

SECTION 23 30 00

HVAC AIR DISTRIBUTION
05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 52.2 (2017) Method of Testing General
Ventilation Air-Cleaning Devices for
Removal Efficiency by Particle Size

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (2018) Standard for the Installation of
Air Conditioning and Ventilating Systems

NFPA 96 (2017; TIA 17-1) Standard for Ventilation
Control and Fire Protection of Commercial
Cooking Operations

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1819 (2002) Fire, Smoke and Radiation Damper
Installation Guide for HVAC Systems, 5th
Edition

UNDERWRITERS LABORATORIES (UL)

UL 555 (2006; Reprint Aug 2016) UL Standard for
Safety Fire Dampers

UL 555S (2014; Reprint Aug 2016) UL Standard for
Safety Smoke Dampers

UL 705 (2017; Reprint Oct 2018) UL Standard for
Safety Power Ventilators

UL Electrical Construction (2012) Electrical Construction Equipment
Directory

UL Fire Resistance (2014) Fire Resistance Directory

JAPANESE STANDARDS ASSOCIATION (JSA)

JIS A 1400 (2007) Radiators, Convectors and Similar
Appliances-Methods of Performance Test

JIS A 4009	(2017) Components of Air Duct
JIS A 9504	(2021) Man Made Mineral Fibre Thermal Insulation Materials
JIS A 9511	(2021) Preformed Cellular Plastics Thermal Insulation Materials
JIS B 1518	(2013) Rolling Bearings-Dynamic Load Ratings and Rating Life
JIS B 1521	(2012) Rolling Bearings-Deep Groove Ball Bearings
JIS B 1534	(2013) Rolling Bearings-Tapered Roller Bearings
JIS B 8330	(2000) Testing Methods for Turbo-Fans
JIS B 8616	(2015) Package Air Conditioners
JIS B 8628	(2017) Air to Air Heat and Energy Exchanger and Ventilators
JIS B 9908-1	(2019) Test Method of Air Filter Units for Ventilation and Electric Air Cleaners for Ventilation-Part 1: Technical Specifications, Requirements and Classification System Based Upon Particulate Matter Efficiency
JIS B 9927	(1999) Cleanroom-Air Filters-Test Methods
JIS C 4203	(2010) Single Phase Induction Motors for General Purpose (Amendment 1)
JIS C 4212	(2010; R 2022) Low-Voltage Three-Phase Squirrel-Cage High-Efficiency Induction Motors (Amendment 1)
JIS C 9603	(1988) Ventilating Fans
JIS C 9803	(1999) Household Electric Direct-Acting Room Heaters-Methods for Measuring Performance
JIS G 3302	(2022) Hot Dip Zinc Coated Steel Sheet and Strip
JIS G 3452	(2016) Carbon Steel Pipes for Ordinary Piping (Amendment 1)
JIS G 3553	(2011) Crimped Wire Cloth (Amendment 1)
JIS G 4305	(2015) Cold-Rolled Stainless Steel Plate, Sheet and Strip (Amendment 1)
JIS H 3100	(2018) Copper and Copper Alloy Sheets,

Plates and Strips

JIS H 3300	(2018) Copper and Copper Alloy Seamless Pipes and Tubes
JIS H 4000	(2017) Aluminium and Aluminium Alloy Sheets, Strips and Plates (Amendment 1)
JIS H 8610	(1999) Electroplated-Coatings of Zinc on Iron or Steel
JIS H 8641	(2021) Hot Dip Galvanized Coatings
JIS HB 71	(2019) Electrical Safety
JIS K 5600-5-5	(1999) Testing Methods for Paints- Part 5 : Mechanical Property of Film Section 5 : Scratch Hardness (Stylus Method)
JIS K 5600-5-6	(1999) Testing Methods for Paints - Part 5 : Mechanical Property of Film-Section 6 : Adhesion Test (Cross-Cut Test)
JIS K 5600-7-9	(2006) Testing Methods for Paints Part 7 : Determination Of Resistance to Cyclic Corrosion Conditions Section 9 : Salt Fog/Dry/Humidity
JIS K 6741	(2016; R 2021) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipes
JIS Z 2330	(2012) Non-Destructive Testing-Selection of Leak Testing Method
JIS Z 2371	(2015) Methods of Salt Spray Testing
JIS Z 4812	(1995) HEPA Filters for Radioactive Aerosols
JIS Z 8734	(2000) Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure-Precision Methods for Reverberation Rooms

THE JAPAN REFRIGERATION AND AIR CONDITIONING INDUSTRY ASSOCIATION
(JRAIA)

JRA 4036	(2014) Air Handling Unit
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MINISTRY OF LAND, INFRASTRUCTURE, TRANSPORT AND TOURISM (MLIT)

MLIT-M	(2019) Public Building Construction Standard Specification
JBE-S	(2014) Japanese Building Equipment Seismic Standard Design

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.2.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 3 mm glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU - [_____]
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF - [_____]
VAV Box Number	VAV - [_____]
Fan Coil Unit Number	FC - [_____]
Terminal Box Number	TB - [_____]

SERVICE	LABEL AND TAG DESIGNATION
Unit Ventilator Number	UV - [_____]

Identify similar services with different temperatures or pressures. Where pressures could exceed 860 kilopascal, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

- a. Each point of entry and exit of pipe passing through walls.
- b. Each change in direction, i.e., elbows, tees.
- c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.
- d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 22 meter. All labels must be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
13 thru [_____] mm	13 mm
40 thru [_____] mm	[_____] mm
65 mm and larger	[_____] mm

1.2.3 Color Coding

Color coding of all piping systems must be in accordance with MLIT-M or the base standard.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G[, [_____]]

SD-03 Product Data

Fire Dampers

Automatic Smoke-Fire Dampers

Automatic Smoke Dampers

Air Handling Units; G[, [_____]]

Room Fan-Coil Units; G[, [_____]]

Coil Induction Units; G[, [_____]]

Constant Volume, Single Duct Terminal Units; G[, [_____]]

Variable Volume, Single Duct Terminal Units; G[, [_____]]

Variable Volume, Single Duct, Fan-Powered Terminal Units; G[, [_____]]

Dual Duct Terminal Units; G[, [_____]]

Reheat Units; G[, [_____]]

Energy Recovery Devices; G[, [_____]]

Test ProceduresDiagrams; G[, [_____]]

SD-06 Test Reports

Performance Tests

Damper Acceptance Test; G[, [_____]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

Fire Dampers

Manual Balancing Dampers

Automatic Smoke-Fire Dampers

Automatic Smoke Dampers

Centrifugal Fans

In-Line Centrifugal Fans

Axial Flow Fans

Centrifugal Type Power Wall Ventilators

Centrifugal Type Power Roof Ventilators

Propeller Type Power Roof Ventilators

Air-Curtain Fans

Ceiling Exhaust Fans

Air Handling Units

Room Fan-Coil Units

Coil Induction Units

Constant Volume, Single Duct Terminal Units

Variable Volume, Single Duct Terminal Units

Variable Volume, Single Duct, Fan-Powered Terminal Units

Dual Duct Terminal Units

Reheat Units

Unit Ventilators

Energy Recovery Devices

Hydronic Modular Panels

Prefabricated Radiant-Heating Electric Panels

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

- a. Submit a written certificate from any recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.
- b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the JIS a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.
- c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.4.1 Prevention of Corrosion

Protect metallic materials against corrosion. Provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with JIS H 8641 for exterior locations and cadmium-plated in conformance with JIS H 8610 for interior locations.[Provide written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.]

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be Refrigerant Handling Technician (Reibai-Furontou-Toriatsukai-Gijutsusha). Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4.4 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.4.5 Test Procedures

Submit proposed test procedures and test schedules for the [ductwork leak test, and] performance tests of systems, at least 2 weeks prior to the start of related testing.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization located in Japan.

2.2 STANDARD PRODUCTS

Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units", provide components and equipment that are standard products of

manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, fire dampers, and balancing dampers.

- a. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least two years before bid opening.
- b. Prior to this two year period, these standard products must have been sold on the commercial market using advertisements in manufacturers' catalogs or brochures. These manufacturers' catalogs, or brochures must have been copyrighted documents or have been identified with a manufacturer's document number.
- c. Provide equipment items that are supported by a service organization.

2.3 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates 40 mm that are high and smaller must be 1.6 mm thick, with engraved lettering 3 mm high; identification plates larger than 40 mm high must be 3 mm thick, with engraved lettering of suitable height. Identification plates 40 mm high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.4 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for [catwalks,] [operating platforms,] [ladders,] [and] [guardrails] are specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.5 ELECTRICAL WORK

- a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.
- b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with JIS C 4203.

- c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with JIS C 4212.
- d. Provide motors in accordance with JIS C 4212 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.
- e. [Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW or less and adjustable frequency drives for larger motors.]
[Provide variable frequency drives for motors as specified in Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS.]

2.6 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

2.7 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in JBE-S

2.8 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing.

2.9 DUCT SYSTEMS

2.9.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with MLIT-M.

2.9.1.1 Metallic Flexible Duct

- a. Provide duct that conforms to MLIT-M with factory-applied insulation, vapor barrier, and end connections. Provide ducts designed for working pressures of 497 Pa and 373 Pa. Provide flexible round duct length that does not exceed 1525 mm. Secure connections by applying adhesive for 51 mm over rigid duct, apply flexible duct 51 mm over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

- b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.
- c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of 25 mm thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.9.1.2 Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed 1.5 m. Provide runouts that are preinsulated, factory fabricated. Provide either field or factory applied vapor barrier. Provide not less than 0.60 L glass fabric duct connectors coated on both sides with neoprene. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2.9.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately 150 mm in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods.

2.9.1.4 High Temperature Service Duct Connections

Provide material that is approximately 2.38 mm thick, 1.2 to 1.36 kg per square meter weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 650 degrees C.

2.9.1.5 Aluminum Ducts

JIS H 4000, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.9.1.6 Copper Sheets

JIS H 3100, light cold rolled temper.

2.9.1.7 Corrosion Resisting (Stainless) Steel Sheets

JIS G 4305

2.9.2 Duct Access Doors

Provide hinged access doors conforming to MLIT-M in ductwork and plenums where indicated and at all air flow measuring primaries, automatic

dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 375 by 450 mm, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 600 by 600 mm or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.9.3 Fire Dampers

Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. Provide a pressure relief door upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then provide a factory installed pressure relief damper. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies in conformance with UL Fire Resistance. Provide [curtain type with damper blades] [in the air stream] [out of the air stream] [or] [single blade type] [or] [multi-blade type] fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph Fire Damper Acceptance Test and NFPA 90A.

