenance and disassembly.
 - .2 Space for servicing, disassembly, and removal of equipment and components: provide as recommended by the Manufacturer, Code or as indicated; whichever is the more stringent.
 - .3 Equipment drains: pipe to floor drains in a manner which non-obstructing or a trip hazard.
 - .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.
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- .5 Provide new materials and equipment of proven design, quality and of current models with published ratings for which replacement parts are readily available.
 - .6 Uniformity:
 - .1 Use product of one Manufacturer unless otherwise specified, for equipment or material of the same type of classification.
 - .2 Installation:
 - .1 Unless otherwise specified, follow the Manufacturer's recommendations for safety, adequate access for inspection, maintenance and repairs.
 - .2 Permit equipment maintenance and disassembly with minimum disturbance to connecting piping and duct systems without interference with building structure or other equipment.
 - .3 Lubrication:
 - .1 Provide accessible lubricating means for bearings, including permanent lubrication "Lifetime" bearings. Extended grease nipples to be supplied.

1.5 EQUIPMENT INSTALLATION

- .1 There are existing TRANE air handling units requiring assembly.
- .2 AHU-7 & 8:
 - .1 Erect and install unit on a flat surface level within 3mm and of sufficient strength to support the unit.
 - .2 Provide components furnished as per manufacturer's literature.
 - .3 Provide all water, steam and condensate piping so water circuits are serviceable, without having to dismantle excessive lengths of pipe.
 - .4 Provide valves in water piping upstream and downstream of each coil for isolating the coils for maintenance and to balance and trim the system. Install valves and accessories so that coils can be removed without excessive removal of control valves and services.
 - .5 Provide drain valves and vent cocks to each coil.
 - .6 Provide strainers ahead of all pumps and controls valves.
 - .7 Provide certified wiring schematics to the electrical division for the equipment and controls.
 - .8 Provide all necessary control wiring as recommended by the manufacturer and specified herein.
 - .9 Provide condensate traps in accordance with manufacturers recommendations.
 - .10 Insulate all piping c/w jacket where indicated.
 - .11 Provide ductwork connections to new unit c/w bypass ductwork. Provide flexible ductwork at all connections to new unit.
 - .12 Contractor shall provide for a complete and operable installation of the new units.

1.6 ANCHOR BOLTS AND TEMPLATES

- .1 Supply anchor bolts and templates for installation by other divisions.
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1.7 TRIAL USAGE

- .1 Departmental Representative may use equipment and systems for test purposes or for continuity of operation prior to acceptance. Supply labour, material, and instruments required for testing and operation. Duration of testing will be fifteen (15) days.

1.8 PROTECTION OF OPENINGS

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system. Provide temporary caps or same material as system to be protected. Filter media shall not be an acceptable means of system protection.

1.9 ELECTRICAL

- .1 Electrical work to conform to Division 26 including the following:
 - .1 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems. Refer to Division 26 for quality of materials and workmanship.
 - .2 Any costs associated with deviation of mechanical equipment rating affecting electrical Division 26 shall be carried by this contract.
 - .3 All control wiring and conduit associated with AHU-7 and AHU-8 controls shall be provided by Divisions 21, 23, and 25 including power wiring to all control panels, interconnection between the AHUs and other field-mounted control devices. Emergency power circuits are provided by Division 26 in the vicinity of the power source.
 - .4 All control wiring and conduit associated with Building Automation System and HVAC controls shall be provided by Divisions 21, 23, and 25 including power wiring to all control panels and other field-mounted control devices. Emergency power circuits are provided by Division 26 in the vicinity of the power source.

1.10 IDENTIFICATION AND NAMEPLATES

- .1 Nameplates shall be provided for all control items listed or shown approved control diagrams. Each inscription shall identify its function, such as "mixed air output transducer", "cold deck sensor", etc.
 - .2 All panels and items mounted on panel faces shall be identified by laminated plastic nameplates three 3 mm thick Melamine plastic white with black centre core. Surface shall be a matte finish. All corners shall be square. The lettering shall be accurately aligned and engraved into the white core. Size of nameplates shall be 25 mm by 67 mm minimum. Lettering shall be minimum 7 mm high normal black lettering.
 - .3 Field Sensors, Controlled Devices, and Interior Panel Components shall be identified by 5 cm x 10 cm plastic enclosed cards attached to the device by chain. Data to include: point name, schematic drawing designation number, model number, capillary length, size, range, set point, and other pertinent data. Print shall be 5 mm high and produced from a laser printer in dark black.
 - .4 Room sensing elements are to be similarly identified by stick on labels on the inside cover. The point name shall be displayed on the face of the cover by engraved or laminated nameplates.
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- .5 Submit samples of identification tags and lists of wording proposed to Departmental Representative for approval. Indicate character height and line thickness.
 - .6 All Controller and companion cabinet interior components must be labelled.

1.11 WIRING AND IDENTIFICATION

- .1 In accordance with Section 26 05 00 – Common Work Results for Electrical
- .2 Provide numbered plastic ring markings on all branch control wiring.
- .3 Use colour-coded wires in communication cables, maintain colour coding throughout.
- .4 Identify all power sources at each panel location.

1.12 PREPARATION FOR FIRESTOPPING

- .1 Fire-stopping material and installation within annular space between pipes, ducts, insulation, and adjacent fire separation: specified in Section 07 84 00 – Fire Stopping.
- .2 Uninsulated, unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe to move without damaging fire-stopping material.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation

1.13 SPARE PARTS & SPECIAL TOOLS

- .1 Provide in accordance with Section 01 78 00 – Closeout Submittals.

1.14 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
 - .2 One-line diagram from sensor and control points to Field Interface device and/or Terminal Control Unit including all components and cables.
 - .3 All instruments, control devices, attachments and accessories, complete with specifications and calibration details. Indicate controller and auxiliary control cabinet locations.
 - .4 Control diagrams, sequence for operations, and control logic for each controlled area.
 - .5 Complete the valve and actuator schedule listing including the following information:
 - .1 Designation
 - .2 Service
 - .3 Unit model
 - .4 Point I.D.
 - .5 Design flow
 - .6 Pressure drop
 - .7 Required CV
 - .8 Valve size
 - .9 Actual CV
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- .6 Show drawing for each input/output device, showing all information associated with each particular point including:
 - .1 Sensing element type and location
 - .2 Transmitter type and range
 - .3 Details of associated field wiring schematics, schedules and termination's
 - .4 Point address
 - .5 Set points or curves or graphs and alarm limits (H + L, 3 types) and signal range
 - .6 Manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter

1.15 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 73 00 – Execution Requirements.
 - .1 Leave work area clean at end of each day.
 - .2 Final Cleaning:
 - .1 Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 211 – Construction Demolition Waste Management Disposal.

Prior to turnover to Departmental Representative, clean interior and exterior of all new systems. Replace all air and hydronic filters on new and modified systems. Vacuum interior of new and modified ductwork and air handling units.

1.16 CONFLICT/CO-ORDINATION DRAWINGS

- .1 For congested areas, prior to installation the Contractor shall prepare interference drawings indicating proposed location of all systems and equipment including ductwork, piping, fans, diffusers, conduits, lighting fixtures, etc. Prior to installation the Contractor shall submit the drawings to the Departmental Representative for review.
 - .1 At minimum provide conflict drawings for the following areas:
 - .1 Mechanical room M-6.
 - .2 Architectural, structural, and electrical outlines may be shown to assist in coordination of work; confirm final arrangements before layout of mechanical work.
 - .3 Do not scale from drawings.
 - .4 Except where dimensioned, drawings indicate general mechanical layouts only.
 - .5 Provide field drawings to show relative positions of various services. Obtain approval before beginning work. Drawings must show coordination between all equipment and systems within the given space. All sub-trades to coordinate their work in conjunction with others.
 - .6 Within two (2) weeks of Award of Contract, mechanical and electrical trades to verify that proposed rooms, shafts, chases, reflected ceiling elevations, etc. provide adequate space for the installation of mechanical and electrical systems. This is to identify if there are any spatial shortcomings and to give adequate time for the Departmental Representative and
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trades to make any dimensional changes and to make clear to all trades where items are to be installed. Installation and layout will not be on a first come first layout basis.

- .7 If this procedure is not followed the Contractor shall be responsible for all modifications required to integrate the systems and equipment.

1.17 LOCATION OF MECHANICAL EQUIPMENT

- .1 Allow for 1500 mm of adjustment for exact location of air handling units, ducts, piping, etc. at no extra cost or credit.

1.18 CUTTING, PATCHING, AND CORING

- .1 Provide cutting, patching and coring of all walls, ceiling and concrete slabs and other surfaces as required for mechanical work. Check with Departmental Representative prior to core drilling and cutting of structure regarding building requirements and policies. Provide notification, clearance, and protection.
- .2 The following procedure shall be followed for cutting and core drilling:
 - .1 The Contractor is to coordinate and summarize all new cores and openings in building structure. The Contractor is to investigate on site and locate any existing available hole which may be re-used for new systems.
 - .2 The Contractor is to prepare a layout sketch showing all existing openings and holes and required new openings and holes, with size and locations to the closest grid line in both directions, and submit for review and approval by the Departmental Representative.
 - .3 Refer to the structural documents for requirements for reinforcing at each location.
 - .4 The Contractor is to proceed with reinforcing tracing as per requirements and scanning for electrical conduit. Scanning to be completed using ground penetrating Radar (GPR) technology.
 - .5 The Contractor shall identify at each location prior to coring and cutting the location, direction and layer of each reinforcing bar and conduit.
 - .6 Any core or opening where reinforcing steel was cut during the cutting and coring process must be retained on site, and the Contractor must inform the Departmental Representative with the following information: size of the reinforcing bar, reinforcing layer location (top steel or bottom slab steel) and direction of the bar (east – west or north – south).
- .3 Patch and make good surfaces cut, damaged or disturbed, to the Departmental Representative's approval.
- .4 Provide dust-tight screens or partitions to localize dust generating activities and for protection of finished areas of work, workers, and the public.
- .5 Refer to special precautions required for work within or penetrating the clean room areas.

1.19 MECHANICAL PROGRESS BILLING BREAKDOWN

- .1 Upon award of contract, provide mechanical progress billing breakdown in accordance with Section 01 73 00 – Execution Requirements.
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1.20 TESTING ADJUSTING AND BALANCING (TAB) FOR HVAC

- .1 Contractor shall allow for complete testing, adjusting and balancing of system within tender quotation. Allow for two (2) days of on site assistance during testing, balancing and commissioning for coordination efforts with mechanical contractor, controls contractor and Department Representative.
- .2 Purpose:
 - .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
 - .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal operating conditions and emergency conditions.
 - .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges and modes.

1.21 DEMONSTRATION AND TRAINING

- .1 The Contractor shall provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being general “canned” training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach.
 - .2 Provide one (1) - eight (8) hour day of classroom instruction. One (1) comprehensive training manual (English) shall be provided for each trainee which describes in detail the data included in each training program. All equipment and material required for classroom training shall be provided by the Contractor.
 - .3 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the equipment location.
 - .4 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
 - .5 Review contents of manual in detail to explain aspects of operation and maintenance.
 - .6 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.
 - .7 Training Program:
 - .1 Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. This phase shall be augmented with on-the-job training during the fifteen (15) day acceptance period. Training shall include the following:
 - .1 General EMCS architecture (overview).
 - .2 On-site review of all system components with brief descriptions of functions and details.
 - .3 System Communications (overview).
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- .4 Operator interface functions for control of HVAC systems (detailed).
- .5 Control descriptive logic (detailed for each system).
- .6 Report generation (overview).
- .7 Elementary preventative maintenance (detailed).
 - .1 General equipment layout.
 - .2 Troubleshooting of all EMCS components.
 - .3 Preventative maintenance of all EMCS components.
 - .4 Sensors and controls maintenance and calibration.

1.22 DFL MECHANICAL STANDARDS

- .1 All materials and workmanship shall - as a minimum - be in accordance with the latest edition of the following:
 - .1 National Building Code - NBC,
 - .2 Ontario Building Code (OBC),
 - .3 AN / CGA - b149.1 & .2, ASHRAE 90.1
 - .4 Ontario plumbing & fire codes,
 - .5 NFPA standards, particularly NFPA 13, 14 & 96,
 - .6 All other applicable provincial, municipal and safety codes and regulations.
- .2 Confirm all piping / ductwork dimensions and elevations on site prior to installation or ordering equipment. Contractor shall allow
 - 1. Contractor to arrange for all necessary hot work permits, allow for 24 hours' notice at least for Departmental Representative to issue.
 - 2. Be responsible for removal and reinstating ceilings as necessary. Protect T-bar grid & tiles during work.
 - 3. Contractor shall be responsible for relocating any services obstructing the path of new piping / ductwork / equipment and shall do so after Departmental Representative's approval and at no additional cost.
 - 4. Smoke eaters & powered exhaust fans vented to outside of building must be used during all brazing / welding / soldering / cutting / grinding activities to minimize contamination & odor to adjacent areas particularly in clean rooms.
 - 5. All building HVAC return / exhaust grills within construction area must be blocked at all times during construction. Provide dust seals or temporary filters on all supply diffusers. Do not operate HVAC until final clean-up.
 - 6. Contractor to provide complete system of pipe supports and to anchor all piping in accordance with MSS SP-58 and MSS SP-69 and to match existing building supports. All supports & hangers

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- to be e. MYATT, ITT Grinnell, copper b-line or approved equal. Provide full support plan to Departmental Representative for approval before commencing work.
7. Contractor to support piping from structural members with clevis hangers at adequate spacing to insure no sag or failure of joints. Adequately brace piping and allow for expansion or contraction. Provide expansion loops or joints sized to compensate for changes in pipe length caused by a temperature differential of 65°C (150°F)
 8. Use of perforated band, wire chain or solid ring type hangers is not permitted.
 9. Use of c-clamps on beams is not permitted, use beam clamp to support all threaded rods.
 10. Several systems or part of systems will be subject to a shut-down period. Be responsible for having all necessary tools, manpower and equipment required to maximize the production during a shut-down. All shut downs shall be coordinated with Departmental Representative with a 48 hours' notice.
 11. Verify the exact location of existing services and mains to be tying-in, removed or capped prior to commencing work.
 12. Provide vibration hanger kit & duct flexible connections to all ceiling exhaust fans. Wire bridge all duct connectors for electrical continuity, use #8 AWG.
 13. Use flat bottom duct transition pieces for effective drainage.
 14. All duct work and sheet metal shall be in accordance with S.M.A.C.N.A. - low velocity system.
 15. Seal all longitudinal and circumference duct joints with high velocity duct sealer, "Duro Dyne" or approved equal.
 16. As a minimum, provide 25mm thick, heavy density, rigid fiberglass insulation with vapor barrier and jacketing on all plumbing piping. Insulate the last 3048mm from outside of all exhaust & fresh air intake ductwork with 38mm fiberglass wrap. All insulation joints to be staggered. All joints to be taped with foil tape, electric tape is not permitted. Provide removable insulation joints at all valves & unions with Velcro strips.
 17. All exposed jacketing to be GCI 0.4mm Alumaclad, pebbled (stucco) finish.
 18. Provide 305mm insulation protection galvanized shield / saddle plates with lock tabs at each pipe hanger location.
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19. All piping to be pressure tested for a minimum of 24 hours and in accordance with the code requirements, do not conceal or insulate any piping until tested, inspected & approved by Departmental Representative.
 20. Provide new volume control and splitter dampers on all new and modified ductwork. Fire dampers must be provided on all ducts or air transfer openings penetrating a building fire separation.
 21. Flexible ducts shall be limited to a maximum length of 1828mm and minimum diameter of 152mm.
 22. All HVAC controls and wiring shall be sized, selected by a specialized controls sub-trade in full accordance with equipment manufacturer recommendations.
 23. Isolate copper pipe from hanger or other piping where electrolytic action can occur.
 24. Vent and prime all p-trap fixtures in accordance with the Ontario latest edition plumbing code. Use automatic primers, "Ancon" or "Zurn" at all new & existing floor drains. All fixtures vent to be connected to the building common plumbing vents.
 25. Approved plumbing accessories & valves: Ancon, Zurn, Watts or Crane.
 26. All drainage and vent piping to be cast iron with MJ joints or DWV copper as rated by manufacturers for return air plenum use and approved by code.
 27. All plumbing piping shall be type "L" new copper with lead free soldered joints unless otherwise specified.
 28. All temperature & pressure gauges to be 102-127mm dial size, stainless steel & glycerin fill. Use thermos-wells on all temperature gauges.
 29. Use VMC Korfund Maxi-Flex neoprene mounting floor pads on all heavy equipment to isolate vibration & protect flooring. Grade / color to match load.
 30. Use Parker QIX filter / regulator w/ gauge at all compressed air terminals, model B20-G.
 31. Use Armstrong CBV for all circuit balancing valves.
 32. All fire protection work to be carried out by CFAA technicians. Distribute all pendant sprinkler heads in accordance with NFPA-13 ordinary hazards classification. All new pendants heads to be recessed series RFII – Royal Flush II by TYCO – model# TY3551 or approved equal.
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33. Label all piping, equipment & ductwork with reference to their service and location. Use W.H.Brady labels style, B-946 vinyl film, 50mm wide. Match building identification / labeling system as follow:

- 33.1 White letters & arrows on green tape:
 - 33.1.1 Domestic & separated cold water
 - 33.1.2 Chilled water supply & return
 - 33.1.3 Condensed & tower water supply & return
 - 33.1.4 Drainage, sanitary, storm & vents
 - 33.1.5 HVAC supply & return, exhaust air & fresh air intake ductwork
- 33.2 Black letters & arrows on yellow tape:
 - 33.2.1 Domestic hot water
 - 33.2.2 Heating water supply & return
 - 33.2.3 Compressed air
- 33.3 White letters & arrows on red tape:
 - 33.3.1 Fire & sprinklers protection system
- 33.4 White letters & arrows on blue tape:
 - 33.4.1 Lab services (LN2, GN2 supply, purge & vents)

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 SEISMIC RESTRAINT

- .1 Provide services of a Seismic Engineer licensed in the province of Ontario for the seismic design of isolation and seismic restraint and control.
 - .2 Seismic restraints are to be provided for all operational and functional components of mechanical building systems in accordance with National Building Code, ASHRAE Standard – A Practical Guide to Seismic Restraint, SMACNA – Seismic Restraint Manual.
 - .3 At the completion of the project the Seismic Engineer shall review the installations on site, and shall prepare a written report with a sealed letter certifying that the installations have been completed in accordance with their design and shop drawings.
 - .4 Provide seismic restraint for the following systems:
 - .1 Pipe equal or larger than:
 - .1 65 mm diameter pipe in general areas
 - .2 30 mm diameter pipe in mechanical rooms
 - .3 25 mm diameter pipe containing natural gas.
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- .4 Any trapeze suspension, supporting items with a combined weight that exceeds the above items.
 - .2 Duct equal or larger than:
 - .1 0.55m² cross sectional area of duct.
 - .3 Base Mounted Equipment
 - .1 All base mounted equipment that meets any of the following conditions requires attachments and seismic restrain as specified by the Seismic Engineer:
 - .1 Connected to natural gas, or
 - .2 With an overturning movement, or
 - .3 Greater than 181 kg of operational weight.
 - .5 Elastomeric pads:
 - .1 Neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
 - .2 Rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
 - .6 Elastomeric mounts:
 - .1 Colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.
 - .7 Springs:
 - .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than
 - .2 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
 - .3 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
 - .4 Cadmium plate for outdoor installations.
 - .5 Colour code springs.
 - .8 Hangers:
 - .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
 - .2 Stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

3.2 PAINTING

- .1 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
 - .2 Prime and touch up marred, finished paintwork to match original. Use primer or enamel to match original. Do not paint over the nameplates.
 - .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.
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- .4 Hangers, supports, and equipment fabricated from ferrous metals shall be given at least one coat of corrosion resistant primer paint before shipment to the job site.
 - .5 Touch-up damaged surfaces of all mechanical equipment and materials, to the satisfaction of the Departmental Representative. Use primer or enamel to match the original. Do not paint over the nameplates.
 - .6 Provide materials and labour to prime and paint all exposed ductwork in Bay 3, and Mechanical Room M6 after ductwork installation using brush or roller application.
 - .7 Contractor shall provide colour schedule to Departmental Representative, prior to painting.

3.3 TESTING

- .1 General:
 - .1 Test and verify all major subsystems of the complete EMCS including all field components.
 - .2 Testing shall be done in phases under the direction of the Departmental Representative.
 - .3 The Contractor shall provide all test equipment. Two-way radios will be provided by the Departmental Representative.
 - .4 All test equipment such as digital thermometers, humidistat, volumeters, and milliamp and volt meters shall be certified as accurate by an independent testing laboratory no later than one (1) month prior to the tests.
 - .5 Notify the Departmental Representative in writing at least seven (7) days before testing is to take place.
 - .6 Provide all necessary personnel and co-ordination with other trades.
 - .7 Perform tests in presence of the Departmental Representative.
 - .8 Demonstrate the proper operation of each component.
 - .9 Correct any deficiencies and re-test in the presence of the Departmental Representative, until designated part of the system performs satisfactorily.
 - .10 Acceptance of tests by the Departmental Representative shall not relieve the Contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

3.4 COMPLETION TESTS

- .1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.
 - .2 Test and calibrate all field and OWS hardware including stand alone capabilities of each Controller.
 - .3 Verify each Analog to Digital converter.
 - .4 Check all operating software.
 - .5 Check all application software. Provide samples of all logs and commands.
 - .6 Verify each CDL including energy optimization programs.
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- .7 Check all alarms for proper operation by actual trip of field instrumentation and equipment. Obtain Departmental Representative's authorization before proceeding.
 - .8 Debug all software.
 - .9 Blow out flow measuring and static pressure stations with high pressure air.

3.5 FINAL OPERATIONAL ACCEPTANCE TEST

- .1 A final operational test of not less than fifteen (15) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total EMCS system and all monitored and controlled equipment included in this Tender.
 - .2 Demonstrate that it is functioning properly in accordance with all requirements of this specification.
 - .3 The correct operation of all monitored controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software.
 - .4 If the equipment operates at an average effectiveness level (AEL) of at least 99% during the performance test period of fifteen (15) consecutive calendar days, it will be deemed to have met Standard of Performance, and final acceptance of the system shall be made, provided the Contractor has satisfied all other requirements of this specification.
 - .5 In the event the required AEL is not reached during the initial fifteen (15) calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for fifteen (15) consecutive calendar days. The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period.
 - .6 Downtime shall result whenever the EMCS is unable to fulfill all required functions detailed within this specification due to any malfunction of either hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed.
 - .7 System downtime for each incident shall be measured by those intervals during the performance period between the time that the Contractor or duly authorized representative is notified of equipment failure and the time that the system is returned to proper operating condition. Notification of down time shall be by means of OWS located in the Contractor's office and a modem to the system. Downtime of the system resulting from the causes as follows will not be considered as system failures:
 - .1 Downtime resulting from an outage of the main power supply in excess of the capability of any back-up power source(s), provided that the automatic initiation of all back-up sources was accomplished and provided that the automatic shutdown and restart of components fulfills the requirements of this specification.
 - .2 Failure of a communications link, provided that the Controllers automatically and correctly operates in the stand-alone mode and provided that the failure was not due to a failure of Contractor-furnished equipment.
 - .3 A functional failure resulting from an individual sensor or controller provided that the system has recorded the fault, the mechanical equipment is defaulted to the
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fail-safe mode, and that the AEL of the total of sensors and controllers is at least 99% during the thirty-day test period.

3.6 FINAL COMMISSIONING

- .1 When the Contractor is satisfied as to proper system operation they shall advise the Departmental Representative to establish a date for detailed Final Acceptance. This will involve a point-by-point check of all hardware and software items including graphics and displayed data, as well as perform tasks as directed.
- .2 This phase of the work shall be carried out under the complete direction of the Departmental Representative or his authorised representative.
- .3 Provide at least one (1) technical personnel capable of re-calibrating all field hardware and modifying software.
- .4 Provide a detailed daily schedule showing items to be tested and personnel available. All equipment must be verified locally for operation and alarms.
- .5 The key document for recording the commissioning shall be a listing of the system data base. The document shall be prepared by the EMCS Contractor for the Departmental Representative's approval. This listing shall include the key name or tag, English description, point type and address, engineering units, low and high limits, and a space for remarks and Departmental Representative's acceptance signature.
- .6 The Departmental Representative's acceptance signature shall also be required for all executive and application programs as specified.
- .7 Once final commissioning is complete provide a complete new set of filters for all equipment.

3.7 DEMONSTRATION

- .1 The Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, materials, and instruments required for testing.
- .2 Trial usage to apply to the following equipment and systems:
 - .1 AHU-7 & 8.
 - .2 Humidifier and control valves.
 - .3 Duct Systems.
 - .4 Controls.
 - .5 Fire Alarm Connections Interlocks.
 - .6 EMCS and sequences of operation.
- .3 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operations and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials