****

USACE / NAVFAC / AFCEC / NASA **UFGS-23 30 00 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**

UFGS-23 00 00 (August 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 30 00

HVAC AIR DISTRIBUTION

05/20

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.2.1 Mechanical Equipment Identification
1.2.1.1 Charts
1.2.1.2 Diagrams
1.2.2 Service Labeling
1.2.3 Color Coding
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Prevention of Corrosion
1.4.2 Asbestos Prohibition
1.4.3 Ozone Depleting Substances Technician Certification
1.4.4 Detail Drawings
1.4.5 Test Procedures
1.5 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.2 STANDARD PRODUCTS
2.3 IDENTIFICATION PLATES
2.4 EQUIPMENT GUARDS AND ACCESS
2.5 ELECTRICAL WORK
2.6 ANCHOR BOLTS
2.7 SEISMIC ANCHORAGE
2.8 PAINTING
2.9 INDOOR AIR QUALITY
2.10 DUCT SYSTEMS
2.10.1 Metal Ductwork
2.10.1.1 Metallic Flexible Duct
2.10.1.2 Insulated Nonmetallic Flexible Duct Runouts
2.10.1.3 General Service Duct Connectors
2.10.1.4 High Temperature Service Duct Connections
2.10.1.5 Aluminum Ducts

2.10.1.6 Copper Sheets
2.10.1.7 Corrosion Resisting (Stainless) Steel Sheets
2.10.2 Duct Access Doors
2.10.3 Fire Dampers
2.10.4 Manual Balancing Dampers
2.10.5 Manual Balancing Dampers
2.10.5.1 Square or Rectangular Dampers
2.10.5.1.1 Duct Height 300 mm 12 inches and Less
2.10.5.1.1.1 Frames
2.10.5.1.1.2 Single Leaf Blades
2.10.5.1.1.3 Blade Axles
2.10.5.1.1.4 Axle Bearings
2.10.5.1.1.5 Control Shaft/Hand Quadrant
2.10.5.1.1.6 Finish
2.10.5.1.2 Duct Height Greater than 300 mm 12 inches
2.10.5.1.2.1 Dampers
2.10.5.1.2.2 Frames
2.10.5.1.2.3 Blades
2.10.5.1.2.4 Blade Axles
2.10.5.1.2.5 Axle Bearings
2.10.5.1.2.6 Blade Actuator
2.10.5.1.2.7 Blade Actuator Linkage
2.10.5.1.2.8 Control Shaft/Hand Quadrant
2.10.5.1.2.9 Finish
2.10.5.2 Round Dampers
2.10.5.2.1 Frames
2.10.5.2.2 Blades
2.10.5.2.3 Blade Axles
2.10.5.2.4 Axle Bearings
2.10.5.2.5 Control Shaft/Hand Quadrant
2.10.5.2.6 Finish
2.10.6 Automatic Balancing Dampers
2.10.7 Automatic Smoke-Fire Dampers
2.10.8 Automatic Smoke Dampers
2.10.9 Air Supply And Exhaust Air Dampers
2.10.10 Air Deflectors (Volume Extractors) and Branch Connections
2.10.11 Plenums and Casings for Field-Fabricated Units
2.10.11.1 Plenum and Casings
2.10.11.2 Casing
2.10.11.3 Access Doors
2.10.11.4 Factory-Fabricated Insulated Sheet Metal Panels
2.10.11.5 Duct Liner
2.10.12 Sound Attenuation Equipment
2.10.12.1 Systems with total pressure above 1 kPa 4 Inches Water Gauge
2.10.12.2 System with total pressure of 1 kPa 4 Inch Water Gauge and Lower
2.10.12.3 Acoustical Duct Liner
2.10.13 Diffusers, Registers, and Grilles
2.10.13.1 Diffusers
2.10.13.2 Perforated Plate Diffusers
2.10.13.3 Linear Diffusers
2.10.13.4 Security Ceiling Diffusers
2.10.13.5 Registers and Grilles
2.10.13.6 Registers
2.10.13.7 Security Supply Air Registers Except in Cells
2.10.13.8 Security Return and Other Air Registers Except in Cells
2.10.13.9 Security Supply Air Registers in Cells
2.10.13.10 Security Return and Other Type Air Registers in Cells

2.10.14 Louvers
2.10.15 Air Vents, Penthouses, and Goosenecks
2.10.16 Bird Screens and Frames
2.10.17 Radon Exhaust Ductwork
2.11 AIR SYSTEMS EQUIPMENT
2.11.1 Fans
2.11.1.1 Centrifugal Fans
2.11.1.2 In-Line Centrifugal Fans
2.11.1.3 Axial Flow Fans
2.11.1.4 Panel Type Power Wall Ventilators
2.11.1.5 Centrifugal Type Power Wall Ventilators
2.11.1.6 Centrifugal Type Power Roof Ventilators
2.11.1.7 Propeller Type Power Roof Ventilators
2.11.1.8 Air-Curtain Fans
2.11.1.9 Ceiling Exhaust Fans
2.11.2 Coils
2.11.2.1 Direct-Expansion Coils
2.11.2.2 Water Coils
2.11.2.3 Steam Heating Coils
2.11.2.4 Steam Preheat (Nonfreeze) Coils
2.11.2.5 Electric Heating Coil
2.11.2.6 Eliminators
2.11.2.7 Sprayed Coil Dehumidifiers
2.11.2.8 Corrosion Protection for Coastal Installations
2.11.3 Air Filters
2.11.3.1 Extended Surface Pleated Panel Filters
2.11.3.2 Extended Surface Nonsupported Pocket Filters
2.11.3.3 Cartridge Type Filters
2.11.3.4 Sectional Cleanable Filters
2.11.3.5 Replaceable Media Filters
2.11.3.6 Automatic Renewable Media Filters
2.11.3.7 Electrostatic Filters
2.11.3.8 High-Efficiency Particulate Air (HEPA) Filters
2.11.3.9 Holding Frames
2.11.3.10 Filter Gauges
2.12 AIR HANDLING UNITS
2.12.1 Field-Fabricated Air Handling Units
2.12.2 Factory-Fabricated Air Handling Units
2.12.2.1 Casings
2.12.2.2 Heating and Cooling Coils
2.12.2.3 Air Filters
2.12.2.4 Fans
2.12.2.5 Access Sections and Filter/Mixing Boxes
2.12.2.6 Diffuser Sections
2.13 TERMINAL UNITS
2.13.1 Room Fan-Coil Units
2.13.1.1 Enclosures
2.13.1.2 Fans
2.13.1.3 Coils
2.13.1.4 Drain Pans
2.13.1.5 Manually Operated Outside Air Dampers
2.13.1.6 Filters
2.13.1.7 Motors
2.13.2 Coil Induction Units
2.13.2.1 Enclosures
2.13.2.2 Air Plenums
2.13.2.3 Coils
2.13.2.4 Screens
2.13.2.5 Drain Pan

2.13.3 Variable Air Volume (VAV) and Dual Duct Terminal Units
2.13.3.1 Constant Volume, Single Duct Terminal Units
2.13.3.2 Variable Volume, Single Duct Terminal Units
2.13.3.3 Variable Volume, Single Duct, Fan-Powered Terminal Units
2.13.3.4 Dual Duct Terminal Units
2.13.3.5 Ceiling Induction Terminal Units
2.13.3.6 Series Fan Powered Variable Air Volume (VAV) Terminals
2.13.3.6.1 Casing
2.13.3.6.2 Fans and Motors
2.13.3.6.3 Flow Sensor
2.13.3.6.4 Primary VAV Damper or Valve
2.13.3.6.5 Regulator
2.13.3.6.6 Electrical
2.13.3.6.7 Filters
2.13.3.7 Reheat Units
2.13.3.7.1 Hot Water Coils
2.13.3.7.2 Steam Coils
2.13.3.7.3 Electric Resistance Heaters
2.13.4 Unit Ventilators
2.13.4.1 Enclosures
2.13.4.2 Electric Resistance Heating Elements
2.13.4.3 Fans
2.13.4.4 Coils
2.13.4.5 Drain Pans
2.13.4.6 Filters
2.13.4.7 Dampers
2.13.4.8 Motors
2.13.4.9 Outside Air Intakes
2.14 ENERGY RECOVERY DEVICES
2.14.1 Rotary Wheel
2.14.2 Run-Around-Coil
2.14.3 Heat Pipe
2.14.4 Desiccant Wheel
2.14.5 Plate Heat Exchanger
2.15 FACTORY PAINTING
2.16 SUPPLEMENTAL COMPONENTS/SERVICES
2.16.1 Chilled, Condenser, or Dual Service Water Piping
2.16.2 Refrigerant Piping
2.16.3 Water or Steam Heating System Accessories
2.16.4 Condensate Drain Lines
2.16.5 Backflow Preventers
2.16.6 Insulation
2.16.7 Controls
2.17 RADIANT PANELS
2.17.1 Hydronic Modular Panels
2.17.1.1 Panels
2.17.1.2 Heat Sink
2.17.1.3 Water Tubes
2.17.1.4 Finish
2.17.1.5 Performance
2.17.1.6 Capacity
2.17.1.7 Water Connections
2.17.1.8 Installation
2.17.1.9 Accessories
2.17.2 Hydronic Linear Panels
2.17.2.1 Panels
2.17.2.2 Heat Sink
2.17.2.3 Water Tubes
2.17.2.4 Mounting

2.17.2.5 Finish
2.17.2.6 Performance
2.17.2.7 Capacity
2.17.2.8 Water Connections
2.17.2.9 Accessories
2.17.3 Prefabricated Radiant-Heating Electric Panels
2.17.3.1 Description
2.17.3.2 Panel
2.17.3.3 Heating Element
2.17.3.4 Electrical Connections
2.17.3.5 Exposed-Side Panel Finish
2.17.3.6 Surface-Mounting Trim
2.17.3.7 Wall Thermostat

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.2.1 Condensate Drain Lines
3.2.2 Equipment and Installation
3.2.3 Access Panels
3.2.4 Flexible Duct
3.2.5 Metal Ductwork
3.2.5.1 Underground Ductwork
3.2.5.2 Radon Exhaust Ductwork
3.2.5.3 Light Duty Corrosive Exhaust Ductwork
3.2.6 FRP Ductwork
3.2.7 Kitchen Exhaust Ductwork
3.2.7.1 Ducts Conveying Smoke and Grease Laden Vapors
3.2.7.2 Exposed Ductwork
3.2.7.3 Concealed Ducts Conveying Moisture Laden Air
3.2.8 Acoustical Duct Lining
3.2.9 Dust Control
3.2.10 Insulation
3.2.11 Duct Test Holes
3.2.12 Power Roof Ventilator Mounting
3.2.13 Power Transmission Components Adjustment
3.3 EQUIPMENT PADS
3.4 CUTTING AND PATCHING
3.5 CLEANING
3.6 PENETRATIONS
3.6.1 Sleeves
3.6.2 Framed Prepared Openings
3.6.3 Insulation
3.6.4 Closure Collars
3.6.5 Firestopping
3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT
3.7.1 Temperatures less than 50 degrees C 120 degrees F
3.7.2 Temperatures between 50 and 205 degrees C 120 and 400 degrees F
3.7.3 Temperatures greater than 205 degrees C 400 degrees F
3.7.4 Finish Painting
3.7.5 Color Coding Scheme for Locating Hidden Utility Components
3.8 IDENTIFICATION SYSTEMS
3.9 DUCTWORK LEAK TEST
3.10 DUCTWORK LEAK TESTS
3.11 DAMPER ACCEPTANCE TEST
3.12 TESTING, ADJUSTING, AND BALANCING
3.13 PERFORMANCE TESTS
3.14 CLEANING AND ADJUSTING

3.15 RADIANT PANELS
3.15.1 Installation
3.15.2 Soldering
3.15.3 Connections
3.16 OPERATION AND MAINTENANCE
3.16.1 Operation and Maintenance Manuals
3.16.2 Operation And Maintenance Training

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA | **UFGS-23 30 00 (May 2020)**

Preparing Activity: USACE | **Superseding without Revision UFGS-23 00 00 (August 2018)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION 23 30 00

HVAC AIR DISTRIBUTION
05/20

****

NOTE: This guide specification covers the requirements for air supply, distribution, ventilation, and exhaust portions of an HVAC system.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Coordinate the use of this specification with other sections, as appropriate, in order to specify a complete HVAC built-up system.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

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.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S12.51	(2012; R 2017) American National Standard Acoustics - Determination of Sound Power Levels and Sound Energy Levels of Noise Sources using Sound Pressure - Precision Methods for Reverberation Test Rooms

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)

ACCA Manual 4	(2001) Installation Techniques for Perimeter Heating and Cooling; 11th Edition

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 220	(2005;R 2012) Test Methods for Air Curtain Units
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 260 I-P	(2012) Sound Rating of Ducted Air Moving and Conditioning Equipment
AHRI 350	(2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation

	Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI 440	(2008) Performance Rating of Room Fan-Coils
AHRI 880 I-P	(2011) Performance Rating of Air Terminals
AHRI 885	(2008; Addendum 2011) Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets
AHRI DCAACP	(Online) Directory of Certified Applied Air-Conditioning Products
AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

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

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2010) Ventilation for Acceptable Indoor Air Quality
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct
ASHRAE 70	(2006; R 2011) Method of Testing for Rating the Performance of Air Outlets and Inlets
ASHRAE 84	(2020) Method of Testing Air-to-Air Heat Exchangers
ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A924/A924M	(2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B280	(2020) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B766	(1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment

ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E2016	(2020) Standard Specification for Industrial Woven Wire Cloth

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GERMAN INSTITUTE FOR STANDARDIZATION (DIN)

DIN EN 14037	(2016) Free Hanging Heating and Cooling Surfaces for Water with a Temperature Below 120 Degrees C - Part 1: Pre-Fabricated Ceiling Mounted Radiant Panels for Space Heating
DIN EN 14240	(2004) Ventilation for Buildings

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001	(2016; Rev 6) HEPA and ULPA Filters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2018) Motors and Generators

NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 96	(2021) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA 701	(2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

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

SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition
SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition
SMACNA 1884	(2003) Fibrous Glass Duct Construction Standards, 7th Edition
SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition
SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

U.S. DEPARTMENT OF ENERGY FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

PL-109-58	(1992; R 2005) Energy Efiicient Procument Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 94	(2013; Reprint Jun 2020) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 181	(2013; Reprint Apr 2017) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 555S	(2014; Reprint Oct 2020) UL Standard for Safety Smoke Dampers
UL 586	(2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Oct 2018) UL Standard for Safety Power Ventilators
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015) Standard for Air Filter Units
UL 1995	(2015) UL Standard for Safety Heating and Cooling Equipment
UL 2021	(2015; Reprint Dec 2016) UL Standard for Safety Fixed and Location-Dedicated Electric Room Heaters
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Electrical Construction	(2012) Electrical Construction Equipment Directory
UL Fire Resistance	(2014) Fire Resistance Directory

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 1/8-inch 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 - [_____]
Unit Ventilator Number	UV - [_____]

Identify similar services with different temperatures or pressures. Where pressures could exceed 860 kilopascal 125 pounds per square inch, gage, 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 75 feet. 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 [_____] mm1/2 thru 1-3/8 inch	13 mm1/2 inch
40 thru [_____] mm1-1/2 thru 2-3/8 inch	[_____] mm3/4 inch
65 mm and larger2-1/2 inch and larger	[_____] mm1-1/4 inch

1.2.3 Color Coding

****
NOTE: The MIL-STD-101 system is for ground based piping systems and compressed gas cylinders. The color coding is not compatible with ASME A13.1 which is commonly used for facilities work
****

Color coding of all piping systems must be in accordance with [ASME A13.1] [MIL-STD-101].

1.3 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

For Navy projects, delete the following submittal items and associated bracketed information: Drawings, Test Procedures, Diagrams, and Bolts.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G[, [_____]]

SD-03 Product Data

Metallic Flexible Duct

Insulated Nonmetallic Flexible Duct Runouts

Duct Connectors

Duct Access Doors; G[, [_____]]

Fire Dampers

Manual Balancing Dampers; G[, [_____]]

Automatic Smoke-Fire Dampers

Automatic Smoke Dampers

Sound Attenuation Equipment

Acoustical Duct Liner

Diffusers

Registers and Grilles

Louvers

Air Vents, Penthouses, and Goosenecks

Centrifugal Fans

In-Line Centrifugal Fans

Axial Flow Fans

Panel Type Power Wall Ventilators

Centrifugal Type Power Wall Ventilators

Centrifugal Type Power Roof Ventilators

Propeller Type Power Roof Ventilators

Air-Curtain Fans

Ceiling Exhaust Fans

PL-109-58 label for ceiling exhaust fan product; S

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[, [_____]]

Ceiling Induction Terminal Units; G[, [_____]]

Reheat Units; G[, [_____]]

Unit Ventilators

Energy Recovery Devices; G[, [_____]]

Hydronic Modular Panels; G[, [_____]]

Prefabricated Radiant-Heating Electric Panels; G[, [_____]]

Test Procedures

Diagrams; G[, [_____]]

Indoor Air Quality for Duct Sealants; S

SD-06 Test Reports

Performance Tests; G[, [_____]]

Damper Acceptance Test; G[, [_____]]

SD-07 Certificates

Bolts

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G[, [_____]]

Fire Dampers; G[, [_____]]

Manual Balancing Dampers; G[, [_____]]

Automatic Smoke-Fire Dampers; G[, [_____]]

Automatic Smoke Dampers; G[, [_____]]

Centrifugal Fans; G[, [_____]]

In-Line Centrifugal Fans; G[, [_____]]

Axial Flow Fans; G[, [_____]]

Panel Type Power Wall Ventilators; G[, [_____]]

Centrifugal Type Power Wall Ventilators; G[, [_____]]

Centrifugal Type Power Roof Ventilators; G[, [_____]]

Propeller Type Power Roof Ventilators; G[, [_____]]

Air-Curtain Fans; G[, [_____]]

Ceiling Exhaust Fans; G[, [_____]]

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[, [_____]]

Ceiling Induction Terminal Units; G[, [_____]]

Reheat Units; G[, [_____]]

Unit Ventilators; G[, [_____]]

Energy Recovery Devices; G[, [_____]]

Hydronic Modular Panels; G[, [_____]]

Prefabricated Radiant-Heating Electric Panels; G[, [_____]]

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.4 QUALITY ASSURANCE

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

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally 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 ASTM International (ASTM), the ASME International (ASME), or other standards, 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.

d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at http://femp.energy.gov/procurement.[Equipment having a lower efficiency may be specified if the designer determines such equipment to be more life-cycle cost effective.]

1.4.1 Prevention of Corrosion

****
NOTE: Refer to sub-section titled "Painting" for painting requirements.
****

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 ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 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

****
NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.
****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. 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

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

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

****

NOTE: Use this paragraph for Air Force, Army and NASA projects.

In order to comply with UFC 1-200-02, designs must achieve energy consumption levels that are at least 30 percent below the baseline established in the 2010 publication of ASHRAE 90.1. The Designer of Record must design HVAC systems that assist in achieving this requirement.

****

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. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.2 STANDARD PRODUCTS

****

NOTE: Use this paragraph for Navy projects.

****

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. In product categories covered by ENERGY STAR or the Federal Energy

Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

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 1-1/2-inches high and smaller must be 1.6 mm 1/16-inch thick, with engraved lettering 3 mm 1/8-inch high; identification plates larger than 40 mm 1-1/2-inches high must be 3 mm 1/8-inch thick, with engraved lettering of suitable height. Identification plates 40 mm 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.4 EQUIPMENT GUARDS AND ACCESS

****

NOTE: Catwalks, ladders, and guardrails could be required. If so, select the applicable item and indicate on drawings. If not applicable, delete the entire last sentence.

****

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 08 31 00 ACCESS DOORS AND PANELS.

2.5 ELECTRICAL WORK

****

NOTE: Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting interferes with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (SD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 INTERIOR ELECTRICAL SYSTEMS.

****

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 00INTERIOR 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 NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

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 NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 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 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED 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

****

NOTE: Retain this paragraph for use as required by NASA for NASA projects. For other agencies, retain this paragraph only when equipment is to be installed in areas of seismic activity.

****

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981

2.8 PAINTING

****

NOTE: Use upgraded materials/coatings in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as indentified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. For projects in these locations, include the sentence below to paint in accordance with Section 09 96 00 HIGH PERFORMANCE COATINGS; designer to edit and include Section 09 96 00.

****

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. Paint in accordance with Section 09 96 00 HIGH-PEFORMANCE COATINGS.

2.9 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.10 DUCT SYSTEMS

****

NOTE: Identify all pressure classification for all ductwork in accordance with SMACNA 1966, including points of changes in pressure classification, on the drawings. Indicate pitch of ductwork, low spots in ductwork, and means of disposing of condensate, where required. Size outdoor air intakes so that rain and snow are not drawn into the ductwork. Slope watertight intakes to a drain line and provide means to dispose of the water. The requirement that outdoor air intake ducts and plenums be fabricated watertight with soldered or brazed joints and seams can be eliminated where rain or snow does not get drawn into the outdoor air intake.

Limit the use of flexible duct (due to the inordinate pressure drop and corresponding fan energy consumption that it causes). Show the extent of flexible duct on the drawings. Ensure that the restrictions in these standards pertaining to the use of non-metallic materials in air distribution plenums are adhered to.

The flammability and combustibility of non-metallic duct materials is controlled by NFPA 90A, 90B, and 91. Show the extent of non-metallic duct on the drawings when these standards limit its use.

The minimum duct seal level must conform to ASHRAE 90.1 including: Outdoor supply ducts and return

ducts must meet seal level A. Outdoor exhaust ducts must meet a seal level C. Unconditioned space supply ducts with 50 mm 2 inches w.c. or less must meet seal level B and greater than 50 mm 2 inches w.c. must meet seal level A. Unconditioned space exhaust duct must meet seal level C and return duct must meet seal level B. Conditioned space supply ducts with 50 mm 2 inches w.c. or less must meet seal level C and greater than 50 mm 2 inches w.c. must meet seal level B. Conditioned space exhaust duct must meet seal level B and return duct must meet seal level C.

For Navy projects all ductwork must meet the requirements of Seal Class A.

****

2.10.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

a. Construct ductwork meeting the requirements for the duct system static pressure specified in APPENDIX D of Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

c. Provide ductwork that meets the requirements of Seal Class [A][C]. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.

d. Provide ductwork that meets the requirements of Seal Class A. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.

e. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants are classified as "Other" within the SCAQMD Rule 1168 sealants table). Provide validation of indoor air quality for duct sealants.

f. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 50 mm 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not

acceptable.

g. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

2.10.1.1 Metallic Flexible Duct

a. Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 497 Pa 2 inches water gauge positive and 373 Pa 1.5 inches water gauge negative. Provide flexible round duct length that does not exceed 1525 mm 5 feet. Secure connections by applying adhesive for 51 mm 2 inches over rigid duct, apply flexible duct 51 mm 2 inches 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 1 inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.10.1.2 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 5 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 0.60 L 20 ounce 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.

2.10.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately 150 mm 6 inches 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. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

2.10.1.4 High Temperature Service Duct Connections

Provide material that is approximately 2.38 mm 3/32 inch thick, 1.2 to 1.36 kg per square meter 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 650 degrees C 1200 degrees F.

2.10.1.5 Aluminum Ducts

ASTM B209M ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.10.1.6 Copper Sheets

ASTM B152/B152M, light cold rolled temper.

2.10.1.7 Corrosion Resisting (Stainless) Steel Sheets

ASTM A167

2.10.2 Duct Access Doors

****
NOTE: Provide duct access doors at regular intervals to facilitate the cleaning of duct systems for applications requiring clean air supplies, such as hospitals, laboratories, electronics servicing and similar activities.
****

Provide hinged access doors conforming to SMACNA 1966 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 15 by 18 inches, 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 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.10.3 Fire Dampers

****
NOTE: Indicate the location of each fire damper and details of the damper installations according to NFPA 90A. Three-hour rated fire dampers must be specifically identified on the drawings. Use pressure relief damper upstream of the fire damper for Army and Air Force projects only.
****

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.

2.10.4 Manual Balancing Dampers

****

NOTE: Use this paragraph for Air Force, Army and NASA projects.

Show all volume dampers on the drawings. Do not rely upon diffuser and register volume dampers for balancing.

****

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 12 inches. 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.

2.10.5 Manual Balancing Dampers

****

NOTE: Use this paragraph for Navy projects.

Show all manual volume dampers on the drawings. Do not rely upon diffuser and register volume dampers for balancing.

****

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 12 inches. 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.

2.10.5.1 Square or Rectangular Dampers

2.10.5.1.1 Duct Height 300 mm 12 inches and Less

2.10.5.1.1.1 Frames

Width	Height	Galvanized Steel Thickness	Length
Maximum 483 mm 19 inches	Maximum 300 mm 12 inches	Minimum 0.91 mm 20 gauge	Minimum 75 mm 3 inches
More than 483 mm 19 inches	Maximum 300 mm 12 inches	Minimum 1.6 mm 16 gauge	Minimum 75 mm 3 inches

2.10.5.1.1.2 Single Leaf Blades

Width	Height	Galvanized Steel Thickness	Length
Maximum 483 mm 19 inches	Maximum 300 mm 12 inches	Minimum 0.91 mm 20 gauge	Minimum 75 mm 3 inches
More than 483 mm 19 inches	Maximum 300 mm 12 inches	Minimum 1.6 mm 16 gauge	Minimum 75 mm 3 inches

2.10.5.1.1.3 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 19 inches	Maximum 300 mm 12 inches	Galvanized Steel	Minimum 10 mm 3/8 inch
More than 483 mm 19 inches	Maximum 300 mm 12 inches	Galvanized Steel	Minimum 13 mm 1/2 inch

2.10.5.1.1.4 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 19 inches	Maximum 300 mm 12 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
More than 483 mm 19 inches	Maximum 300 mm 12 inches	oil-impregnated bronze

2.10.5.1.1.5 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 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.10.5.1.1.6 Finish

Mill Galvanized

2.10.5.1.2 Duct Height Greater than 300 mm 12 inches

2.10.5.1.2.1 Dampers

Provide dampers with multi-leaf opposed-type blades.

2.10.5.1.2.2 Frames

Maximum 1200 mm 48 inches in height; maximum 1200 mm 48 inches in width;
minimum of 1.6 mm 16 gauge galvanized steel,
minimum of 127 mm 5 inches long.

2.10.5.1.2.3 Blades

Minimum of 1.6 mm 16 gauge galvanized steel; 150 mm 6 inch nominal width.

2.10.5.1.2.4 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.

2.10.5.1.2.5 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.

2.10.5.1.2.6 Blade Actuator

Minimum 50 mm 1/2 inch diameter galvanized steel.

2.10.5.1.2.7 Blade Actuator Linkage

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

2.10.5.1.2.8 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 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.10.5.1.2.9 Finish

Mill Galvanized

2.10.5.2 Round Dampers

2.10.5.2.1 Frames

Size	Galvanized Steel Thickness	Length
100 to 500 mm4 to 20 inches	Minimum 0.91 mm 20 gauge	Minimum 152 mm 6 inches
550 to 750 mm 22 to 30 inches	Minimum 0.91 mm 20 gauge	Minimum 152 mm 6 inches
775 to 1000 mm 32 to 40 inches	Minimum 1.6 mm 16 gauge	Minimum 152 mm 6 inches

2.10.5.2.2 Blades

Size	Galvanized Steel Thickness
100 to 500 mm4 to 20 inches	Minimum 0.91 mm 20 gauge
550 to 750 mm 22 to 30 inches	Minimum 1.6 mm 16 gauge
775 to 1000 mm 32 to 40 inches	Minimum 3.5 mm 10 gauge

2.10.5.2.3 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 mm4 to 20 inches	Minimum 10 mm 3/8 inch square
550 to 750 mm 22 to 30 inches	Minimum 13 mm 1/2 inch square
775 to 1000 mm 32 to 40 inches	Minimum 19 mm 3/4 inch square

2.10.5.2.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, nylon, or a solid plastic equivalent to nylon. Axle bearings intended for low leakage at the damper frame must be neoprene, nitrile, or equivalent of 60 or greater durometer to reduce damper blade vibration. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

Size	Material
100 to 500 mm4 to 20 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
550 to 750 mm 22 to 30 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
775 to 1000 mm 32 to 40 inches	oil-impregnated bronze, or stainless steel sleeve bearing

2.10.5.2.5 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 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.10.5.2.6 Finish

Mill Galvanized

2.10.6 Automatic Balancing Dampers

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

2.10.7 Automatic Smoke-Fire Dampers

****

NOTE: Use this paragraph for Navy projects only. When this paragraph is not used, delete "Automatic Smoke-Fire Dampers" from the submittal list.

For smoke-fire dampers, use UL 555S Class III, unless the particular building and application such as hospital dictates the use of UL 555S Class II instead.

****

Multiple blade type, 82 degrees C 180 degrees F 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 250 degrees F for 30 minutes). Ensure that pressure drop in the damper open position does not exceed 25 Pa 0.1 inch water gauge with average duct velocities of 13 m/second 2500 fpm.

2.10.8 Automatic Smoke Dampers

****

NOTE: Use this paragraph for Navy projects only. When this paragraph is not used, delete "Automatic Smoke Dampers" from the submittal list.

For smoke-fire dampers, use UL 555S Class III, unless the particular building and application such as hospital dictates the use of UL 555S Class II instead.

****

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 250 degrees F for 30 minutes). Ensure that pressure drop in the damper open position does not exceed 25 Pa 0.1 inch water gauge with average duct velocities of 13 m/second 2500 fpm.

2.10.9 Air Supply And Exhaust Air Dampers

****

NOTE: Use this paragraph for Air Force, Army and NASA projects.

****

Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - SI ASHRAE 90.1 - IP, including maximum Damper Leakage for:

a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 250 Pa 1.0 inch w.g. for motorized dampers is 20 L/s per square m 4 cfm per square foot of damper area and non-motorized dampers are not allowed.

b. All other Climate Zones the maximum damper leakage at 250 Pa 1.0 inch w.g. is 50 L/s per square m 10 cfm per square foot and for non-motorized dampers is 100 L/s per square m 20 cfm per square foot of damper area.

Dampers smaller than 600 mm 24 inches in either direction may have leakage of 200 L/s per square m 40 cfm per square foot.

2.10.10 Air Deflectors (Volume Extractors) and Branch Connections

****

NOTE: Air deflectors are for Army and Air Force projects only.

****

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.

2.10.11 Plenums and Casings for Field-Fabricated Units

****

NOTE: If field-fabricated air handling units are not used, delete this paragraph entirely. Delete inapplicable sentences or items. Delete the push-button station if not required.

****

2.10.11.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in SMACNA 1966, as applicable. Construct system casing of not less than 1.6 mm 16 gauge galvanized sheet steel. Furnish cooling coil drain pans with 25 mm 1 inch threaded outlet to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 1.6 mm 16 gauge steel, galvanized after fabrication or of 1.3 mm 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304, 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 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.10.11.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in SMACNA 1966.

2.10.11.3 Access Doors

****

NOTE: Determine whether an electrical push-button to stop the fan by a person inside the casing is required. If required, check the drawings to ensure that the item is shown, and properly coordinated with electrical drawings. Use push-button stations for Army and Air Force projects only.

****

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 36 by 18 inches and locate them 450 mm 18 inches 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.

2.10.11.4 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 20 gauge galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 13 mm 1/2 inch under operation. Construct details, including joint sealing, not specifically covered, as indicated in SMACNA 1966. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.10.11.5 Duct Liner

****

NOTE: If duct liner is used, remove this paragraph.

****

Unless otherwise specified, duct liner is not permitted.

2.10.12 Sound Attenuation Equipment

****

NOTE: Use sound attenuators or acoustical duct liner only where acoustical treatment is required and there are no other suitable alternatives. Do not use acoustical duct liner in medical facilities.

Refer to UFC 3-450-02, Power Plant Acoustics , for

noise criteria. Include sound power levels required in the appropriate schedule on the drawings.
****

2.10.12.1 Systems with total pressure above 1 kPa 4 Inches Water Gauge

Provide sound attenuators on the discharge duct of each fan operating at a total pressure above 1 kPa 4 inch water gauge, 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 0.63 inch water gauge. Construct traps to be airtight when operating under an internal static pressure of 2.5 kPa 10 inch water gauge. Provide air-side surface capable of withstanding air velocity of 50 m/s 10,000 fpm. 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 ASTM C1071, Type I or II. 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 1 inch 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 SMACNA 1966. Provide acoustical insulation with a thermal conductivity "k" of not more than 0.0389 W/m-K 0.27 Btu/inch/square foot/hour/degree F at 24 degrees C 75 degrees F mean temperature. Provide an internal perforated zinc-coated metal liner that is not less than 0.7 mm 24 gauge with perforations not larger than 6.35 mm 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

2.10.12.2 System with total pressure of 1 kPa 4 Inch Water Gauge 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 22 gauge. Provide fibrous glass acoustical fill. Provide net sound reduction indicated. Obtain values on a test unit not less than 600 by 600 mm 24 by 24 inches 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 inch water gauge.

2.10.12.3 Acoustical Duct Liner

Use fibrous glass designed or flexible elastomeric duct liner for lining ductwork and conforming to the requirements of ASTM C1071, 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 1 inch 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.

2.10.13 Diffusers, Registers, and Grilles

****

NOTE: Coordinate with paragraph Sound Attenuation Equipment.

If diffusers or registers or grilles are not required, delete reference to the omitted items. Delete specified performance characteristics peculiar to the omitted items. If any one or two of the three types of units are omitted, delete the corresponding subparagraph.

****

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 50 fpm 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 ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. 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 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.10.13.1 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.

2.10.13.2 Perforated Plate Diffusers

****
NOTE: Use this paragraph for Navy projects only.
****

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

2.10.13.3 Linear Diffusers

****
NOTE: Use this paragraph for Navy projects only.
****

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.

2.10.13.4 Security Ceiling Diffusers

****
NOTE: Use this paragraph for brig facilities only.
****

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 14 gage minimum with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.10.13.5 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 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 150 mm 6 inches 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.

2.10.13.6 Registers

****
NOTE: Use this paragraph for Navy projects only.

Delete paragraph, "Registers and Grilles," when this paragraph is used.
****

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.]

2.10.13.7 Security Supply Air Registers Except in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

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 3/4 inch o.c. vane spacing. Provide a 1.9 mm 14 gage (minimum) perforated faceplate with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.10.13.8 Security Return and Other Air Registers Except in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

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 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.10.13.9 Security Supply Air Registers in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

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 14 gage (minimum) faceplate with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

2.10.13.10 Security Return and Other Type Air Registers in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

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 14 gage (minimum) faceplate with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum)wall sleeve.

2.10.14 Louvers

****
NOTE: Ensure that louver selection includes consideration of parameters such as pressure drop and water penetration.
****

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].

2.10.15 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 SMACNA 1966. 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.

2.10.16 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, 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.

2.10.17 Radon Exhaust Ductwork

Fabricate radon exhaust ductwork installed in or beneath slabs from Schedule 40 PVC pipe that conforms to ASTM D1785. Provide fittings that conform to ASTM D2466. Use solvent cement conforming to ASTM D2564 to make joints. Otherwise provide metal radon exhaust ductwork as specified herein.

2.11 AIR SYSTEMS EQUIPMENT

****
NOTE: Required items in this paragraph are determined by whether field-fabricated air handling units apply or whether equipment external to air handling units are used in the distribution system.
****

2.11.1 Fans

****
NOTE: Coordinate with paragraph Sound Attenuation

Equipment. Include any applicable noise criteria in appropriate equipment schedule on the drawings.

Refer to UFC 3-450-02, Power Plant Acoustic, for vibration criteria. Detail vibration isolation required on the drawings and include it in the appropriate schedule.

Design and detail ductwork near air moving devices to minimize system effect on the fans in accordance with AMCA 201. Add system effect to the duct friction loss and indicate fan static pressure on drawings for the designed ductwork configuration.

Indicate the location of each duct smoke detector in the HVAC system and include the detectors on the schematic and associated ladder diagram. Provide duct smoke detectors according to NFPA 90A. Duct detectors are intended to shut associated air distribution fans and smoke dampers, if provided. Duct smoke detectors are not for use inside ducts where ambient temperatures exceeds 38 degrees C 100 degrees F.

When the building is equipped with a fire alarm system, connect the duct smoke detectors to the fire alarm control panel (FACP) for alarm initiation. Show wiring to the FACP for either new or existing fire alarm systems.

Fans with motors greater than 0.5 kW 3/4 hp must have automatic controls capable of shutting off fans when not required.

HVAC systems having a total fan system power exceeding 3.7 kW 5 hp must meet the provisions of ASHRAE 90.1. These include ASHRAE 90.1, Table 6.5.3.1, Fan Power Limitation:

For supply air volumes less than 9,400 L/s 20,000 cfm the allowable nameplate motor power for a constant volume fan is 1.9 kW/1000 L/s 1.2 hp/1000 cfm and for a variable volume fan is 2.7 kW/1000 L/s 1.7 hp/1000 cfm.

For supply air volumes of 9,400 L/s 20,000 cfm and greater the allowable nameplate motor power for a constant volume fan is 1.7 kW/1000 L/s 1.1 hp/1000 cfm and for a variable volume fan is 2.4 kW/1000 L/s 1.5 hp/1000 cfm.

****

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 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 AMCA 300 and rated in

accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than [150] [140] [120] percent of the connected driving capacity. Provide variable pitch motor sheaves for 11 kW 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). 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 AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

2.11.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III 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 30 inches. Provide backward-inclined airfoil design fan blades for wheels over 750 mm 30 inches 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 36 inches in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 900 mm 36 inches 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 200,000 hours as defined by ABMA 9 and ABMA 11. 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.]

2.11.1.2 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 200,000 hours as defined by ABMA 9 and ABMA 11.[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.]

2.11.1.3 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 200,000 hours of operation as defined by ABMA 9 and ABMA 11. 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.]

2.11.1.4 Panel Type Power Wall Ventilators

Provide propeller type fans, assembled on a reinforced metal panel with venturi opening spun into panel. Provide direct or V-belt driven fans with wheels less than 600 mm 24 inches in diameter and provide V-belt driven fans with wheels 600 mm 24 inches in diameter and larger. Provide fans with wall mounting collar. Provide lubricated bearings. Equip fans with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Provide [dripproof][totally enclosed fan cooled][explosion-proof] type motor enclosure. Install [gravity][motor operated] backdraft dampers where indicated.

2.11.1.5 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.

2.11.1.6 Centrifugal Type Power Roof Ventilators

****
NOTE: Delete kitchen exhaust fan when not required.
****

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.

2.11.1.7 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.

2.11.1.8 Air-Curtain Fans

****
NOTE: Provide air curtains designed as fly fans on all exterior entranceways to food preparation areas, except where the entranceway is to be used only as an emergency exit. Include air curtains for service windows and service entries whenever feasible on the exterior of the entranceway. When air curtains are mounted in locations significantly above normal door heights, verify curtain air velocities and noise levels.
****

Provide fans that conform to AMCA 220 with AMCA seal. Furnish air curtains with a weatherproof housing constructed of high impact plastic or minimum 1.3 mm 18 gauge 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 3 inches thick at the discharge nozzle. Provide air velocity that is not less than 8 m/s 1600 fpm across the entire entryway when measured 900 mm 3 feet above the floor.] [Provide air curtains designed for use on customer entranceways that develop an air curtain not less than 200 mm 8 inches thick at the discharge opening. Provide velocity that is not less than 3 m/s 600 fpm across the entire entryway when measured 900 mm 3 feet 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 8 inches thick at the discharge opening. Provide air velocity that is not less than 3 m/s 600 fpm across the entire opening of the service window measured 900 mm 3 feet below the air discharge opening.]

2.11.1.9 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. Provide U.L. listed fans. Provide PL-109-58 labeled ceiling exhaust fan product. Provide proof of PL-109-58 label for ceiling exhaust fan product.

2.11.2 Coils

****

NOTE: Research local conditions to determine the effect of corrosive atmosphere on dissimilar metals. Where condenser or evaporator coils are to be installed in corrosive atmospheres, rewrite the specification for coils and fins for these specific conditions. Consider the following coil and fin combinations based on past experience with the suitability of these materials in dealing with the local conditions.

a. Copper coil and aluminum fins, coated.

b. Copper coil and copper fins, coated.

c. Aluminum coil and aluminum fins, coated.

d. Aluminum coil and aluminum fins, uncoated.

e. Copper coil and copper fins, uncoated.

Provide either phenolic, vinyl or epoxy/electrodeposition coating. For coils with relatively close fin spacing such as those found in most unitary equipment, the phenolic or epoxy/electrodeposition coating is preferred, as these have less tendency to bridge across the fins than vinyl, better thermal conductivity than vinyl and in many conditions weathers better than vinyl.
****

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 [0.016][0.020][0.024] inches].[Provide red brass tube wall thickness that is a minimum of [0.89][1.24] mm [0.035] [0.049] inches]. [Provide aluminum fins that are [0.14][0.19] mm [0.0055][0.0075] inch minimum thickness.][Provide copper fins that are 0.114 mm 0.0045 inch minimum thickness.] Provide casing and tube support sheets that are not lighter than 1.6 mm 16 gauge 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 AHRI 410.[Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.]

2.11.2.1 Direct-Expansion Coils

****
NOTE: Use this paragraph for Army and Air Force projects only.
****

Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to ASTM B280 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 UL 1995.

2.11.2.2 Water Coils

Install water coils with a pitch of not less than 10 mm/m 1/8 inch/foot 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 UL 1995.

2.11.2.3 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 1/2 inch 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 testcoils in accordance with UL 1995.

2.11.2.4 Steam Preheat (Nonfreeze) Coils

Provide steam-distribution-tube type steam (nonfreeze) coils with condensing tubes not less than 25 mm 1 inch outside diameter for tube lengths 1.5 m 60 inches and over and 13 mm 1/2 inch outside diameter for tube lengths under 1.5 m 60 inches. Construct headers from cast iron, welded steel, or copper. Provide distribution tubes that are not less than 15 mm 5/8 inch outside diameter for tube lengths 1.5 m 60 inches and over and 10 mm 3/8 inch outside diameter for tube lengths under 1.5 m 60 inches 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 144 inches. 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 UL 1995.

2.11.2.5 Electric Heating Coil

****
NOTE: Use this paragraph for Navy projects only. Choose the second set of brackets if an air-conditioning unit for EDP is specified.
****

Provide an electric duct heater coil in accordance with UL 1995 and NFPA 70. 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.

2.11.2.6 Eliminators

****
NOTE: Use this paragraph for Navy projects only.
****

Equip each cooling coil having an air velocity of over 2 m/s 400 fpm 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 2-1/2 inches center-to-center on face. Provide each bend with an integrally formed hook as indicated in the SMACNA 1884.

2.11.2.7 Sprayed Coil Dehumidifiers

****
NOTE: Use this paragraph for Navy projects only.
****

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.

2.11.2.8 Corrosion Protection for Coastal Installations

****
NOTE: Use this paragraph for Navy projects only.

Specify corrosion protection for exterior HVAC equipment, including air handling units, heat exchanger coil surfaces, equipment casings, air-cooled water chiller coils, heat pumps, and air conditioning units, that is exposed to the weather within 8 km (5 miles) of a sea (salt) water coast.

At these coastal locations, this corrosion protection is also required on HVAC equipment within buildings that are subject to the outside weather conditions. Specifically, equipment requiring protection is defined as the first HVAC equipment (excluding louvers) met by the outside air in the supply air ductwork system.

Specifier will survey the HVAC equipment market place, find and specify the manufacturer's standard off-the-shelve anti-corrosion options for "coastal" or "sea coast" installations. Specify the various systems (utilizing the word "or") offered by three competitive equipment selections. This approach is by far less costly than specifying custom corrosion protection.

Manufacturer's standard off-the-shelve anti-corrosion options for "coastal" or "sea coast" installations also vary with type and size of HVAC equipment.

After thorough investigation of the commercial market, determines manufacturer's standard off-the-shelve anti-corrosion options are not available for the selected equipment, contact the Mechanical Design Branch, NAVFAC LANT for consultation if the need for this protection is considered mandatory by the station.

For installations at MCAS Cherry Point and MCB Camp

LeJeune, including New River, and installations at NAS Oceana including Dam Neck, specify corrosion protection for all outside, and specific inside HVAC equipment exposed to the weather. Follow the guidance specified in the criteria NOTE above.
****

[_____]

2.11.3 Air Filters

****
NOTE: Select filters based on the functional needs of the area served, including indoor air quality. The combination of the extended surface pleated panel filters and the extended surface nonsupported pocket filters or the cartridge filter of the same efficiency are intended to fulfill the filtration requirements in UFC 3-410-01, Heating, Ventilating, and Air-Conditioning Systems for areas where indoor air quality is of primary concern. Consider limiting the variety of filter sizes required to minimize inventory requirements for system maintenance.

In the event the retention of efficiency values in the specification becomes too cumbersome, revise the requirements by referring to the efficiencies indicated on the drawings, to show for each air handling unit or system the efficiency of the air filters required, and the maximum initial resistance.
****

List air filters according to requirements of UL 900, 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 UL 586.

2.11.3.1 Extended Surface Pleated Panel Filters

Provide 50 mm 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 2.54 m/s 500 fpm that does not exceed 0.09 kPa 0.36 inches water gauge. 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.

2.11.3.2 Extended Surface Nonsupported Pocket Filters

Provide [750][_____] mm [30][_____] inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s [500][_____] fpm that does not exceed [0.1125][_____] kPa [0.45][_____] inches water gauge. Provide UL Class 1 filters. 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.

2.11.3.3 Cartridge Type Filters

Provide 305 mm 12 inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s [500][_____] fpm that does not exceed [0.14][_____] kPa [0.56][_____] inches, water gauge. Provide UL class 1 filters, 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.

2.11.3.4 Sectional Cleanable Filters

****
NOTE: Delete washing and charging racks when not required.
****

Provide [25][50] mm [1][2] inch thick cleanable filters. Provide viscous adhesive in 20 L 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one L one quart 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.

2.11.3.5 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 2 inches 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 16 gauge 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 [300][_____] fpm, with initial resistance of [32][_____] Pa [0.13][_____] inches water gauge. Provide MERV that is not less than [_____] when tested according to ASHRAE 52.2.

2.11.3.6 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 14 gauge 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 65 feet 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 1/4 inch when subjected to air flow at 2.54 m/s 500 fpm. 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 175 degrees F. Support media on both the leaving and entering air faces. Clean media must have initial resistance that does not exceed 45 Pa 0.18 inch water gauge at its rated velocity of 2.54 m/s 500 fpm. Set control so that the resistance to air flow is between 100 and 125 Pa 0.40-and 0.50 inch water gauge 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 0.50 inch water gauge, that is at least 592 (55) grams of ASHRAE Standard Test Dust per square meter foot of media area, when tested according to the dynamic testing provisions of ASHRAE 52.2.

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 1 inch, 24 kg/cubic meter 1-1/2 pound density neoprene coated fibrous glass with thermal conductivity not greater than 0.04 W/m-K 0.27 Btu/hour/degree F/square foot/inch 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.

2.11.3.7 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 65 foot 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 0.25 inch water gauge at 2.54 m/s 500 fpm face velocity.

d. A MERV of the combination that is not less than 15 when tested according to ASHRAE 52.2 at an average operating resistance of 125 Pa 0.50 inch water gauge. 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 0.65 inch water gauge at 2.54 m/s 500 fpm face velocity, with a MERV of the combination not less than 16 when tested according to ASHRAE 52.2. 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.

2.11.3.8 High-Efficiency Particulate Air (HEPA) Filters

****

NOTE: Use high-efficiency particulate air filters in CLEAN ROOMS (White Rooms or Dust Controlled Facilities), clean work stations, and for critical

areas of hospitals. Show the efficiency of the prefilter on the drawings. Provide efficiency that is sufficient for the anticipated contamination load and the degree of prefiltration required. Reference ASME AG-1 either all or in part when extreme temperature or humidity requirements exist. Ensure that requirements added to text from ASME AG-1 are essential to customer's needs to prevent unnecessary expenses from being added to the project, as this standard is not intended for routine commercial applications. When used, add ASME AG-1 to paragraph REFERENCES.

****

Provide HEPA filters that meet the requirements of IEST RP-CC-001 and are individually tested and certified to have an efficiency of not less than [95] [99.97] percent, and an initial resistance at [_____] m/s fpm that does not exceed [_____] Pa inches water gauge. 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 3/4 inch 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 1/16 inch, and squareness that is maintained to within 3.2 mm 1/8 inch. 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.

2.11.3.9 Holding Frames

Fabricate frames from not lighter than 1.6 mm 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.11.3.10 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 3-7/8 inches in diameter, with white dials with black figures, and [graduations] [graduated in 0.0025 kPa 0.01 inch of water,] with a minimum range of 0.25 kPa 1 inch of water 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 tips with integral compression fittings, two molded plastic vent valves, two 1.5 m 5 foot minimum lengths of 6.35 mm 1/4 inch diameter [aluminum] [vinyl] tubing, and all hardware and accessories for gauge mounting.

2.12 AIR HANDLING UNITS

****

NOTE: To prevent condensate overflow, calculate the size of condensate drain pans for air handling units where abnormally high latent loads are encountered such as high humidity locations or units operating with 100 percent outside air. Where the potential exists for a manufacturer's standard condensate pan to be smaller than the size calculated, include the size required in the equipment schedule on the drawings.

For AHU's intended for outdoor installation, note on equipment schedule that AHU roof (used for Army projects only) must slope a minimum of 6 mm/300 mm 1/4 in per ft and overhang wall panels by a minimum of 50 mm 2 inches.

****

2.12.1 Field-Fabricated Air Handling Units

Provide built-up units as specified in paragraph DUCT SYSTEMS. Provide fans, coils spray-coil dehumidifiers, and air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types indicated.

2.12.2 Factory-Fabricated Air Handling Units

****

NOTE: Coordinate with paragraph Fans and paragraph Coils.

****

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 AHRI 430 and AHRI certified for cooling.

2.12.2.1 Casings

Provide the following:

a. [Casing sections [[single] [50 mm 2 inch double] wall type] [as indicated], constructed of a minimum 1.3 mm 18 gauge galvanized steel, or 1.3 mm 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304.][Inner casing of double-wall units that are a minimum one mm 20 gauge solid galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304.] 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 18 gauge outer and one mm 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 300 mm 12 inches wide by 300 mm 12 inches high. Access doors must be a minimum 600 mm 24 inches wide, the full height of the unit casing or a minimum of 1800 mm 6 foot, whichever is less. [Install a minimum 200 by 200 mm 8 by 8 inches 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 16 gauge [galvanized steel] [corrosion resisting sheet steel conforming to ASTM A167, Type 304], conforming to ASHRAE 62.1. 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. Casing insulation that conforms to NFPA 90A. Insulate single-wall casing sections handling conditioned air with not less than 25 mm 1 inch thick, 24 kg/cubic meter 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.033 W/m-K 0.23 Btu/hr-sf-F. Insulate double-wall casing sections handling conditioned air with not less than 50 mm 2 inches 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 ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. 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 ASTM C1071.

h. A latched and hinged inspection door, in the fan and coil sections. Plus additional inspection doors, access doors and access sections

[_____][where indicated].

2.12.2.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.12.2.3 Air Filters

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

2.12.2.4 Fans

****
NOTE: Coordinate with paragraph Sound Attenuation Equipment.

Refer to UFC 3-450-02, Power Plant Acoustics, for vibration criteria. Detail vibration isolation required and include it in the appropriate schedule on the drawings.
****

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 ABMA 9 and ABMA 11. 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 25 hp and below and fixed pitch above 20 kW 25 hp as defined by AHRI Guideline D.] 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 AMCA 300, ASHRAE 68, or AHRI 260 I-P.

2.12.2.5 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.

2.12.2.6 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 [8][_____] inches water gauge 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.

2.13 TERMINAL UNITS

****
NOTE: Coordinate with paragraph Sound Attenuation Equipment.
****

2.13.1 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 AHRI 350. 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 AHRI 440, and meet the requirements of UL 1995.

2.13.1.1 Enclosures

Fabricate enclosures from not lighter than 1.3 mm 18 gauge steel, reinforced and braced. Provide enclosures with front panels that are removable and have 7 mm 1/4 inch closed cell insulation or 13 mm 1/2 inch 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 4,500 fpm. 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 according to UL 94 and the material complies with the heat deflection criteria specified in UL 1995. 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.

2.13.1.2 Fans

Provide steel or aluminum, multiblade, 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.

2.13.1.3 Coils

Fabricate coils from not less than 10 mm 3/8 inch 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 1/2 inch 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 300 psi or under water at 1700 kPa 250 psi air pressure. Provide coils suitable for 1400 kPa 200 psi working pressure. Make provisions for coil removal.

2.13.1.4 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 21 gauge 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 3/4 inch NPT or 15 mm 5/8 inch 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 1 inch minimum over the auxiliary drain pan.

2.13.1.5 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.

2.13.1.6 Filters

Provide disposable type filter that complies with ASHRAE 52.2. Provide filters in each unit that are removable without the use of tools.

2.13.1.7 Motors

****
NOTE: Edit depending on whether the units are freestanding, built-in or both. Values for high static motors cover 115V, 230V, and 277V.
****

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) (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
94200	70	110	90
142300	100	110	110
189400	170	150	150
283600	180	210	220
378800	240	240	230
4721000	310	250	270
5661200	440	400	440

High Static Motors	
Unit Capacity (L/S) (cfm)	Maximum Power Consumption (Watts)
94200	145
142300	145
189400	210
283600	320
378800	320
4721000	530
5661200	530

2.13.2 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 ASA S12.51. 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.

2.13.2.1 Enclosures

Fabricate enclosures from not lighter than 1.2 mm 18 gauge 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.

2.13.2.2 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.

2.13.2.3 Coils

Fabricate coils from not less than 10 mm 3/8 inch 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 1/2 inch 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 300 psi or under water at 1700 kPa 250 psi air pressure and provide coils suitable for 1400 kPa 200 psi working pressure.

2.13.2.4 Screens

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

2.13.2.5 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 21 gauge 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 22 gauge steel are allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 0.9 mm 21 gauge steel material or of die-formed 0.9 mm 21 gauge 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 3/4 inch NPT or 15 mm 5/8 inch OD.

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

****
NOTE: Delete reheat coils when not required.
****

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 22 gauge or aluminum sheet not lighter than 1.3 mm 18 gauge. 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 AHRI 880 I-P with the calculations prepared in accordance with AHRI 885. Provide sound power level as indicated. Show discharge sound power for minimum and [375][_____] Pa [1-1/2][_____] inches water gauge inlet static pressure. Provide acoustical lining according to NFPA 90A.

2.13.3.1 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 3/4 to 6 inch water gauge.

2.13.3.2 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 3/4 to 6 inch water gauge. Provide units with an internal resistance not exceeding 100 Pa 0.4 inch water gauge 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 0 to 1 inch water gauge range.

2.13.3.3 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 3/4 to 6 inch water gauge. 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.

2.13.3.4 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 1 to 8 inch water gauge 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 inch water gauge at maximum flow range.

2.13.3.5 Ceiling Induction Terminal Units

****
NOTE: Do not use ceiling induction units on NAVFAC projects.
****

Provide ceiling induction unit with a calibrated primary air volume

sensing device, primary air valve, induced air damper, and insulated induction tube. Arrange unit to induce air from the ceiling plenum to maintain a maximum total flow circulated to the conditioned space. Vary primary air upon demand of the room thermostat. Upon a demand for maximum cooling, provide a unit that delivers 100 percent primary air and, at minimum cooling, delivers [50] [25] percent primary air. Provide a terminal unit capable of closing to full shut off without additional actuators or linkage changes. Provide terminals that reset primary air volume within plus or minus 5 percent determined by the thermostat regardless of upstream changes in the static pressure. Provide a minimum inlet static pressure that does not exceed 250 Pa 1 inch water gauge, including a maximum of 75 Pa 0.3 inch water gauge downstream static pressure. Provide external differential pressure taps separate from control pressure taps for primary air flow measurement with 0 to 250 Pa 0 to 1 inch water gauge range. Make each unit normally [open] [closed] upon loss of pneumatic pressure. Factory pipe actuator and accuracy controls requiring only field installation of 138 kPa 20 psi pneumatic main air and room thermostat.

2.13.3.6 Series Fan Powered Variable Air Volume (VAV) Terminals

****

NOTE: For evaporator variable airflow applications such as VAV or multizone, provisions for capacity control and minimum capacity must be indicated. Provide capacity control by compressor unloading or multiple compressors. For minimum capacity control, provide these applications with factory installed hot-gas bypass.

****

Provide units factory assembled, designed, tested, rated in accordance with AHRI 880 I-P, that are AHRI certified, listed in the AHRI DCAACP and that produce a supply air discharge mix by modulation of conditioned primary air and recirculating of return air. Provide units that include casing, centrifugal fan and motor, primary VAV damper or valve, electronic volume regulator, discharge air damper, primary air inlet cone with high and low pressure flow sensors, recirculating air filter frames, filter, and electrical disconnect. [Provide hot water heating coils integral to the terminal, or provide insulated hot water coil section attached to the discharge of the terminal.]

2.13.3.6.1 Casing

Provide removable full bottom access panels for servicing internal components without disturbing duct connections. Insulate inside of casing with manufacturer's standard insulation. Provide units that have recirculating air inlet equipped with filter frame, round primary damper or valve, and unit mounting brackets.

2.13.3.6.2 Fans and Motors

Provide centrifugal, forward curved, multiblade, fan wheels with direct-drive motors. Provide motors that are the high efficiency permanent-split capacitor type with thermal overload protection, permanently lubricated bearings, and have three speeds or are equipped with solid state speed controllers. Provide isolation between fan motor assembly and unit casing. Provide fan and motor that is removable through casing access panel.

2.13.3.6.3 Flow Sensor

Provide ring or cross type sensor with minimum of two pickup points which average the velocity across the inlet. Obtain flow measurement within plus or minus 5 percent of rated airflow with 1.5 diameters of straight duct upstream of unit and inlet static variation of 124 to 1240 Pa 0.5 to 5.0 inches water gauge. Supply flow measuring taps and calibration flowchart with each unit for field balancing airflows.

2.13.3.6.4 Primary VAV Damper or Valve

Provide galvanized steel damper blade that closes against gasket inside unit. Connect damper to operating shaft with a positive mechanical connection. Provide nylon bearing for damper shaft. Cylindrical die cast aluminum valve inlet tapered to fit round flexible ducts with integral flow diffuser and beveled self-centering disc. Provide damper or valve leakage at shutoff that does not exceed 2 percent of capacity at 250 Pa 1 inch water gauge pressure.

2.13.3.6.5 Regulator

Provide electronic volume regulator. Electronic controls contained in NEMA ICS 6, Type 1 enclosure sealed from airflow. Provide unit with controls mounted on side or on air valve. System powered regulators are not permitted. Provide volume regulator that resets primary air volume as determined by thermostat, within upstream static pressure variation noted in paragraph titled "Flow Sensor." Provide volume regulators that are field adjustable, factory set and calibrated to indicated maximum and minimum primary airflows, direct acting and normally [open] [closed] upon loss of pneumatic pressure.

2.13.3.6.6 Electrical

Provide unit that incorporates single point electrical connection with electrical disconnect. Provide electrical components that are UL or ETL listed, installed in accordance with NFPA 70 and mounted in control box. Units UL or ETL listed as an assembly do not require airflow switch interlock with electric heating coil, when factory assembled.

2.13.3.6.7 Filters

Provide UL listed throwaway 25 mm one inch thick fiberglass filters, standard dust-holding capacity.

2.13.3.7 Reheat Units

2.13.3.7.1 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 16 gauge, 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 250 psi air pressure and provide coils suitable for 1400 kPa 200 psi working pressure. Install drainable coils in the air handling units with a pitch of not less than 10

mm per m 1/8 inch per foot of tube length toward the drain end. Coils must conform to the provisions of AHRI 410.

2.13.3.7.2 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 16 gauge 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 250 psi hydrostatic test pressure or 1400 kPa 250 psi air pressure, and are for [700] [1400] kPa [100] [200] psi steam working pressure. Provide steam-distribution tube type preheat coils with condensing tubes having not less than 15 mm 5/8 inch outside diameters. Provide distribution tubes that have not less than 10 mm 3/8 inch 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 1/2 inch. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Provide coils that conform to the provisions of AHRI 410.

2.13.3.7.3 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 Underwriters Laboratories and NFPA 70 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.

2.13.4 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 AHRI 350. 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. Make the sequence of control any one of the standard ANSI cycles specified in paragraph CONTROLS.

2.13.4.1 Enclosures

Fabricate enclosures from not lighter than 1.6 mm 16 gauge 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 1/2 inch 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 4500 fpm. 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.

2.13.4.2 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.

2.13.4.3 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.

2.13.4.4 Coils

Provide coils that are circuited for a maximum water velocity of 2.4 m/s 8 fps without excessive pressure drop and are otherwise as specified for hot water coils in paragraph TERMINAL UNITS.

2.13.4.5 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 18 gauge 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 20 gauge steel is allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 1.3 mm 18 gauge steel material, or of die-formed 1.3 mm 18 gauge 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 3/4 inch NDT or 18 mm 5/8 inch OD.

2.13.4.6 Filters

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

2.13.4.7 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.

2.13.4.8 Motors

****
NOTE: Edit based on whether the units are freestanding, built-in, or both.
****

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.

2.13.4.9 Outside Air Intakes

Provide the manufacturer's standard design outside air intakes furnished with 13 mm 1/2 inch mesh bird screen or louvers on 13 mm 1/2 inch centers.

2.14 ENERGY RECOVERY DEVICES

2.14.1 Rotary Wheel

****
NOTE: Show energy recovery device supply/exhaust filters, preheat coils, backdraft dampers, exhaust dampers, recirculation dampers, face and bypass dampers, drainage provisions, controls and like ancillaries on the drawings and supplement by the specifications as necessary. Select minimum acceptable energy transfer effectiveness and maximum acceptable cross-contamination.

Delete moisture resistance and chain drive if not required.
****

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 ASHRAE 84 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.

2.14.2 Run-Around-Coil

****

NOTE: Delete "factory fabricated and tested" if not required.

Coordinate with paragraph Glycol Solution in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS. Glycol is considered a hazardous waste. If the base does not have a used glycol waste program, using glycol can be an expensive maintenance item.

****

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] [_____].

2.14.3 Heat Pipe

****

NOTE: Include face air velocity, static pressure drop, temperature requirements for entering and leaving air or exhaust streams on the equipment schedule for heat pipes.

Delete flexible connectors if not required.

****

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 [1/2][5/8][1] inch 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 ASHRAE 15 & 34, 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 16 gauge 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.

2.14.4 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.

2.14.5 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 20 gauge G90, galvanized steel, double wall construction with 25 mm one inch insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

2.15 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. 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 1/8 inch. 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 ASTM D520 Type I.

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.

2.16 SUPPLEMENTAL COMPONENTS/SERVICES

2.16.1 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

2.16.2 Refrigerant Piping

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

2.16.3 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].

2.16.4 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.

2.16.5 Backflow Preventers

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

2.16.6 Insulation

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

2.16.7 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].

2.17 RADIANT PANELS

****

NOTE: There are currently no performance certification requirements or standards in the US for radiant ceiling panels. Until those performance

certification procedures are developed, accepted and published, the European Standards DIN EN 14037 and DIN EN 14240 will be utilized.
****

****
NOTE: For radiant cooling panels, special care must be taken to avoid condensation on the panels. The design must include a sequence of operation to circulate chilled water to the panels at a temperature slightly above the room dew point temperature and must be able to adjust the chilled water temperature as required based on changes in the room relative humidity.
****

2.17.1 Hydronic Modular Panels

2.17.1.1 Panels

Modular radiant panels will fit into a standard 600 mm x 600 mm24 inch x 24 inch or 600 mm x 1200 mm24 inch x 48 inch 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 must be supported from the T-bar assembly. Panels must be [14 gauge] or [16 gauge] extruded aluminum or sheet steel.

2.17.1.2 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.

2.17.1.3 Water Tubes

Tubes must consist of ASTM B75/B75M [13 mm] [1/2 inch] [16 mm] [5/8 inch] 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 and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling). 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.

2.17.1.4 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.

2.17.1.5 Performance

Manufacturer will provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.17.1.6 Capacity

****
NOTE: Include the last bracketed sentence if it is deemed necessary to confirm heating and/or cooling capacity after the panels are installed.
****

Modular radiant panel capacity will be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) 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.]

2.17.1.7 Water Connections

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

2.17.1.8 Installation

Panels will be installed as recommended by the manufacturer.

2.17.1.9 Accessories

Stainless steel braded hoses, 300 mm12 inches or 450 mm18 inches long will be supplied with the panels.

The top of the heating and cooling panels must be covered with 38 mm1-1/2 inches thick 16kg/m31 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 0.79 m2 deg C/W4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.

2.17.2 Hydronic Linear Panels

2.17.2.1 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.

2.17.2.2 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.

2.17.2.3 Water Tubes

Tubes must consist of ASTM B75/B75M 13 mm1/2 inch or 16mm5/8 inch 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 and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.17.2.4 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.

2.17.2.5 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.

2.17.2.6 Performance

Manufacturer must provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.17.2.7 Capacity

****
NOTE: Include the last bracketed sentence if it is deemed necessary to confirm heating and/or cooling capacity after the panels are installed.
****

Modular radiant panel capacity must be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) 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.]

2.17.2.8 Water Connections

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

2.17.2.9 Accessories

Stainless steel braded hoses, 300 mm12 inches or 450 mm18 inches long will be supplied with the panels.

The top of the heating and cooling panels must be covered with 38 mm1-1/2 inches thick 16kg/m31 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 0.79 m2 deg C/W4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.

2.17.3 Prefabricated Radiant-Heating Electric Panels

2.17.3.1 Description

Sheet metal enclosed panel with heating element suitable for [lay-in installation flush with T-bar ceiling grid] [surface mounting] [recessed mounting]. Comply with UL 2021

2.17.3.2 Panel

Minimum 0.7 mm0.027 inch thick, galvanized steel sheet back panel riveted to minimum 1.0 mm0.040 inch thick, galvanized steel sheet front panel with fused-on crystalline surface.

2.17.3.3 Heating Element

Powdered graphite sandwiched between sheets of electric insulation.

2.17.3.4 Electrical Connections

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

2.17.3.5 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.]

2.17.3.6 Surface-Mounting Trim

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

2.17.3.7 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 [3][_____] feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional [910][_____] mm [3][_____] feet.

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] [units except room [fan-coil units][and][coil-induction units]]. Provide a depth of each seal of 50 mm 2 inches plus 0.1 mm for each Pa the number of inches, measured in water gauge, 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 6 inch 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 08 31 00 ACCESS DOORS AND PANELS.

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 SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. 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

****
NOTE: Due to potential contaminants of air-stream, such as pesticides and corrosion, use underground ductwork only for exhaust air.
****

Provide PVC plastisol coated galvanized steel underground ductwork with coating on interior and exterior surfaces and watertight joints. Install ductwork as indicated, according to ACCA Manual 4 and manufacturer's instructions. Maximum burial depth is 2 m 6 feet.

3.2.5.2 Radon Exhaust Ductwork

****
NOTE: Design subslab ventilation for radon mitigation as prescribed in TM 5-810-1.
****

Perforate subslab suction piping where indicated. Install PVC joints as specified in ASTM D2855.

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

****
NOTE: Study characteristics of exhaust stream constituents and contaminant materials to determine service life and safety controlling parameters. Consider that constituents concentrate upon evaporation of carrier. Some concentrates detonate upon impact. Design to preclude concentrate high-allow for out water washing. Review fire protection provisions, and the need for fire stops. The manufacturer cannot be held responsible for performance of his product, unless the specification delineates product exposure. Modify or supplement specification criteria as necessary.
****

Provide fibrous glass reinforced plastic ducting and related structures that conform to SMACNA 1403. 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 50 degrees F, heat cure joints by exothermic reaction heat packs.

3.2.7 Kitchen Exhaust Ductwork

****

NOTE: Show on the drawings the requirements in NFPA 96 pertaining to enclosures around kitchen exhaust ducts.

The referenced SMACNA HVAC Duct Construction Manual does not cover negative pressures in excess of 747 Pa 3 inches water gauge. If the static pressure within the duct can exceed 75 mm 3 inches negative, then the spacing and duct thickness must be indicated on the drawings and the paragraph accordingly.

Specify stainless steel duct for projects in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

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 18 gauge, Type 304L or 316L, stainless steel] [minimum 1.6 mm 16 gauge carbon steel]. [Include with duct construction an external perimeter angle sized in accordance with SMACNA 1966, except place welded joint reinforcement on maximum of 600 mm 24 inch 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 18 gauge, 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 18 gauge, Type 300 series, stainless steel] [1.6 mm 16 gauge, galvanized steel] [0.55 mm 16 ounce, 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.

3.2.8 Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C916, Type I,

NFPA 90A, UL 723, and ASTM E84. 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 SMACNA 1966. 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 SMACNA 1966 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

****

NOTE: Show the location of duct test holes on the drawings. Locate holes so as to implement the requirements of Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

****

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 1/2 inch 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 3-inch 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

****

NOTE: Cover general cleaning and rubbish removal requirements in Division 01.

****

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

****

NOTE: Where sleeves are installed in the bearing walls, the designer must provide design details in drawings of the structural steel sleeves. Consult with structural engineers for the design details.

****

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 15 inches and smaller. Build framed, prepared openings for round duct larger than 380 mm 15 inches 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 one inch 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 ASTM C553, Type 1, Class B-2.

3.6.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 1 mm 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 1 mm 20 gauge 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 60 degrees F, 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 4 inches 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 15 inches in diameter or less from 1 mm 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 380 mm 15 inches from 1.40 mm 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 380 mm 15 inches or less from 1 mm 20 gauge galvanized steel. Install collars with fasteners a maximum of 150 mm 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 300 mm 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 500 mm 20 inches 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 120 degrees F. 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 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat to metal surfaces subject to temperatures less than 50 degrees C 120 degrees F.

3.7.2 Temperatures between 50 and 205 degrees C 120 and 400 degrees F

Apply two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm two mils to metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F.

3.7.3 Temperatures greater than 205 degrees C 400 degrees F

Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm two mils to metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F.

3.7.4 Finish Painting

****

NOTE: Use this paragraph for Air Force, Army and NASA projects.

Coordinate color code marking with Section 09 90 00.

****

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

****

NOTE: Use this paragraph for Air Force, Army and NASA projects.

Coordinate the Color Code Table with the installation. Delete identification plate specified in Section 09 90 00 PAINTS AND COATINGS if color coding scheme is specified.

****

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 3/8 inch 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 3 foot wide, 750 mm 30 inches high, and 13 mm 1/2 inches thick. Make the board of wood fiberboard and frame under glass or 1.6 mm 1/16 inch transparent plastic cover. Make the color code symbols approximately 19 mm 3/4 inch in diameter and the related lettering in 13 mm 1/2 inch 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

****

NOTE: There is a similar requirement for identification in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Ensure that color coding for all mechanical systems is coordinated.

NOTE: Delete when identification tags are not considered necessary on small projects.

****

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 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 2 mm 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.9 DUCTWORK LEAK TEST

****

NOTE: Omit this paragraph for Navy projects. Delete the bracketed portion of "Test Procedures" in SD-03, and "Performance Tests" in SD-06 of this Section.

This paragraph may be omitted where all ductwork is constructed to static pressure Class 125, 250, or 500 Pa 1/2, 1, or 2 inch W.G.. Delete the corresponding requirements in SD-06 of this Section and corresponding paragraph in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS when this paragraph is deleted.

Otherwise, derive the leakage rate for each system based on procedure outlined in SMACNA 1972 CD for Seal Class A. If round/oval metal ductwork only is specified, use C sub L = 3, otherwise C sub L = 6 may be used. Make the value of P used equal to the highest duct static pressure class; i.e., 3, 4, 6, or 10, for the ductwork to be tested. Where major components such as fans, coils, filters, etc. are

included in ductwork test, include an appropriate allowance in the maximum allowable leakage rate.

Use this paragraph in Air Force, Army and NASA projects.

****

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 3 inch water gauge through Class 2500 Pa 10 inch water gauge.] Provide test procedure, apparatus, and report that conform to SMACNA 1972 CD. The maximum allowable leakage rate is [_____] L/s cfm. Complete ductwork leak test with satisfactory results prior to applying insulation to ductwork exterior or concealing ductwork.

3.10 DUCTWORK LEAK TESTS

****

NOTE: Use this paragraph in Navy Projects.

****

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

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

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

****

NOTE: Determine the number of hours of instruction based on the number and complexity of the systems specified.

****

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 --