2.9.4 Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 300 mm. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.5 Manual Balancing Dampers

- a. Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators.

- b. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 300 mm. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide access doors or panels in hard ceilings, partitions and walls for access to all concealed damper operators and damper locking setscrews. Coordinate location of doors or panels with other affected contractors.
- c. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.5.1 Square or Rectangular Dampers

2.9.5.1.1 Duct Height 300 mm and Less

2.9.5.1.1.1 Frames

Width	Height	Galvanized Steel Thickness	Length
Maximum 483 mm	Maximum 300 mm	Minimum 0.91 mm	Minimum 75 mm
More than 483 mm	Maximum 300 mm	Minimum 1.6 mm	Minimum 75 mm

2.9.5.1.1.2 Single Leaf Blades

Width	Height	Galvanized Steel Thickness	Length
Maximum 483 mm	Maximum 300 mm	Minimum 0.91 mm	Minimum 75 mm
More than 483 mm	Maximum 300 mm	Minimum 1.6 mm	Minimum 75 mm

2.9.5.1.1.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

Width	Height	Material	Square Shaft
Maximum 483 mm	Maximum 300 mm	Galvanized Steel	Minimum 10 mm
More than 483 mm	Maximum 300 mm	Galvanized Steel	Minimum 13 mm

2.9.5.1.1.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

Width	Height	Material
Maximum 483 mm	Maximum 300 mm	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
More than 483 mm	Maximum 300 mm	oil-impregnated bronze

2.9.5.1.1.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 50 mm off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.5.1.1.6 Finish

Mill Galvanized

2.9.5.1.2 Duct Height Greater than 300 mm

2.9.5.1.2.1 Dampers

Provide dampers with multi-leaf opposed-type blades.

2.9.5.1.2.2 Frames

Maximum 1200 mm in height; maximum 1200 mm in width; minimum of 1.6 mm galvanized steel, minimum of 127 mm long.

2.9.5.1.2.3 Blades

Minimum of 1.6 mm galvanized steel; 150 mm nominal width.

2.9.5.1.2.4 Blade Axles

To support the blades of round dampers, provide galvanized square steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

2.9.5.1.2.5 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, or solid nylon, or a solid plastic

equivalent to nylon. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

2.9.5.1.2.6 Blade Actuator

Minimum 50 mm diameter galvanized steel.

2.9.5.1.2.7 Blade Actuator Linkage

Mill Galvanized steel bar and crank plate with stainless steel pivots.

2.9.5.1.2.8 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 50 mm off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.5.1.2.9 Finish

Mill Galvanized

2.9.5.2 Round Dampers

2.9.5.2.1 Frames

Size	Galvanized Steel Thickness	Length
100 to 500 mm	Minimum 0.91 mm	Minimum 152 mm
550 to 750 mm	Minimum 0.91 mm	Minimum 250 mm
775 to 1000 mm	Minimum 1.6 mm	Minimum 250 mm

2.9.5.2.2 Blades

Size	Galvanized Steel Thickness
100 to 500 mm	Minimum 0.91 mm
550 to 750 mm	Minimum 1.6 mm
775 to 1000 mm	Minimum 3.5 mm

2.9.5.2.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts

supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

Size	Shaft Size and Shape
100 to 500 mm	Minimum 10 mm square
550 to 750 mm	Minimum 13 mm square
775 to 1000 mm	Minimum 19 mm square

2.9.5.2.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, or solid nylon, or a solid plastic equivalent to nylon. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

Size	Material
100 to 500 mm	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
550 to 750 mm	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
775 to 1000 mm	oil-impregnated bronze, or stainless steel sleeve bearing

2.9.5.2.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 50 mm off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.5.2.6 Finish

Mill Galvanized

2.9.6 Automatic Balancing Dampers

Provide dampers as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.9.7 Automatic Smoke-Fire Dampers

Multiple blade type, 82 degrees C fusible fire damper link; smoke damper assembly to include [pneumatically powered][electric] damper operator. UL 555 as a 1.5 hour rated fire damper; further qualified under UL 555S as

a leakage rated damper. Provide a leakage rating under UL 555S that is no higher than Class [II][or][III] at an elevated temperature Category B (121 degrees C for 30 minutes). Ensure that pressure drop in the damper open position does not exceed 25 Pa with average duct velocities of 13 m/second.

2.9.8 Automatic Smoke Dampers

UL listed multiple blade type, supplied by smoke damper manufacturer, with [pneumatic][electric] damper operator as part of assembly. Qualified under UL 555S with a leakage rating no higher than Class [II][or][III] at an elevated temperature Category B (121 degrees C for 30 minutes). Ensure that pressure drop in the damper open position does not exceed 25 Pa with average duct velocities of 13 m/second.

2.9.9 Air Supply And Exhaust Air Dampers

Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with JIS A 4009 as required by MLIT-M, including maximum Damper Leakage for:

- a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 250 Pa for motorized dampers is 20 L/s per square m of damper area and non-motorized dampers are not allowed.
- b. All other Climate Zones the maximum damper leakage at 250 Pa is 50 L/s per square m and for non-motorized dampers is 100 L/s per square m of damper area.

Dampers smaller than 600 mm in either direction may have leakage of 200 L/s per square m.

2.9.10 Air Deflectors (Volume Extractors) and Branch Connections

Provide air deflectors (volume extractors) at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors (volume extractors), except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors (volume extractors). Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors (volume extractors), also called turning vanes, in 90 degree elbows.

2.9.11 Plenums and Casings for Field-Fabricated Units

2.9.11.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in MLIT-M, as applicable. Construct system casing of not less than 1.6 mm galvanized sheet steel. Furnish cooling coil drain pans with 25 mm threaded outlet to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 1.6 mm steel, galvanized after fabrication or of 1.3 mm corrosion-resisting sheet steel conforming to JIS G 4305, welded and stiffened. Thermally insulate drain pans exposed to the atmosphere to prevent condensation. Coat insulation with a flame resistant waterproofing material. Provide separate drain pans for each vertical coil section, and a separate drain line for each pan. Size pans to ensure capture of entrained moisture on the downstream-air side of the coil. Seal openings in the casing, such as for piping connections, to prevent air leakage. Size the water seal for the drain to maintain a pressure of at least 500 Pa greater than the maximum negative pressure in the coil space.

2.9.11.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in MLIT-M.

2.9.11.3 Access Doors

Provide access doors in each section of the casing. Weld doorframes in place, gasket each door with neoprene, hinge with minimum of two brass hinges, and fasten with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, make doors 900 by 450 mm and locate them 450 mm above the floor. Where the space available does not accommodate doors of this size, use doors as large as the space accommodates. Swing doors so that fan suction or pressure holds doors in closed position, airtight. Provide a push-button station, located inside the casing, to stop the supply.

2.9.11.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components are allowed for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Provide panels of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Seal and insulate panel joints. Provide and gasket access doors to prevent air leakage. Provide panel construction that is not less than one mm galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 13 mm under operation. Construct details, including joint sealing, not specifically covered, as indicated in MLIT-M. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.9.11.5 Duct Liner

Unless otherwise specified, duct liner is not permitted.

2.9.12 Sound Attenuation Equipment

2.9.12.1 Systems with total pressure above 1 kPa

Provide sound attenuators on the discharge duct of each fan operating at a total pressure above 1 kPa, and, when indicated, at the intake of each fan system. Provide sound attenuators elsewhere as indicated. Provide factory fabricated sound attenuators, tested by an independent laboratory for sound and performance characteristics. Provide a net sound reduction as indicated. Maximum permissible pressure drop is not to exceed 157 Pa. Construct traps to be airtight when operating under an internal static pressure of 2.5 kPa. Provide air-side surface capable of withstanding air velocity of 50 m/s. Certify that the equipment can obtain the sound reduction values specified after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Provide sound absorbing material conforming to JIS A 9511. Provide sound absorbing material that meets the fire hazard rating requirements for insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. For connection to ductwork, provide a duct transition section. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system can be provided if complying with requirements specified for factory fabricated sound attenuators, in lieu of factory fabricated sound attenuators. Construct the double-walled duct and fittings from an outer metal pressure shell of zinc-coated steel sheet, 25 mm thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Provide a sufficient length of run to obtain the noise reduction coefficient specified. Certify that the sound reduction value specified can be obtained within the length of duct run provided. Provide welded or spiral lock seams on the outer sheet metal of the double-walled duct to prevent water vapor penetration. Provide duct and fittings with an outer sheet that conforms to the metal thickness of high-pressure spiral and round ducts and fittings shown in MLIT-M. Provide acoustical insulation with a thermal conductivity "k" of not more than 0.0389 W/m-K at 24 degrees C mean temperature. Provide an internal perforated zinc-coated metal liner that is not less than 0.7 mm with perforations not larger than 6.35 mm in diameter providing a net open area not less than 10 percent of the surface.

2.9.12.2 System with total pressure of 1 kPa and Lower

Use sound attenuators only where indicated. Provide factory fabricated sound attenuators that are constructed of galvanized steel sheets. Provide attenuator with outer casing that is not less than 0.85 mm. Provide fibrous glass acoustical fill. Provide net sound reduction indicated. Obtain values on a test unit not less than 600 by 600 mm outside dimensions made by a certified nationally recognized independent acoustical laboratory. Provide air flow capacity as indicated or required. Provide pressure drop through the attenuator that does not exceed the value indicated, or that is not in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Acoustically test attenuators with metal duct inlet and outlet sections while under the rated air flow conditions. Include with the noise reduction data the effects of flanking paths and vibration transmission. Construct sound attenuators to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 500 Pa.

2.9.12.3 Acoustical Duct Liner

Use fibrous glass designed or flexible elastomeric duct liner for lining ductwork and conforming to the requirements of JIS A 9511, Type I and II. Provide uniform density, graduated density, or dual density liner composition, as standard with the manufacturer. Provide not less than 25 mm thick coated lining. Where acoustical duct liner is used, provide the thermal equivalent of the insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS for liner or combination of liner and insulation applied to the exterior of the ductwork. Increase duct sizes shown to compensate for the thickness of the lining used. [In lieu of sheet metal duct with field-applied acoustical lining, provide acoustically equivalent lengths of fibrous glass duct, elastomeric duct liner or factory fabricated double-walled internally insulated duct with perforated liner.]

2.9.13 Diffusers, Registers, and Grilles

Provide factory-fabricated units of [steel][corrosion-resistant steel][or][aluminum] that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 0.25 m/s in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to Japanese Industry Standards (JIS). Provide sound rated and certified inlets and outlets according to MLIT-M. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 2 m above the floor, protect them by a grille or screen.

2.9.13.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Construction for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.9.13.2 Perforated Plate Diffusers

Provide adjustable [one-way,] [two-way,] [three-way,][][four-way] air pattern controls as indicated. Provide diffuser faceplates that do not sag or deflect when operating under design conditions.

2.9.13.3 Linear Diffusers

Make joints between diffuser sections that appear as hairline cracks.

Provide alignment slots for insertion of key strips or other concealed means to align exposed butt edges of diffusers.[Equip with plaster frames when mounted in plaster ceiling.] Do not use screws and bolts in exposed face of frames or flanges. Metal-fill and ground smooth frames and flanges exposed below ceiling. Furnish separate pivoted or hinged adjustable air-volume-damper and separate air-deflection blades.

2.9.13.4 Security Ceiling Diffusers

Provide diffusers that are steel with faceplate, fixed diffusion louvers, with flat surface margin, and an opposed blade damper. Provide faceplate that is 1.9 mm minimum with 13 by 13 mm holes on 5 mm spacing and a minimum free area of 45 percent.

2.9.13.5 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 150 mm below the ceiling unless otherwise indicated. Locate return and exhaust registers 150 mm above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.9.13.6 Registers

Double-deflection supply registers.[Provide manufacturer-furnished volume dampers. Provide volume dampers of the group-operated, opposed-blade type and key adjustable by inserting key through face of register. Operating mechanism must not project through any part of the register face. Automatic volume control devices are acceptable.][Provide exhaust and return registers as specified for supply registers, except provide exhaust and return registers that have a single set of nondirectional face bars or vanes having the same appearance as the supply registers.][Set face bars or vanes at [_____] degrees.]

2.9.13.7 Security Supply Air Registers Except in Cells

Provide supply air registers, except in prisoner cells and prisoner holding cells, that are steel with individually adjustable horizontal and vertical vanes, perforated faceplate, flat surface margin and opposed blade damper. Put vertical vanes in front; with 19 mm o.c. vane spacing. Provide a 1.9 mm (minimum) perforated faceplate with 13 by 13 mm holes on 5 mm spacing and a minimum free area of 45 percent.

2.9.13.8 Security Return and Other Air Registers Except in Cells

Provide return, exhaust, transfer and relief air registers, except in prisoner cells and prisoner holding cells, that are steel with perforated faceplate, flat surface margin, opposed blade damper, and duct mounting sleeve. Provide 14 gage (minimum) faceplate with 13 by 13 mm holes on 5 mm spacing and a minimum free area of 45 percent.

2.9.13.9 Security Supply Air Registers in Cells

Provide supply air registers in prisoner cells and prisoner holding cells

that are steel with perforated faceplate, flat surface margin, extension sleeve, opposed blade damper, and back mounting flanges. Provide a 1.9 mm (minimum) faceplate with 13 by 13 mm holes on 5 mm spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

2.9.13.10 Security Return and Other Type Air Registers in Cells

Provide steel return, exhaust, transfer and relief air registers in prisoner cells and prisoner holding cells with perforated faceplate, flat surface margin, wall sleeve, opposed blade damper, and back mounting flanges. Provide 1.9 mm (minimum) faceplate with 13 by 13 mm holes on 5 mm spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

2.9.14 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section [07 60 00 FLASHING AND SHEET METAL] [08 91 00 METAL [WALL][AND][DOOR] LOUVERS].

2.9.15 Air Vents, Penthouses, and Goosenecks

Fabricate air vents, penthouses, and goosenecks from galvanized steel [or aluminum] sheets with galvanized [or aluminum] structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to MLIT-M. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

2.9.16 Bird Screens and Frames

Provide bird screens that conform to JIS G 3553, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.9.17 Radon Exhaust Ductwork

Fabricate radon exhaust ductwork installed in or beneath slabs from Schedule 40 PVC pipe that conforms to JIS K 6741. Use solvent cement conforming to JIS K 6741 to make joints. Otherwise provide metal radon exhaust ductwork as specified herein.

2.10 AIR SYSTEMS EQUIPMENT

2.10.1 Fans

Test and rate fans according to JIS B 8330. Calculate system effect on air moving devices in accordance with JIS B 8330 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to JIS B 8330 and rated in accordance with JIS B 8330. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than [150] [or 140] [or 120] percent of the connected driving capacity.

Provide variable pitch motor sheaves for 11 kW and below, and fixed pitch as defined by MLIT-M the fan shaft and the motor shaft. This is a non-adjustable speed. Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to JIS B 8330. Provide standard JIS C 9603, arrangement, rotation, and discharge as indicated.

2.10.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with JIS B 8330 as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. [Provide forward curved or backward-inclined airfoil design fan blades in wheel sizes up to 750 mm. Provide backward-inclined airfoil design fan blades for wheels over 750 mm in diameter]. [Provide open-wheel radial type booster fans for exhaust dryer systems, and fans suitable for conveying lint and the temperatures encountered. Equip the fan shaft with a heat slinger to dissipate heat buildup along the shaft. Install an access (service) door to facilitate maintenance to these fans.] Provide fan wheels over 900 mm in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 900 mm or less in diameter that have one or more extra long bearings between the fan wheel and the drive. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than the requirement of JIS B 1518 as defined by JIS B 1521 and JIS B 1534. Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. Provide[[manually] [automatically] operated inlet vanes on suction inlets. Provide [manually] [automatically] operated outlet dampers.] Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have [open] [dripproof] [totally enclosed] [explosion-proof] enclosures. [Provide [manual] [magnetic] [across-the-line] [reduced-voltage-start] type motor starters with [general-purpose] [weather-resistant] [watertight] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]

2.10.1.2 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with

conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than the requirement of JIS B 1518 as defined by JIS B 1521 and JIS B 1534.[Provide motors with [open][dripproof][totally enclosed] [explosion-proof] enclosure.] [Provide [manual] [magnetic] motor starters across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosures.][Provide remote manual switch with pilot indicating light where indicated.]

2.10.1.3 Axial Flow Fans

Provide axial flow fans complete with drive components and belt guard, with steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Provide fan wheels that are dynamically balanced and keyed to the fan shaft, with radially projecting blades of airfoil cross-section. Enclose and isolate fan bearings and drive shafts from the air stream. Permanently lubricate fan bearings or provide them with accessible grease fittings. Provide precision self-aligning ball or roller type fan bearings that are sealed against dust and dirt. Provide fan bearings that have a L50 rated bearing life at not less than the requirement of JIS B 1518 of operation as defined by and JIS B 1534. Provide fan inlets with an aerodynamically shaped bell and an inlet cone. Install diffuser or straightening vanes at the fan discharge to minimize turbulence and provide smooth discharge air flow. Furnish fan unit with [inlet and outlet flanges,] [inlet screen,] [duct equalizer section,] and [manual] [automatic] operation adjustable inlet vanes. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have [open] [dripproof] [totally enclosed] [explosion-proof] enclosure. [Provide [manual] [magnetic] motor starters across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]

2.10.1.4 Centrifugal Type Power Wall Ventilators

Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide removable and weatherproof motor housing. Provide unit housing that is designed for sealing to building surface and for discharge and condensate drippage away from building surface. Construct housing of heavy gauge aluminum. Equip unit with an [aluminum or plated steel wire discharge bird screen,] [disconnect switch,] [[anodized aluminum][stainless steel] wall grille,] [manufacturer's standard [gravity][motor-operated] damper,] an airtight and liquid-tight metallic wall sleeve. Provide [totally enclosed fan cooled] [dripproof] [explosion-proof] type motor enclosure. Use only lubricated bearings.

2.10.1.5 Centrifugal Type Power Roof Ventilators

Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with [birdscreen,] [disconnect switch,] [[gravity] [motorized] dampers,] [sound curb,] [roof curb,] and [extended base]. Provide [dripproof] [explosion-proof] type motor enclosure. Provide centrifugal type kitchen exhaust fans according to UL 705, fitted with V-belt drive, round hood, and windband upblast discharge configuration,

integral residue trough and collection device, with motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings.

2.10.1.6 Propeller Type Power Roof Ventilators

Provide [direct][or][V-belt] driven fans. Provide hinged or removable weathertight fan housing, fitted with framed rectangular base constructed of aluminum or galvanized steel. Provide [totally enclosed fan cooled] [explosion-proof] type motors. Furnish motors with nonfusible, horsepower rated, manual disconnect mount on unit. Furnish fans with [gravity] [motor operated] dampers, [birdscreen][sound curb][roof curb]. Use only lubricated bearings.

2.10.1.7 Air-Curtain Fans

Furnish air curtains with a weatherproof housing constructed of high impact plastic or minimum 1.3 mm rigid welded steel. Provide backward curved, non-overloading, centrifugal type fan wheels, accurately balanced statically and dynamically. Provide motors with totally enclosed fan cooled enclosures. Provide remote manual type motor starters with weather-resistant enclosure actuated when the doorway served is open. Provide air curtains that attain the air velocities specified within 2 seconds following activation. Provide bird screens at air intake and discharge openings. Provide air curtain unit or a multiple unit installation that is at least as wide as the opening to be protected. Provide the air discharge openings to permit outward adjustment of the discharge air. Place installation and adjust according to the manufacturer's written recommendation. Furnish directional controls on air curtains for service windows for easy clean or convenient removal. Design air curtains to prevent the adjustment of the air velocities specified. Make the interior surfaces of the air curtain units accessible for cleaning. Provide certified test data indicating that the fan can provide the air velocities required when fan is mounted as indicated. Provide air curtains designed as fly fans unless otherwise indicated. [Provide air curtains designed for use in service entranceways that develop an air curtain not less than 75 mm thick at the discharge nozzle. Provide air velocity that is not less than 8 m/s across the entire entryway when measured 900 mm above the floor.] [Provide air curtains designed for use on customer entranceways that develop an air curtain not less than 200 mm thick at the discharge opening. Provide velocity that is not less than 3 m/s across the entire entryway when measured 900 mm above the floor. Equip recirculating type air curtains with readily removable filters, or design the filters for in-position cleaning. Provide readily accessible and easily cleanable air capture compartment or design for in-position cleaning.] [Provide air curtains designed for use on service windows that develop an air curtain not less than 200 mm thick at the discharge opening. Provide air velocity that is not less than 3 m/s across the entire opening of the service window measured 900 mm below the air discharge opening.]

2.10.1.8 Ceiling Exhaust Fans

Provide centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide fans with acoustically insulated housing. Provide chatter-proof backdraft damper. Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above.

2.10.2 Coils

Provide fin-and-tube type coils constructed of seamless [copper][red brass] tubes and [aluminum][or][copper] fins mechanically bonded or soldered to the tubes.[Provide copper tube wall thickness that is a minimum of [0.406][0.508][0.6096] mm].[Provide red brass tube wall thickness that is a minimum of [0.89][1.24] mm]. [Provide aluminum fins that are [0.14][0.19] mm minimum thickness.][Provide copper fins that are 0.114 mm minimum thickness.] Provide casing and tube support sheets that are not lighter than 1.6 mm galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of JIS B 8616.

2.10.2.1 Direct-Expansion Coils

Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to JIS H 3300 and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests. Pressure test coils in accordance with Japanese Refrigeration Safety Regulations (Nihon-Reitou-Hoan-Kisoku).

2.10.2.2 Water Coils

Install water coils with a pitch of not less than 10 mm/m of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with Japanese Refrigeration Safety Regulations(Nihon-Reitou-Hoan-Kisoku).

2.10.2.3 Steam Heating Coils

Construct steam coils from cast semisteel, welded steel or copper headers, and [red brass][copper] tubes. Construct headers from cast iron, welded steel or copper. Provide fin tube and header section that float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide each coil with a field or factory installed vacuum breaker. Provide single-tube type coils with tubes not less than 13 mm outside diameter, except for steam preheat coils. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with in accordance with Japanese Refrigeration Safety Regulations (Nihon-Reitou-Hoan-Kisoku).

2.10.2.4 Steam Preheat (Nonfreeze) Coils

Provide steam-distribution-tube type steam (nonfreeze) coils with condensing tubes not less than 25 mm outside diameter for tube lengths 1.5

m and over and 13 mm outside diameter for tube lengths under 1.5 m. Construct headers from cast iron, welded steel, or copper. Provide distribution tubes that are not less than 15 mm outside diameter for tube lengths 1.5 m and over and 10 mm outside diameter for tube lengths under 1.5 m with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes and hold securely in alignment. Limit maximum length of a single coil to 3.66 m. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with Japanese Refrigeration Safety Regulations (Nihon-Reitou-Hoan-Kisoku).

2.10.2.5 Electric Heating Coil

Provide an electric duct heater coil in accordance with Japanese Refrigeration Safety Regulations (Nihon-Reitou-Hoan-Kisoku). Provide duct- or unit-mounted coil. Provide [nickel chromium resistor, single stage, strip] [nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type coil. Provide coil with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Provide galvanized steel or aluminum coil casing and support brackets. Mount coil to eliminate noise from expansion and contraction and for complete accessibility for service.

2.10.2.6 Eliminators

Equip each cooling coil having an air velocity of over 2 m/s through the net face area with moisture eliminators, unless the coil manufacturer guarantees, over the signature of a responsible company official, that no moisture can be carried beyond the drip pans under actual conditions of operation. Construct of minimum 24 gage [zinc-coated steel] [copper] [copper nickel] [or] [stainless steel], removable through the nearest access door in the casing or ductwork. Provide eliminators that have not less than two bends at 45 degrees and are spaced not more than 63 mm center-to-center on face. Provide each bend with an integrally formed hook as indicated in the JIS A 4009.

2.10.2.7 Sprayed Coil Dehumidifiers

Provide assembly with reinforced, braced, and externally insulated galvanized steel casing, vertical in-line spray pump, bronze self-cleaning spray nozzles, galvanized steel pipe spray headers, adjustable float valve with replaceable neoprene seat, manufacturer's standard cooling coil, and welded black steel drain tank. Provide overflow drain, make-up, and bleed connection.

2.10.2.8 Corrosion Protection for Coastal Installations

2.10.3 Air Filters

List air filters according to requirements of JIS B 9908-1, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of JIS B 9908-1.

2.10.3.1 Extended Surface Pleated Panel Filters

Provide 50 mm depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to JIS B 9908-1. Provide initial resistance at 2.54 m/s that does not exceed 0.09 kPa. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.10.3.2 Extended Surface Nonsupported Pocket Filters

Provide [750][_____] mm depth, sectional, replaceable dry media type filters of the size indicated when tested according to JIS B 9908-1. Provide initial resistance at [2.54][_____] m/s that does not exceed [0.1125][_____] kPa. Provide fibrous glass media, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Provide pockets that do not sag or flap at anticipated air flows. Install each filter [with an extended surface pleated panel filter as a prefilter] in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.10.3.3 Cartridge Type Filters

Provide 305 mm depth, sectional, replaceable dry media type filters of the size indicated when tested according to JIS B 9908-1. Provide initial resistance at [2.54][_____] m/s that does not exceed [0.14][_____] kPa. Provide JIS Z 4812, and pleated microglass paper media with corrugated aluminum separators, sealed inside the filter cell to form a totally rigid filter assembly. Fluctuations in filter face velocity or turbulent airflow have no effect on filter integrity or performance. Install each filter with an extended surface pleated media panel filter as a prefilter in a factory preassembled side access housing, or a factory-made sectional frame bank, as indicated.

2.10.3.4 Sectional Cleanable Filters

Provide [25][50] mm thick cleanable filters. Provide viscous adhesive in 20 L containers in sufficient quantity for 12 cleaning operations and not less than one L for each filter section. Provide one washing and charging tank for every 100 filter sections or fraction thereof; with each washing and charging unit consisting of a tank and [single][double] drain rack mounted on legs and drain rack with dividers and partitions to properly support the filters in the draining position.

2.10.3.5 Replaceable Media Filters

Provide the [dry-media][viscous adhesive] type replaceable media filters, of the size required to suit the application. Provide filtering media that is not less than 50 mm thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Enclose pad in a holding frame of not less than 1.6 mm galvanized steel, equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [1.5][_____] m/s, with initial resistance of [32][_____] Pa.

2.10.3.6 Automatic Renewable Media Filters

Provide the following:

- a. Automatic, renewable media filters consisting of a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass supplied in convenient roll form, and filter that does not require water supply, sewer connections, adhesive reservoir, or sprinkler equipment as part of the operation and maintenance requirements.
- b. Basic frame that is fabricated of not less than 2 mm galvanized steel, and sectional design filters with each section of each filter fully factory assembled, requiring no field assembly other than setting in place next to any adjacent sections and the installation of media in roll form.
- c. Each filter complete with initial loading of filter media drive motor adequate to handle the number of sections involved, and [painted steel] [stainless steel] control box containing a warning light to indicate media runout, a runout switch, and a Hand-Off-Auto selector switch.
- d. Media feed across the filter face in [full-face increments] [increments] automatically controlled as determined by [filter pressure differential] [time interval control] [time interval control with pressure override] [photo electric control] to provide substantially constant operating resistance to airflow and varying not more than plus or minus 10 percent. Roll or enclose media in such a way that collected particulates can not re-entrain.
- e. Rolls of clean media, no less than 19.8 m long, rerolled on disposable spools in the rewind section of the filter after the media has accumulated its design dirt load. Equip rewind section with a compression panel to tightly rewind used media for ease of handling. Provide media made of continuous, bonded fibrous glass material, UL Class 2, that does not compress more than 6 mm when subjected to air flow at 2.54 m/s. Factory charge media with an odorless and flame retardant adhesive which does not flow while in storage nor when subjected to temperatures up to 79.4 degrees C. Support media on both the leaving and entering air faces. Clean media must have initial resistance that does not exceed 45 Pa at its rated velocity of 2.54 m/s. Set control so that the resistance to air flow is between 100 and 125 Pa unless otherwise indicated.
- f. Dust holding capacity, of 80 percent average arrestance under these operating conditions, when operating at a steady state with an upper operating resistance of 125 Pa, that is at least 592 (55) grams of ASHRAE Standard Test Dust per square meter of media area, when tested according to the dynamic testing provisions of JIS B 9908-1.
- g. The horizontal type automatic renewable media filters, when used in conjunction with factory fabricated air handling units, that are dimensionally compatible with the connecting air handling units, and horizontal type filter housings with all exposed surfaces factory insulated internally with 25 mm, 24 kg/cubic meter density neoprene coated fibrous glass with thermal conductivity not greater than 0.04 W/m-K of thickness.
- h. Access doors for horizontal filters with double wall construction as specified for plenums and casings for field-fabricated units in paragraph DUCT SYSTEMS.

2.10.3.7 Electrostatic Filters

Provide the following:

- a. The combination dry agglomerator/extended surface, nonsupported pocket electrostatic filters or the combination dry agglomerator/automatic renewable, media (roll) type electrostatic filters, as indicated (except as modified). Supply each dry agglomerator electrostatic air filter with the correct quantity of fully housed power packs and equip with silicon rectifiers, manual reset circuit breakers, low voltage safety cutout, relays for field wiring to remote indication of primary and secondary voltages, with lamps mounted in the cover to indicate these functions locally. Equip power pack enclosure with external mounting brackets, and low and high voltage terminals fully exposed with access cover removed for ease of installation. Furnish interlock safety switches for each access door and access panel that permits access to either side of the filter, so that the filter is de-energized in the event that a door or panel is opened.
- b. Ozone generation within the filter that does not exceed five parts per one hundred million parts of air. Locate high voltage insulators in a serviceable location outside the moving air stream or on the clean air side of the unit. Fully expose ionizer wire supports and furnish ionizer wires precut to size and with formed loops at each end to facilitate ionizer wire replacement.
- c. Agglomerator cell plates that allow proper air stream entrainment of agglomerates and prevent excessive residual dust build-up, with cells that are open at the top and bottom to prevent accumulation of agglomerates which settle by gravity. Where the dry agglomerator electrostatic filter is indicated to be the automatic renewable media type, provide a storage section that utilizes a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass for dry agglomerator storage section service supplied in 19.8 m lengths in convenient roll form. Otherwise, provide section construction and roll media characteristics as specified for automatic renewable media filters. Also a dry agglomerator/renewable media combination with an initial air flow resistance, after installation of clean media, that does not exceed 62.3 Pa at 2.54 m/s face velocity.
- d. Where the dry agglomerator electrostatic filter is indicated to be of the extended surface nonsupported pocket filter type, provide a storage section as specified for extended surface non-supported pocket filters, with sectional holding frames or side access housings as indicated.
- e. A dry agglomerator/extended surface nonsupported pocket filter section combination with initial air flow resistance, after installation of clean filters, that does not exceed 162 Pa at 2.54 m/s face velocity. Furnish front access filters with full height air distribution baffles and upper and lower mounting tracks to permit the baffles to be moved for agglomerator cell inspection and service. When used in conjunction with factory fabricated air handling units, supply side access housings which have dimensional compatibility.

2.10.3.8 High-Efficiency Particulate Air (HEPA) Filters

Provide HEPA filters that meet the requirements of JIS Z 4812 and are individually tested and certified to have an efficiency of not less than

[95] [99.97] percent in accordance with JIS B 9927, and an initial resistance at [_____] m/s that does not exceed [_____] Pa. Provide filters that are constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated filter medium. Provide interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer that are cemented to the perimeter of the [upstream] [downstream] face of the filter cell sides. Provide self-extinguishing rubber-base type adhesive or other materials conforming to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide filter cell sides that are [19 mm thick exterior grade fire-retardant plywood] [cadmium plated steel] [galvanized steel] assembled in a rigid manner. Provide overall cell side dimensions that are correct to 2 mm, and squareness that is maintained to within 3.2 mm. Provide holding frames that use spring loaded fasteners or other devices to seal the filter tightly within it and that prevent any bypass leakage around the filter during its installed life. Provide air capacity and the nominal depth of the filter as indicated. Install each filter in a factory preassembled side access housing or a factory-made sectional supporting frame as indicated. Provide prefilters of the type, construction and efficiency indicated.

2.10.3.9 Holding Frames

Fabricate frames from not lighter than 1.6 mm sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.10.3.10 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least 98 mm in diameter, with white dials with black figures, and [graduations] [graduated in 0.0025 kPa,] with a minimum range of 0.25 kPa beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure taps with integral compression fittings, two molded plastic vent valves, two 1.5 m minimum lengths of 6.35 mm diameter [aluminum] [vinyl] tubing, and all hardware and accessories for gauge mounting.

2.11 AIR HANDLING UNITS

2.11.1 Factory-Fabricated Air Handling Units

Provide [single-zone draw-through type] [or] [single-zone blow-through type] [or] [multizone blow-through type] [blow-through double-deck type] [blow-through triple deck type] units as indicated. Units must include fans, coils, airtight insulated casing, [prefilters,] [secondary filter sections,] [and] [diffuser sections where indicated,] [air blender] adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, [mixing box] [combination sectional filter-mixing box,] [[pan] [drysteam] [spray type] humidifier,] vibration-isolators, and appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the

capacity indicated. Provide air handling unit that is rated in accordance with JRA 4036.

2.11.1.1 Casings

Provide the following:

- a. [Casing sections [[single] [50 mm double] wall type] [as indicated], constructed of a minimum 1.3 mm galvanized steel, or 1.3 mm corrosion-resisting sheet steel conforming to JIS G 4305.][Inner casing of double-wall units that are a minimum one mm solid galvanized steel or corrosion-resisting sheet steel conforming to JIS G 4305.] Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.
- b. Individually removable exterior panels with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, according to paragraph AIR HANDLING UNITS, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.
- c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 1.3 mm outer and one mm inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to JIS G 4305. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 300 mm wide by 300 mm high. Access doors must be a minimum 600 mm wide, the full height of the unit casing or a minimum of 1800 mm, whichever is less. [Install a minimum 200 by 200 mm sealed glass window suitable for the intended application, in all access doors.]
- d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 1.4 mm [galvanized steel] [corrosion resisting sheet steel conforming to JIS G 4305.] Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing.
- e. Insulate single-wall casing sections handling conditioned air with not less than 25 mm thick, 24 kg/cubic meter density coated fibrous glass material having a thermal conductivity not greater than 0.033 W/m-K. Insulate double-wall casing sections handling conditioned air with not less than 50 mm of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.
- f. Factory applied fibrous glass insulation that conforms to JIS A 9511, except that the minimum thickness and density requirements do not apply. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute

for use on double-wall access doors and inspections doors [and casing sections].

- g. Duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of JIS A 9511.
- h. A latched and hinged inspection door, in the fan and coil sections. Plus additional inspection doors, access doors and access sections [_____] [where indicated].

2.11.1.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.11.1.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.11.1.4 Fans

Provide the following:

- a. Fans that are double-inlet, centrifugal type with each fan in a separate scroll. Dynamically balance fans and shafts prior to installation into air handling unit, then after it has been installed in the air handling unit, statically and dynamically balance the entire fan assembly. Mount fans on steel shafts, accurately ground and finished.
- b. Fan bearings that are sealed against dust and dirt and are precision self-aligning ball or roller type, with L50 rated bearing life at not less than 200,000 hours as defined by JIS B 1521 and JIS B 1534. Provide bearings that are permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Support bearings by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Do not fasten bearings directly to the unit sheet metal casing. Furnish fans and scrolls with coating indicated.
- c. Fans that are driven by a unit-mounted, or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Furnish belt guards that are the three-sided enclosed type with solid or expanded metal face. Design belt drives for not less than a 1.3 service factor based on motor nameplate rating.
- d. [Motor sheaves that are variable pitch for 20 kW and below and fixed pitch above 20 kW as defined by MLIT-M.] Where fixed sheaves are required, the use of variable pitch sheaves is allowed during air balance, but replace them with an appropriate fixed sheave after air balance is completed. Select variable pitch sheaves to drive the fan at a speed that produces the specified capacity when set at the approximate midpoint of the sheave adjustment. Furnish motors for V-belt drives with adjustable bases, and with [open][splashproof][totally enclosed] enclosures.

- e. Motor starters of [manual][magnetic][across-the-line][reduced-voltage-start] type with [general-purpose][weather-resistant][watertight] enclosure. Select unit fan or fans to produce the required capacity at the fan static pressure with sound power level as indicated. Obtain the sound power level values according to JIS B 8330, JIS B 8330.

2.11.1.5 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

2.11.1.6 Diffuser Sections

Furnish diffuser sections between the discharge of all housed supply fans [and cooling coils of blow-through single zone units][and][filter sections of those units with high efficiency filters located immediately downstream of the air handling unit fan section]. Provide diffuser sections that are fabricated by the unit manufacturer in a manner identical to the remainder of the unit casing, designed to be airtight under positive static pressures up to [2][_____] kPa and with an access door on each side for inspection purposes. Provide a diffuser section that contains a perforated diffusion plate, fabricated of galvanized steel, Type 316 stainless steel, aluminum, or steel treated for corrosion with manufacturer's standard corrosion-resisting finish, and designed to accomplish uniform air flow across the down-stream [coil][filters] while reducing the higher fan outlet velocity to within plus or minus 5 percent of the required face velocity of the downstream component.

2.12 TERMINAL UNITS

2.12.1 Room Fan-Coil Units

Provide base units that include galvanized coil casing, coil assembly drain pan [valve and piping package,] [outside air damper,] [wall intake box,] air filter, fans, motor, fan drive, motor switch, an enclosure for cabinet models and casing for concealed models, leveling devices integral with the unit for vertical type units, and sound power levels as indicated. Obtain sound power level data or values for these units according to test procedures based on JIS B 8616. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models are acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Fasten each unit securely to the building structure. Provide units with capacity indicated. Provide room fan-coil units that are certified as complying with MLIT-M, and meet the requirements of in accordance with Japanese Refrigeration Safety Regulations (Nihon-Reitou-Hoan-Kisoku).

2.12.1.1 Enclosures

Fabricate enclosures from not lighter than 1.3 mm steel, reinforced and

braced. Provide enclosures with front panels that are removable and have 7 mm closed cell insulation or 13 mm thick dual density foil faced fibrous glass insulation. Make the exposed side of a high density, erosion-proof material suitable for use in air streams with velocities up to 23 m/s. Provide a discharge grille that is [adjustable] [fixed] and that is of such design as to properly distribute air throughout the conditioned space. Plastic discharge and return grilles are acceptable provided the plastic material is certified by the manufacturer to be classified as flame resistant and the material complies with the heat deflection criteria per in accordance with Japanese Refrigeration Safety Regulations (Nihon-Reitou-Hoan-Kisoku). Provide galvanized or factory finished ferrous metal surfaces with corrosion resistant enamel, and access doors or removable panels for piping and control compartments, plus easy access for filter replacement. Provide duct discharge collar for concealed models.

2.12.1.2 Fans

Provide steel or aluminum, multi-blade, centrifugal type fans. In lieu of metal, fans and scrolls could be of non-metallic materials of suitably reinforced compounds with smooth surfaces. Dynamically and statically balance the fans. Provide accessible assemblies for maintenance. Disassemble and re-assemble by means of mechanical fastening devices and not by epoxies or cements.

2.12.1.3 Coils

Fabricate coils from not less than 10 mm outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Provide coils with not less than 13 mm outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Test coils hydrostatically at 2000 kPa or under water at 1700 kPa air pressure. Provide coils suitable for 1400 kPa working pressure. Make provisions for coil removal.

2.12.1.4 Drain Pans

Size and locate drain and drip pans to collect all water condensed on and dripping from any item within the unit enclosure or casing. Provide condensate drain pans designed for self-drainage to preclude the buildup of microbial slime and thermally insulated to prevent condensation and constructed of not lighter than 0.9 mm type 304 stainless steel or noncorrosive ABS plastic. Provide insulation with a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and of a waterproof type or coated with a waterproofing material. Design drain pans so as to allow no standing water and pitch to drain. Provide minimum 19 mm NPT or 15 mm OD drain connection in drain pan. Provide plastic or metal auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages; if metal, provide auxiliary pans that comply with the requirements specified above. Extend insulation at control and piping connections 25 mm minimum over the auxiliary drain pan.

2.12.1.5 Manually Operated Outside Air Dampers

Provide manually operated outside air dampers according to the arrangement indicated, and parallel airfoil type dampers of galvanized construction. Provide blades that rotate on stainless steel or nylon sleeve bearings.

2.12.1.6 Filters

Provide disposable type filter that complies with JIS B 9908-1. Provide filters in each unit that are removable without the use of tools.

2.12.1.7 Motors

Provide motors of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Provide motor switch with two or three speeds and off, manually operated, and mounted on an identified plate [inside the unit below or behind an access door][or][adjacent to the room thermostat][as indicated]. In lieu of the above fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent is allowed. Provide motors with permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Provide a motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity that does not exceed the following values:

Free Discharge Motors			
Unit Capacity (L/S)	Maximum Power Consumption (Watts)		
	115V	230V	277V
94	70	110	90
142	100	110	110
189	170	150	150
283	180	210	220
378	240	240	230
472	310	250	270
566	440	400	440

High Static Motors	
Unit Capacity (L/S)	Maximum Power Consumption (Watts)
94	145
142	145
189	210

High Static Motors	
Unit Capacity (L/S)	Maximum Power Consumption (Watts)
283	320
378	320
472	530
566	530

2.12.2 Coil Induction Units

Provide base unit that includes air plenums, air-discharge nozzles, air discharge grilles, recirculation grilles, water coil assembly, valve and piping package, condensate drain pan, and adjustable air-balancing dampers, plus an enclosure for cabinet models and casing for concealed models. Make each unit capable of producing not less than the capacity indicated without exceeding the indicated static pressure. Provide a sound power level as indicated with power level data or values for these units based on tests conducted according to or JIS Z 8734. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. The values obtained for the standard cabinet models are acceptable for concealed models without separate tests, provided there is no variation between models as to coil configuration, air discharge nozzles, air balancing dampers, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Secure each unit to the building structure. Provide units with capacity indicated.

2.12.2.1 Enclosures

Fabricate enclosures from not lighter than 1.2 mm steel, reinforced and braced. Provide a removable front panel of enclosure and insulate when required acoustically and to prevent condensation. Provide discharge grilles that are [adjustable][integrally stamped] and properly distribute air throughout the conditioned space. Plastic discharge and return grilles are not acceptable. Provide access doors for all piping and control compartments.

2.12.2.2 Air Plenums

Fabricate plenums from galvanized steel with interior acoustically baffled and lined with sound absorbing material to attenuate the sound power from the primary air supply to the room. Provide heat-resistant nozzles that are integral with or attached airtight to the plenum. Where coil induction units are supplied with vertical runouts, furnish a streamlined, vaned, mitered elbow transition piece for connection between the unit and ductwork. Provide an adjustable air-balancing damper in each unit.

2.12.2.3 Coils

Fabricate coils from not less than 10 mm outside diameter seamless copper tubing, with copper or aluminum fins, mechanically bonded or soldered to the tubes. Furnish coil connections with not less than 13 mm outside

diameter flare or sweat connectors, accessory piping package with terminal connections suitable for connection to the type of control valve supplied, and manual air vent. Test coils hydrostatically at 2000 kPa or under water at 1700 kPa air pressure and provide coils suitable for 1400 kPa working pressure.

2.12.2.4 Screens

Provide easily accessible lint screens or throwaway filters for each unit.

2.12.2.5 Drain Pan

Size and locate drain and drip pans to collect condensed water dripping from any item within the unit enclosure. Provide drain pans constructed of not lighter than 0.9 mm steel, galvanized after fabrication, and thermally insulated to prevent condensation. Provide insulation that has a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and that is a waterproof type or coated with a waterproofing material. In lieu of the above, drain pans constructed of die-formed 0.8 mm steel are allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 0.9 mm steel material or of die-formed 0.9 mm type 304 stainless steel insulated as specified above. Pitch drain pans to drain. Provide drain connection when a condensate drain system is indicated. Make connection a minimum 19 mm NPT or 15 mm OD.

2.12.3 Variable Air Volume (VAV) and Dual Duct Terminal Units

- a. Provide VAV and dual duct terminal units that are the type, size, and capacity shown, mounted in the ceiling or wall cavity, plus units that are suitable for single or dual duct system applications. Provide actuators and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. For each VAV terminal unit, provide a temperature sensor in the unit discharge ductwork.
- b. Provide unit enclosures that are constructed of galvanized steel not lighter than 0.85 mm or aluminum sheet not lighter than 1.3 mm. Provide single or multiple discharge outlets as required. Units with flow limiters are not acceptable. Provide unit air volume that is factory preset and readily field adjustable without special tools. Provide reheat coils as indicated.
- c. Attach a flow chart to each unit. Base acoustic performance of the terminal units upon units tested according to JRA 4036 with the calculations prepared in accordance with JIS B 8616. Provide sound power level as indicated. Show discharge sound power for minimum and [375][_____] Pa inlet static pressure.

2.12.3.1 Constant Volume, Single Duct Terminal Units

Provide constant volume, single duct, terminal units that contain within the casing, a constant volume regulator. Provide volume regulators that control air delivery to within plus or minus 5 percent of specified air flow subjected to inlet pressure from 200 to 1500 Pa.

2.12.3.2 Variable Volume, Single Duct Terminal Units

Provide variable volume, single duct, terminal units with a calibrated air volume sensing device, air valve or damper, actuator, and accessory

relays. Provide units that control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 200 to 1500 Pa. Provide units with an internal resistance not exceeding 100 Pa at maximum flow range. Provide external differential pressure taps separate from the control pressure taps for air flow measurement with a 0 to 250 Pa range.

2.12.3.3 Variable Volume, Single Duct, Fan-Powered Terminal Units

Provide variable volume, single duct, fan-powered terminal units with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Provide units that control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 200 to 1500 Pa. Provide unit fan that is centrifugal, direct-driven, double-inlet type with forward curved blades. Provide either single speed with speed controller or three-speed, permanently lubricated, permanent split-capacitor type fan motor. Isolate fan/motor assembly from the casing to minimize vibration transmission. Provide factory furnished fan control that is wired into the unit control system. Provide a factory-mounted pressure switch to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

2.12.3.4 Dual Duct Terminal Units

Provide dual duct terminal units with hot and cold inlet valve or dampers that are controlled in unison by single or dual actuators. Provide actuator as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Provide unit that controls delivered air volumes within plus or minus 5 percent with inlet air variations from 250 to 2000 Pa in either duct. Include mixing baffles with the unit casing. Provide cabinet and closed duct leakage that does not exceed 2 percent of maximum rated air volume. Provide units with an internal resistance that does not exceed [_____] Pa at maximum flow range.

2.12.3.5 Reheat Units

2.12.3.5.1 Hot Water Coils

Provide fin-and-tube type hot-water coils constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Provide headers that are constructed of cast iron, welded steel or copper. Provide casing and tube support sheets that are 1.6 mm, galvanized steel, formed to provide structural strength. Provide tubes that are correctly circuited for proper water velocity without excessive pressure drop and are drainable where required or indicated. At the factory, test each coil at not less than 1700 kPa air pressure and provide coils suitable for 1400 kPa working pressure. Install drainable coils in the air handling units with a pitch of not less than 10 mm per m of tube length toward the drain end. Coils must conform to the provisions of JIS B 8616.

2.12.3.5.2 Steam Coils

Provide steam coils constructed of cast semisteel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered to the tubes. Roll and bush, braze or weld tubes into headers. Provide coil casings and tube support sheets,

with collars of ample width, that are not lighter than 1.6 mm galvanized steel formed to provide structural strength. When required, furnish multiple tube supports to prevent tube sag. Float the fin tube and header section within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide coils that are factory pressure tested and capable of withstanding 1700 kPa hydrostatic test pressure or 1400 kPa air pressure, and are for [700] [1400] kPa steam working pressure. Provide steam-distribution tube type preheat coils with condensing tubes having not less than 15 mm outside diameters. Provide distribution tubes that have not less than 10 mm outside diameter, with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes held securely in alignment. Limit the maximum length of a single coil to 120 times the diameter of the outside tube. Other heating coils must be single tube type with an outside diameter not less than 13 mm. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Provide coils that conform to the provisions of JIS B 8616.

2.12.3.5.3 Electric Resistance Heaters

Provide the duct-mounting type electric resistance heaters consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Provide electric duct heater that meets the requirement of JIS C 9803 and is provided with a built-in or surface-mounted high-limit thermostat. Interlock electric duct heaters electrically so that they cannot be energized unless the fan is running.

2.12.4 Unit Ventilators

Provide unit ventilators that include an enclosure, [galvanized casing,] [cold-rolled steel casing with corrosion resistant coating,] coil assembly, [resistance heating coil assembly,] [valve and piping package,] drain pan, air filters, fan assembly, fan drive, motor, motor controller, dampers, damper operators, and sound power level as indicated. Obtain sound power level data or values for these units according to test procedures based on MLIT-M. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles, when handling standard flow for which the unit air capacity is rated. Secure each unit to the building structure. Provide the unit ventilators with capacity indicated. Provide the year-round classroom type unit ventilator with automatic controls arranged to properly heat, cool, and ventilate the room. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.12.4.1 Enclosures

Fabricate enclosures from not lighter than 1.6 mm galvanized steel, reinforced and braced, or all welded framework with panels to provide equivalent strength. Provide casing that is acoustically and thermally insulated internally with not less than 13 mm thick dual density fibrous glass insulation. Make the exposed side a high density, erosion-proof material suitable for use in air streams with velocities up to 246 m/s. Fasten the insulation with waterproof, fire-resistant adhesive. Design front panel for easy removal by one person. Provide discharge grilles that [have adjustable grilles or grilles with adjustable vanes and] properly distribute air throughout the conditioned space. Provide return grilles that are removable where front panel does not provide access to interior components. Plastic discharge or return grilles are not acceptable. Furnish removable panels or access doors for all piping and

control compartments. Provide fan switch that is key operated or accessible through a locked access panel. Install gaskets at the back and bottom of the unit for effective air seal, as required.

2.12.4.2 Electric Resistance Heating Elements

Provide electric resistance heating elements that are of the sheathed, finned, tubular type, or of the open resistance type designed for direct exposure to the air stream. Provide heating element electrical characteristics as indicated. Where fan motor or control voltage is lower than required for the electric-resistance heating element, install a fused factory mounted and wired transformer.

2.12.4.3 Fans

Provide fans that meet the requirements as specified in paragraph AIR SYSTEMS EQUIPMENT. Provide galvanized steel or aluminum, multiblade, centrifugal type fans, dynamically and statically balanced. Equip fan housings with resilient mounted, self-aligning permanently lubricated ball bearings, sleeve bearings, or combination ball and sleeve bearings, capable of not less than 2000 hours of operation on one oiling. Provide direct-connected fans.

2.12.4.4 Coils

Provide coils that are circuited for a maximum water velocity of 2.4 m/s without excessive pressure drop and are otherwise as specified for hot water coils in paragraph TERMINAL UNITS.

2.12.4.5 Drain Pans

Size and locate drain and drip pans to collect all condensed water dripping from any item within the unit enclosure. Provide drain pans constructed of not lighter than 1.2 mm steel, galvanized after fabrication, and thermally insulated to prevent condensation. Provide insulation that is coated with a fire-resistant waterproofing material. In lieu of the above, drain pans constructed of die-formed 1.0 mm steel is allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 1.3 mm steel material, or of die-formed 1.3 mm type 304 stainless steel insulated as specified above. Pitch drain pans to drain. Furnish drain connection unless otherwise indicated. Make the minimum connection 19 mm NDT or 18 mm OD.

2.12.4.6 Filters

Disposable type rated in accordance with ASHRAE 52.2, installed upstream of coil.

2.12.4.7 Dampers

Provide an outside air proportioning damper on each unit. In addition, provide a vane to prevent excessive outside air from entering unit and to prevent blow-through of outside air through the return air grille under high wind pressures. Where outside air and recirculated air proportioning dampers are provided on the unit, an additional vane is not required. Provide face and bypass dampers for each unit to ensure constant air volume at all positions of the dampers. Furnish each unit with a factory installed control cam assembly, pneumatic motor, or electric motor to operate the face and bypass dampers and outside air damper or outside air

and recirculated air dampers in the sequence as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.12.4.8 Motors

Provide permanent split-capacitor type motors with built-in thermal overload protection and automatic reset. Mount motor on a resilient mounting, isolated from the casing and suitable for operation on electric service available. Provide a manually operated motor switch that provides for 2 or 3 speeds and off, mounted on an identified plate [inside the unit below or behind an access door][or][adjacent to the room thermostat][as indicated]. In lieu of speed control, provide a solid state variable speed controller having minimum speed reduction of 50 percent.

2.12.4.9 Outside Air Intakes

Provide the manufacturer's standard design outside air intakes furnished with 13 mm mesh bird screen or louvers on 13 mm centers.

2.13 ENERGY RECOVERY DEVICES

2.13.1 Rotary Wheel

Provide unit that is a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible heat from exhaust air to supply air stream, with device performance according to JIS B 8628 and that delivers an energy transfer effectiveness of not less than [70][85][_____] percent with cross-contamination not in excess of [0.1][1.0][_____] percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Provide exchange media that is chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Isolate exhaust and supply streams by seals which are static, field adjustable, and replaceable. Equip chain drive mechanisms with ratcheting torque limiter or slip-clutch protective device. Fabricate enclosure from galvanized steel and include provisions for maintenance access. Provide recovery control and rotation failure provisions as indicated.

2.13.2 Run-Around-Coil

Provide assembly that is factory fabricated and tested air-to-liquid-to-air energy recovery system for transfer of sensible heat from exhaust air to supply air stream and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination with maximum energy recovery at minimum life cycle cost. Computer optimize components for capacity, effectiveness, number of coil fins per inch, number of coil rows, flow rate, heat transfer rate of [_____] percent by volume of [ethylene][propylene] glycol solution, and frost control. Provide coils that conform to paragraph AIR HANDLING UNITS. Provide related pumps, and piping specialties that conform to requirements of [Section 23 63 00.00 10 COLD STORAGE REFRIGERATION SYSTEMS][Section 23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS][23 69 00.00 20 REFRIGERATION EQUIPMENT FOR COLD STORAGE][_____] .

2.13.3 Heat Pipe

Provide a device that is a factory fabricated, assembled and tested,

counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat between exhaust and supply streams and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination. Provide heat exchanger tube core that is [15][18][25] mm nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Provide maximum fins per unit length and number of tube rows as indicated. Provide tubes that are fitted with internal capillary wick, filled with a refrigerant complying with in accordance with Japanese Refrigeration Safety Regulations (Nihon-Reitou-Hoan-Kisoku), selected for system design temperature range, and hermetically sealed. Refrigerants containing chlorofluorocarbons (CFC) are prohibited. Provide heat exchanger frame that is constructed of not less than 1.6 mm galvanized steel and fitted with intermediate tube supports, and flange connections. Provide tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio.[Provide a drain pan constructed of welded Type 300 series stainless steel.] Provide heat recovery regulation by [system face and bypass dampers and related control system as indicated][interfacing with manufacturer's standard tilt-control mechanism for summer/winter operation, regulating the supply air temperature and frost prevention on weather face of exhaust side at temperature indicated]. Coil must be fitted with pleated flexible connectors.

2.13.4 Desiccant Wheel

Provide counterflow supply, regeneration airstreams, a rotary type dehumidifier designed for continuous operation, and extended surface type wheel structure in the axial flow direction with a geometry that allows for laminar flow over the operating range for minimum air pressure differentials. Provide the dehumidifier complete with a drive system utilizing a fractional-horsepower electric motor and speed reducer assembly driving the rotor. Include a slack-side tensioner for automatic take-up for belt-driven wheels. Provide an adsorbing type desiccant material. Apply the desiccant material to the wheel such that the entire surface is active as a desiccant and the desiccant material does not degrade or detach from the surface of the wheel which is fitted with full-face, low-friction contact seals on both sides to prevent cross leakage. Provide rotary structure that has underheat, overheat and rotation fault circuitry. Provide wheel assembly with a warranty for a minimum of five years.

2.13.5 Plate Heat Exchanger

Provide energy recovery ventilator unit that is factory-fabricated for indoor installation, consisting of a flat plate cross-flow heat exchanger, cooling coil, supply air fan and motor and exhaust air fan and motor. The casing must be 1 mm G90, galvanized steel, double wall construction with 25 mm insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

2.14 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to JIS H 8641 or JIS G 3302. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to JIS Z 2371 JIS K 5600-7-9, and JIS K 5600-5-5 or JIS K 5600-5-6. Submit evidence of satisfactory paint performance for a minimum of 125 hours for

units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 3 mm. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to JIS H 8641.

Field paint factory painting that has been damaged prior to acceptance by the Contracting Officer in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

2.15 SUPPLEMENTAL COMPONENTS/SERVICES

2.15.1 Chilled, Condenser, or Dual Service Water Piping

The requirements for chilled, condenser, or dual service water piping and accessories are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

2.15.2 Refrigerant Piping

The requirements for refrigerant piping are specified in Section 23 23 00 REFRIGERANT PIPING.

2.15.3 Water or Steam Heating System Accessories

The requirements for water or steam heating accessories such as expansion tanks and steam traps are specified in Section [23 52 00 HEATING BOILERS][23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM][23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS].

2.15.4 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section [22 00 00 PLUMBING, GENERAL PURPOSE][23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS] except as modified herein.

2.15.5 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.15.6 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.7 Controls

The requirements for controls are specified in [Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS][and][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][and][Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

2.16 RADIANT PANELS

2.16.1 Hydronic Modular Panels

2.16.1.1 Panels

Modular radiant panels will fit into a standard 600 mm x 600 mm or 600 mm x 1200 mm suspended T-Bar ceiling grid or flush mounted on a drywall ceiling. For flush mounted ceiling applications, the manufacturer will provide a one piece extruded aluminum frame. Panels shall be supported from the T-bar assembly. Panels shall be [14 gauge] or [16 gauge] extruded aluminum or sheet steel.

2.16.1.2 Heat Sink

The modular panels shall use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.

2.16.1.3 Water Tubes

Tubes shall consist of JIS H 3300 [13 mm] [16 mm] O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. Heat pads will be used between the soldered fitting and the panel to protect the panel surface. The manufacturer will provide water pressure drop data as well as heating output data derived from tests in accordance with JIS A 1400 (heating). The panels will have the capacity to have multiple passes with connections either on the [same end] or [opposite ends], dependent on the number of passes.

2.16.1.4 Finish

All visible components shall be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color shall be white.

2.16.1.5 Performance

Manufacturer will provide water pressure drop data as well as heat and cool output data derived from tests in accordance with JIS A 1400 (heating).

2.16.1.6 Capacity

Modular radiant panel capacity will be tested and certified by manufacturer in accordance with JIS A 1400 (heating) to meet the required performance. Should any performance rating, chilled or hot water supply temperature, water pressure drop, etc. deviate from the schedule, the manufacturer will submit the updated capacity. [The manufacturer will have factory testing facility available to perform performance test of units in accordance with said standard.]

2.16.1.7 Water Connections

Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.

2.16.1.8 Installation

Panels will be installed as recommended by the manufacturer.

2.16.1.9 Accessories

Stainless steel braided hoses, 300 mm or 450 mm long will be supplied with the panels.

The top of the heating and cooling panels shall be covered with 38 mm thick 16kg/m³ formaldehyde-free fiber glass insulation with a minimum R = 0.79 m² deg C/W. The insulation shall be covered with a foil scrim kraft vapor barrier facing.

2.16.2 Hydronic Linear Panels

2.16.2.1 Panels

Linear radiant panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face. The linear radiant panel is to radiate or absorb heat from or to the zone below. Panels must be [14 gauge] or [16 gauge] extruded aluminum.

2.16.2.2 Heat Sink

The modular panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.

2.16.2.3 Water Tubes

Tubes must consist of JIS H 3300 13 mm or 16mm O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. The manufacturer will provide water pressure drop data as well as heating output data derived from tests in accordance with JIS A 1400 (heating).

2.16.2.4 Mounting

Units must be provided with mounting hardware as required for mounting in T-Bar applications or ceiling flush mounting. The manufacturer's standard hardware for mounting panels abutting each other must be submitted for approval.

2.16.2.5 Finish

All visible components must be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color must be white.

2.16.2.6 Performance

Manufacturer must provide water pressure drop data as well as heat output data derived from tests in accordance with JIS A 1400(heating).

2.16.2.7 Capacity

Modular radiant panel capacity must be tested and certified by manufacturer in accordance with JIS A 1400(heating) to meet the required performance. Should any performance rating, chilled or hot water supply

temperature, water pressure drop, etc. deviate from the schedule, the manufacturer must submit the updated capacity. The manufacturer must have factory testing facility available to perform performance test of units in accordance with said standard.

2.16.2.8 Water Connections

Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.

2.16.2.9 Accessories

Stainless steel braided hoses, 300 mm or 450 mm long will be supplied with the panels.

The top of the heating and cooling panels must be covered with 38 mm thick 16kg/m³ formaldehyde-free fiber glass insulation with a minimum R = 0.79 m² deg C/W. The insulation must be covered with a foil scrim kraft vapor barrier facing.

2.16.3 Prefabricated Radiant-Heating Electric Panels

2.16.3.1 Description

Sheet metal enclosed panel with heating element suitable for [lay-in installation flush with T-bar ceiling grid] [or surface mounting] [or recessed mounting].

2.16.3.2 Panel

Minimum 0.7 mm thick, galvanized steel sheet back panel riveted to minimum 1.0 mm thick, galvanized steel sheet front panel with fused-on crystalline surface.

2.16.3.3 Heating Element

Powdered graphite sandwiched between sheets of electric insulation.

2.16.3.4 Electrical Connections

Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.

2.16.3.5 Exposed-Side Panel Finish

[Apply silk-screened finish to match appearance of Architect selected acoustical ceiling tiles.] [Baked-enamel finish in color as selected by Architect.]

2.16.3.6 Surface-Mounting Trim

Sheet metal with baked-enamel finish in color as selected by Architect.

2.16.3.7 Wall Thermostat

Bimetal, sensing elements; with contacts suitable for [low] [line]-voltage circuit, and manually operated on-off switch with contactors, relays, and control transformers.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

- a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.
- b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of [910][_____] mm. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits JIS HB 71 (Electrical-Safety Related work practices) and an additional [910][_____] mm.
- c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all [units]. Provide a depth of each seal of 50 mm plus 0.1 mm for each Pa, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 150 mm concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.2.4 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.2.5 Metal Ductwork

Install according to MLIT-M unless otherwise indicated. Install duct supports for sheet metal ductwork according to MLIT-M, unless otherwise specified. Do not use friction beam clamps indicated in MLIT-M. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

3.2.5.1 Underground Ductwork

Provide PVC plastisol coated galvanized steel underground ductwork with coating on interior and exterior surfaces and watertight joints. Install ductwork as indicated. Maximum burial depth is 2 m.

3.2.5.2 Radon Exhaust Ductwork

Perforate subslab suction piping where indicated. Install PVC joints.

3.2.5.3 Light Duty Corrosive Exhaust Ductwork

For light duty corrosive exhaust ductwork, use PVC plastisol coated galvanized steel with PVC coating on interior [surfaces][and exterior surfaces][and epoxy wash primer coating on exterior surfaces].

3.2.6 FRP Ductwork

Provide fibrous glass reinforced plastic ducting and related structures that conform to JIS A 4009. Provide flanged joints where indicated. Crevice-free butt lay-up joints are acceptable where flanged joints are not indicated. When ambient temperatures are lower than 10 degrees C, heat cure joints by exothermic reaction heat packs.

3.2.7 Kitchen Exhaust Ductwork

3.2.7.1 Ducts Conveying Smoke and Grease Laden Vapors

Provide ducts conveying smoke and grease laden vapors that conform to

requirements of NFPA 96. Make seams, joints, penetrations, and duct-to-hood collar connections with a liquid tight continuous external weld. Provide duct material that is a [minimum 1.3 mm, Type 304L or 316L, stainless steel] [minimum 1.6 mm carbon steel]. [Include with duct construction an external perimeter angle sized in accordance with MLIT-M, except place welded joint reinforcement on maximum of 600 mm centers; continuously welded companion angle bolted flanged joints with flexible ceramic cloth gaskets where indicated; pitched to drain at low points; welded pipe coupling-plug drains at low points; welded fire protection and detergent cleaning penetration; steel framed, stud bolted, and flexible ceramic cloth gasketed cleaning access provisions where indicated. Make angles, pipe couplings, frames, bolts, etc., the same material as that specified for the duct unless indicated otherwise.]

3.2.7.2 Exposed Ductwork

Provide exposed ductwork that is fabricated from minimum 1.3 mm, Type 304L or 316L, stainless steel with continuously welded joints and seams. Pitch ducts to drain at hoods and low points indicated. Match surface finish to hoods.

3.2.7.3 Concealed Ducts Conveying Moisture Laden Air

Fabricate concealed ducts conveying moisture laden air from minimum [1.3 mm, Type 300 series, stainless steel] [1.6 mm, galvanized steel] [0.55 mm, tempered copper sheet]. Continuously weld, braze, or solder joints to be liquid tight. Pitch ducts to drain at points indicated. Make transitions to other metals liquid tight, companion angle bolted and gasketed.

3.2.7.4 Constraction

Ducts shall be constructed of and supported by carbon steel not less than 1.37 mm in thickness or stainless steel not less than 1.09 mm in thickness. All seams, joints, penetrations shall have external weld except duct-to-hood collar connections shall not require a liquidtight continuous external weld as required in NFPA 96.

3.2.7.5 Access Panels

On vertical ductwork where personnel entry is possible, access shall be provided at the top of the vertical riser to accommodate descent. Where personnel entry is not possible, adequate access for cleaning shall be provided on each floor. The exhaust duct shall have a slope downstream of the exhaust air. Access panels shall be of the same material and thickness as the duct. Access panels shall have a gasket or sealant that is rated for 815.6 celsius degrees (1500 F) and shall be greasetight. For hoods with dampers in the exhaust or supply collar, an access panel for cleaning and inspection shall be provided in the duct or the hood within 457 mm of the damper. Access panels shall be provided at the side or at the top of the duct, whichever is more accessible, and at changes of direction. Horizontal duct shall have access panels at 8 feet interval.

3.2.8 Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive , and manufacture's reconnected material. Provide top and bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to

MLIT-M. Provide welded pins, cup-head pins, or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in MLIT-M to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.

3.2.9 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.10 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums [up to the point where the outdoor air reaches the conditioning unit][or][up to the point where the outdoor air mixes with the return air stream].

3.2.11 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.2.12 Power Roof Ventilator Mounting

Provide foamed 13 mm thick, closed-cell, flexible elastomer insulation to cover width of roof curb mounting flange. Where wood nailers are used, predrill holes for fasteners.

3.2.13 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 75 mm margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of

[28][14][_____] calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse [_____] protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 380 mm and smaller. Build framed, prepared openings for round duct larger than 380 mm and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide 25 mm clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with JIS A 9504, Type 1, Class B-2.

3.6.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 1 mm thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with JIS G 3452, Schedule 20.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 1 mm galvanized steel, unless otherwise indicated.

3.6.3 Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 16 degrees C, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

3.6.4 Closure Collars

Provide closure collars of a minimum 100 mm wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 380 mm in diameter or less from 1 mm galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 380 mm from 1.40 mm galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 380 mm or less from 1 mm galvanized steel. Install collars with fasteners a maximum of 150 mm on center. Attach to collars a minimum of 4 fasteners where the opening is 300 mm in diameter or less, and a minimum of 8 fasteners where the opening is 500 mm in diameter or less.

3.6.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 50 degrees C. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

3.7.1 Temperatures less than 50 degrees C

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm, one coat of primer applied to a minimum dry film thickness of 0.0255 mm; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm per coat to metal surfaces subject to temperatures less than 50 degrees C.

3.7.2 Temperatures between 50 and 205 degrees C

Apply two coats of 205 degrees C heat-resisting enamel applied to a total minimum thickness of 0.05 mm to metal surfaces subject to temperatures between 50 and 205 degrees C.

3.7.3 Temperatures greater than 205 degrees C

Apply two coats of heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm to metal surfaces subject to temperatures greater than 205 degrees C.

3.7.4 Finish Painting

The requirements for finish painting of items only primed at the factory, and surfaces not specifically noted otherwise, are specified in Section

09 90 00 PAINTS AND COATINGS.

3.7.5 Color Coding Scheme for Locating Hidden Utility Components

Use scheme in buildings having suspended grid ceilings. Provide color coding scheme that identifies points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid, consisting of a color code board and colored metal disks. Make each colored metal disk approximately 13 mm diameter and secure to removable ceiling panels with fasteners. Insert each fastener into the ceiling panel so as to be concealed from view. Provide fasteners that are manually removable without the use of tools and that do not separate from the ceiling panels when the panels are dropped from ceiling height. Make installation of colored metal disks follow completion of the finished surface on which the disks are to be fastened. Provide color code board that is approximately 1 m wide, 750 mm high, and 13 mm thick. Make the board of wood fiberboard and frame under glass or 1.6 mm transparent plastic cover. Make the color code symbols approximately 19 mm in diameter and the related lettering in 13 mm high capital letters. Mount the color code board [where indicated] [in the mechanical or equipment room]. Make the color code system as indicated below:

Color	System	Item	Location
[_____]	[_____]	[_____]	[_____]

3.8 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 35 mm minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 2 mm diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.9 DUCTWORK LEAK TEST

Perform ductwork leak test for the entire air distribution and exhaust system, including fans, coils, [filters, etc.][filters, etc. designated as static pressure Class 750 Pa through Class 2500 Pa.] Provide test procedure, apparatus, and report that conform to JIS Z 2330. The maximum allowable leakage rate is [_____] L/s. Complete ductwork leak test with satisfactory results prior to applying insulation to ductwork exterior or concealing ductwork.

3.10 DUCTWORK LEAK TESTS

The requirements for ductwork leak tests are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.11 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they

function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.12 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.13 PERFORMANCE TESTS

After testing, adjusting, and balancing is complete as specified, test each system as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Record the testing during the applicable season. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Conduct capacity tests and general operating tests by an experienced engineer. Provide tests that cover a period of not less than [_____] days for each system and demonstrate that the entire system is functioning according to the specifications. Make coincidental chart recordings at points indicated on the drawings for the duration of the time period and record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

Submit test reports for the [ductwork leak test, and] performance tests in booklet form, upon completion of testing. Document phases of tests performed including initial test summary, repairs/adjustments made, and final test results in the reports.

3.14 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of [room fan-coil units][coil-induction units,] [air terminal units,] [unit ventilators,] thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the

building has been documented as beneficially occupied.

3.15 RADIANT PANELS

3.15.1 Installation

Install radiant panels level and plumb, maintaining sufficient clearance for normal services and maintenance.

3.15.2 Soldering

When soldering copper fittings at the panel, a heat pad will be used to protect the panel finish.

3.15.3 Connections

Install piping adjacent to radiant panels to allow for service and maintenance.

3.16 OPERATION AND MAINTENANCE

3.16.1 Operation and Maintenance Manuals

Submit [six] [_____] manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.16.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of [_____] hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --