

Computer -
RM

INDOOR AIR HANDLING UNIT SCHEDULE

ITEM	SUPPLY C.F.M.	DRIVE	COOLING CAP. BTUH (1)		HEATING MBH	MANUFACTURER & MODEL NO.	NOTES
			SENSIBLE	TOTAL			
AHU1-1	320	DIRECT	9,900	15,000	17,000	mitsubishi PKFY-P15NHMU	--
AHU1-2	320	DIRECT	11,250	18,000	20,000	mitsubishi PKFY-P18NHMU	--
AHU1-3	320	DIRECT	9,900	15,000	17,000	mitsubishi PKFY-P15NHMU	--

(1) RATINGS IN ACCORDANCE WITH A.R.I. STANDARD 240.

OUTDOOR HEAT PUMP SCHEDULE

ITEM	COOLING CAPACITY (1) BTUH	HEATING CAPACITY (1) BTUH	MANUFACTURER & MODEL NO.
OHP-1	48,000	54,000	mitsubishi PUMY-P48NHMU

(1) RATINGS IN ACCORDANCE WITH A.R.I. STANDARD 240.

SECTION 15740
VARIABLE REFRIGERANT SYSTEMS EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes variable refrigerant flow (VRF) systems and equipment.
- B. Related Requirements:
 - 1. Division Section "HVAC Instrumentation and controls" for temperature control devices and control wiring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions and required clearances of individual components and profiles.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, weights, and furnished specialties and accessories. Clearly indicate exact models to be furnished.
 - 3. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
 - 4. Refrigerant piping schematics showing sizes and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For variable refrigerant flow systems to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver indoor and outdoor units as factory-assembled units with protective crating and covering.
- B. Coordinate delivery of units in sufficient time to allow movement into building.
- C. Unit shall be stored and handled according to the manufacturer's recommendation.
- D. Handle units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.7 QUALITY ASSURANCE

- A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.
- E. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.8 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer and Installer agree to repair or replace components of variable refrigerant flow systems that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: five year(s) from date of Substantial Completion.
 - 2. In addition the compressor shall have a manufacturer's limited warranty for a period of seven (7) years from date of installation.
- B. System shall be installed by Manufacturer's factory certified and trained dealer.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Filters: One set of washable filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Variable Refrigerant Flow Systems:

- a. Dalken AC
- b. Johnson Controls/Sanyo
- c. LG
- d. Mitsubishi
- e. Samsung

2. Two or Three pipe systems are acceptable.

2.2 HEAT PUMP OUTDOOR UNIT

A. General: The outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

- 1. The sum of connected capacity of all indoor units shall range from 50% to 130% of outdoor rated capacity.
- 2. Outdoor unit shall have a sound rating no higher than 52 dB(A).
- 3. Both refrigerant lines from the outdoor unit to indoor units shall be individually insulated.
- 4. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
- 5. The outdoor unit shall have a high pressure safety switch, low pressure safety switch and over-current protection and DC bus protection.
- 6. The outdoor unit shall have the ability to operate with a maximum height difference of 98 feet and have a total refrigerant tubing length of 393 feet. The greatest length is not to exceed 262 feet between the outdoor unit and the indoor units and shall not require line size changes nor traps.
- 7. The outdoor unit shall have rated performance for heat operation at 0°F ambient temperature without additional low ambient controls.
- 8. The outdoor unit shall be capable of cooling operation down to 23°F outdoor ambient without additional low ambient controls.
- 9. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

B. Unit Cabinet:

- 1. The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

C. Fan:

1. The unit shall be furnished with two direct drive, variable speed motors.
2. The fans will be forward curved type blades for quiet operation.
3. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
4. The fan motor shall be mounted for quiet operation.
5. The fan shall be provided with a raised guard to prevent contact with moving parts.
6. The outdoor unit shall have horizontal discharge airflow.

D. Refrigerant

1. R410A refrigerant shall be required for outdoor unit systems.

E. Coil:

1. The outdoor coil shall be of nonferrous construction with lanced or corrugated fins on copper tubing.
2. The coil fins will have a factory applied corrosion resistant blue-fin finish.
3. The coil shall be protected with an integral metal guard.
4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

F. Compressor:

1. The compressor shall be a single high performance, inverter driven, modulating capacity scroll compressor.
2. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable down to minimum 33% of rated capacity. The compressor shall be equipped with an internal thermal overload.
3. The compressor shall be mounted to avoid the transmission of vibration.

G. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The unit shall be capable of satisfactory operation within voltage limitations of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)
3. The outdoor unit shall be controlled by integral microprocessors.
4. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair, non-polar shielded cable to provide total integration of the system.

2.3 WALL MOUNTED INDOOR UNIT

A. General:

1. The wall-mounted indoor unit section and shall have a modulating linear expansion device and a flat front. The unit shall support individual control.

B. Indoor Unit

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. All casings, regardless of model size, shall have the same white finish
2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
3. There shall be a separate back plate which secures the unit firmly to the wall.

D. Fan:

1. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
4. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

E. Filter:

1. Return air shall be filtered by means of an easily removable, washable filter.

F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. Both refrigerant lines to the indoor units shall be insulated.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)

H. Accessories:

1. Condensate overflow switch
2. Isolation valves on suction and liquid lines

I. Controls:

1. This unit shall use controls provided by manufacturer to perform functions necessary to operate the system.
2. The unit shall be able to control external backup heat.
3. The unit shall have a factory built in receiver for wireless remote control.
4. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
5. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
6. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
7. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
8. Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.
9. The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

2.4 BACKLIT SIMPLE REMOTE CONTROLLER

- A. The Remote Controller shall be backlit and capable of controlling up to 16 indoor units (defined as 1 group). The Backlit Simple Remote Controller shall be compact in size, approximately 3" x 5" and have limited user functionality. The Backlit Simple supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple Remote Controller shall allow the user to change on/off, mode, temperature setting, and fan speed setting and airflow direction. The Backlit Simple Remote Controller shall be able to limit the set temperature range. The Backlit Simple Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple Remote Controller shall display a four-digit error code in the event of system abnormality/error.
- B. The Backlit Simple Remote Controller shall require no addressing. The Backlit Simple Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB15 connection terminal on the indoor unit. The Simple Remote Controller shall require cross-over wiring for grouping across indoor units.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting installation and performance of the Work.
- B. Examine roughing-in for piping to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, roofs, and for suitable conditions where VRF systems will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's instruction for installation of VRF systems.
- B. Comply with requirements for pipe hangers and supports specified in Section "Hangers and Supports for HVAC Piping and Equipment."
- C. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for cable trays specified in Section "Cable Trays for Electrical Systems."
 - 3. Comply with requirements for raceways and boxes specified in Section "Raceways and Boxes for Electrical Systems."
- D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping to allow service and maintenance.
- B. Duct installation requirements are specified in other Sections. Drawings indicate the general arrangement of ducts. Furnish flexible connections at all unit connections.

C. Electrical: Conform to applicable requirements in specification Sections.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section "Identification for HVAC Piping and Equipment."

3.5 COMMISSIONING

A. Verify that installation is as indicated and specified. Furnish manufacturer's system commissioning report with warranty number.

B. Complete installation and startup checks according to manufacturer's written instructions. At a minimum perform the following:

1. Level unit on support structure.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
4. Verify that clearances have been provided for servicing.
5. Check that labels are clearly visible.
6. Verify that controls are connected and operable.
7. Remove shipping bolts, blocks, and tie-down straps.
8. Verify that filters are installed.
9. Adjust vibration isolators.
10. Check acoustic insulation.

C. Lubricate bearings on fan.

D. Check fan-wheel rotation for correct direction without vibration and binding.

E. Adjust fan belts to proper alignment and tension.

F. Start unit according to manufacturer's written instructions.

1. Perform starting of refrigeration in summer only.
2. Complete startup sheets and attach copy with Contractor's startup report.

G. Check and record performance of interlocks and protection devices; verify sequences.

H. Operate unit for an initial period as recommended or required by manufacturer.

I. Calibrate thermostats.

J. Check internal isolators.

K. Check controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.

L. Simulate maximum cooling demand and check the following:

1. Compressor refrigerant suction and hot-gas pressures.
2. Short circuiting air through condenser or from condenser to outside-air intake.

M. After starting and performance testing, change filters, vacuum heat exchanger and cooling and condenser coils, lubricate bearings and adjust belt tension.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

OUTDOOR HEAT PUMP SCHEDULE

ITEM	COOLING CAPACITY (1) BTUH	E.E.R. MIN.	HEATING CAP. M.B.H.(1)		C.O.P. (1)		TRANE MODEL NO.
			HI	LO	HI	LO	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
OHP1-3A&3B	79,000	10.4	75.1	40.1	3.3	2.3	2 - 4TWA042 (3)
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

- (1) RATINGS IN ACCORDANCE WITH A.R.I. STANDARD 240.
- (2) FURNISH DUAL COMPRESSOR UNIT WITH INDEPENDENT REFRIGERATION CIRCUITS. IF NOT AVAILABLE, FURNISH TWO SINGLE COMPRESSOR UNITS AND ASSOCIATED ELECTRICAL MODIFICATIONS.
- (3) COOLING AND HEATING CAPACITY IS TOTAL NET CAPACITY FOR TWO UNITS.
- (4) FURNISH WITH LOW AMBIENT OPTION

INDOOR HEAT PUMP SCHEDULE										
ITEM	SUPPLY C.F.M.	EXT. S.P. (IN. W.C.)	O.A. C.F.M.	FAN HP.	DRIVE	COOLING CAP. BTUH (1)		AUX. HEAT		NOTES
						SENSIBLE	TOTAL	K.W.	STGS.	
IHP1-3	3000	0.5	100/450	1 1/2	BELT	56,900	79,000	14.96	1	(2)(3)

(1) RATINGS IN ACCORDANCE WITH A.R.I. STANDARD 240.

(2) FURNISH DUAL-CIRCUIT SPLIT FACE COIL AND STAGED AIR VOLUME.

(3) UNIT TO HAVE CO2 CONTROLS. OUTSIDE AIR VALUES NOTED ARE MINIMUM/MAXIMUM.

SECTION 15738
SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning and heat pump units to include in emergency, operation, and maintenance manuals.
- B. Manufacturer's startup worksheets for each unit on project.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Three set(s) for each air-handling unit.

2. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- D. All wiring shall be in accordance with the National Electrical Code (N.E.C.) and local codes as required.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Section "Cast-In-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be stored and handled according to the manufacturer's recommendations.
- B. The unit controller shall be shipped separately and shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
 2. Lennox International Inc.
 3. McQuay International.
 4. Trane; a brand of Ingersoll Rand.
 5. YORK; a Johnson Controls company.

2.2 INDOOR UNITS (5 TONS OR LESS)

- A. Concealed Evaporator-Fan Components:
1. Chassis: Galvanized steel with baked enamel finish and flanged edges, removable panels for servicing, and insulation on back of panel.
 2. Insulation: Faced, glass-fiber duct liner.
 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110. Furnished with expansion device, check valve and defrost thermostat accessory.
 4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection. Heater shall be designed specifically for the indoor unit and shall meet all requirements of the National Electric Code and Underwriters Laboratories and shall be so stamped.
 5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
 6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 15058 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed (minimum 3 speed) with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
 7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 8. Filters: 1-inch thick minimum, disposable, framed with filter rack.
 9. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections,

coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

- 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 Inches deep.
- b. Single-wall, galvanized-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

2.3 INDOOR UNITS (6 TONS OR MORE)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110. Furnish dual circuit where specified on drawings.
4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection. Heater shall be designed specifically for the indoor unit and shall meet all requirements of the National Electric Code and Underwriters Laboratories and shall be so stamped.
5. Fan: Forward-curved, centrifugal type, double-width wheel of galvanized steel; directly connected to motor. Adjustable belt drive.
6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 15058 "Common Motor Requirements for HVAC Equipment."
 - b. Adjustable motor sheaves with internal thermal protection and permanent lubrication.
 - c. Three-phase, permanently lubricated, ball-bearing motors with built-in thermal-overload protection.
 - d. Wiring Terminations: Connect motor to chassis wiring with plug connection.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Filters: 1 inch thick, in fiberboard frames with filter rack.
9. Condensate Drain Pans:

- a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 inches deep.
- b. Single-wall, galvanized-steel sheet.
- c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
- d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

2.4 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

- 1. Casing: Heavy gauge galvanized steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
- 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
- 4. Fan: Aluminum-propeller type, directly connected to motor.
- 5. Motor: Permanently lubricated, with integral thermal-overload protection.
- 6. Low Ambient: Permits cooling operation down to 0 deg F.
- 7. Mounting Base: Polyethylene.
- 8. Furnish the following accessories: condenser coil guard, 5 minute anti recycle timer, hard start kit for units with single phase power, defrost for indoor coil, and outdoor air thermostat to prevent resistant heat from energized above 45 deg F (adjustable).

2.5 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section "HVAC Instrumentation and Controls" and Section "Sequence of Operation."
- B. Automatic-reset timer to prevent rapid cycling of compressor.

- C. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit's level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Section "Cast-In-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section "Vibration Controls for HVAC."

3.2 CONNECTIONS

- A. Piping Installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section "Duct Accessories."
- D. Electrical: Comply with all applicable sections regarding electrical and grounding requirements.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

- C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Furnish startup worksheet with close out documents.

- B. Perform the following commissioning for all units:

1. Level unit on support structure.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
4. Verify that clearances have been provided for servicing.
5. Check that labels are clearly visible.
6. Verify that controls are connected and operable.
7. Remove shipping bolts, blocks, and tie-down straps.
8. Verify that filters are installed.
9. Adjust vibration isolators.
10. Check acoustic insulation.
11. Lubricate bearings on fan.
12. Check fan-wheel rotation for correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer's written instructions.
15. Perform starting of refrigeration in summer only.
16. Complete startup sheets and attach copy with Contractor's startup report.
17. Check and record performance of interlocks and protection devices; verify sequences.
18. Operate unit for an initial period as recommended or required by manufacturer.
19. Calibrate thermostats.
20. Check internal isolators.
21. Check controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.
22. Simulate maximum cooling demand and check the following:
23. Compressor refrigerant suction and hot-gas pressures.
24. Short circuiting air through condenser or from condenser to outside-air intake.
25. After starting and performance testing, install clean filters, vacuum heat exchanger and cooling and condenser coils, lubricate bearings and adjust belt tension.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals.
3. Schedule training with Owner, through Architect, with at least 7 days' advance

END OF SECTION

①

PACKAGED ROOF TOP HEAT PUMP SCHEDULE

ITEM	SUPPLY C.F.M.	EXT. S.P. (W.C.)	O.A. C.F.M. (3)	COOLING CAP. BTUH (1)	S.E.E.R./ IEER MIN.	HEATING CAP. (1)		C.O.P. (1)		HSPF (1)	AUX. HEAT		TRANE MODEL NO.
						HI (MBH)	LO (MBH)	HI	LO		K.W.	STAGES	
RTU1-1	3000	1.0"	450	89,000	12.0	86.0	48.0	3.4	2.3	-	27	2	WSC 090 (4)
RTU1-2	1600	1.0"	230	48,500	13.0	44.0	24.8	3.4	2.1	7.8	12	2	WSC 048 (4)
RTU1-3	4000	1.0"	600	118,000	13.1	111.0	69.0	3.6	2.4	-	27	2	WSC 120 (2)
RTU1-4	6000	1.0"	800	170,000	13.5	170.0	90.0	3.2	2.1	-	36	2	WSD 180 (2)
RTU2-1	6000	1.0"	500	170,000	13.5	170.0	90.0	3.2	2.1	-	36	2	WSD 180 (2)
RTU2-2	2700	1.0"	350	89,000	12.0	86.0	48.0	3.4	2.3	-	27	2	WSC 090 (2)
RTU2-3	4000	1.0"	500	118,000	13.1	111.0	69.0	3.6	2.4	-	27	2	WSC 120 (2)
RTU2-4	2000	1.0"	250	62,000	13.0	58.5	34.4	3.5	2.3	8.0	12	2	WSC 060 (2)
RTU2-5	1200	1.0"	180	37,000	13.0	37.0	21.2	3.4	2.1	8.0	6	1	WSC 036 (2)
RTU2-6	5000	1.0"	700	146,000	13.5	136.0	75.0	3.2	2.1	-	36	2	WSD 150 (2)
RTU2-7	2000	1.0"	140	62,000	13.0	58.5	34.4	3.5	2.3	8.0	12	2	WSC 060 (4)

(1) RATINGS IN ACCORDANCE WITH A.R.I. STANDARD 240.

(2) FURNISH ROOF CURB ADAPTER AND FACTORY INSTALLED DISCONNECT.

(3) FURNISH 2 POSITION MOTORIZED OA DAMPER - TO BE FIELD BALANCED.

(4) FURNISH ROOF CURB AND FACTORY INSTALLED DISCONNECT.

W

REFERENCE PACKAGED ROOF TOP HEAT PUMP SCHEDULE		
CURB ADAPTORS		
NEW	OLD EXISTING UNITS	
RTU1-1	WSC090	
RTU1-2	HORIZONTAL APPLICATION	
RTU1-3	SS242E061-17A	
RTU1-4	SFCA-1503-LB	
RTU2-1	SFCA-1503-LB	
RTU2-2	YCD090C3L0BE	
RTU2-3	SFCA-1003-LD	
RTU2-4	SFCA-1003-LD	
RTU2-5	SFCA753-LB	
RTU2-6	SFCA1253-LB	
RTU2-7	NEED NEW CURB	

~~SECTION 15732~~
PACKAGED ROOFTOP UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged, outdoor, rooftop units with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Heat-pump refrigeration components.
 - 3. Hot-gas reheat.
 - 4. Electric-heating coils.
 - 5. Economizer outdoor- and return-air damper section.
 - 6. Roof curbs.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- D. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- E. Evaporator Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Structural members to which RTUs will be attached.
 2. Roof openings
 3. Roof curbs and flashing.
- B. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
- B. Manufacturer's startup worksheets for each unit on project.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fan Belts: One set for each belt-driven fan.
 2. Filters: 3 sets of filters for each unit.

1.8 QUALITY ASSURANCE

- A. ARI Compliance:
 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.

- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units as factory-assembled units with protective crating and covering.
- B. Coordinate delivery of units in sufficient time to allow movement into building.
- C. Handle units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.10 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations with roof construction.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AAON, Inc.
 - 2. Addison Products Company.
 - 3. Carrier Corporation.
 - 4. Johnson Controls
 - 5. Lennox Industries Inc.
 - 6. McQuay International.
 - 7. Trane Company (The);

2.2 ROOFTOP UNITS 3-10 TONS

A. CASING

- 1. General Fabrication Requirements for Casings: Weather resistant heavy gauge steel cabinet with baked enamel finish. Roof panels designed to prevent water from pooling. Furnish knockouts for utility and control

- connections, and lifting lugs. Furnish hinged access panels for inspection and access to controls section, indoor coil, and fan. Access door to filter section to be hinged. Indoor air section to be completely insulated.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. FANS

1. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
2. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
3. Fan Motor: Comply with requirements in Section "Common Motor Requirements for HVAC Equipment."

C. COILS

1. Evaporator Coil: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - a. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating or molded plastic formed with pitch and drain connections complying with ASHRAE 62.1.
2. Condenser Coil: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
3. Hot-Gas Reheat Refrigerant Coil: (Where indicated on schedule) Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
4. Electric-Resistance Heating:
 - a. Heating Elements: Heavy duty nickel chromium elements with contactors for automatic over temperature protection.
 - b. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.

D. REFRIGERANT CIRCUIT COMPONENTS

1. Number of Refrigerant Circuits: Manufacturer's Standard - One or Two.
2. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
3. Refrigeration Specialties:
 - a. Refrigerant: R-410A.
 - b. Expansion valve with replaceable thermostatic element.
 - c. Refrigerant filter/dryer.
 - d. Manual-reset high-pressure safety switch.
 - e. Automatic-reset low-pressure safety switch.

- f. Minimum off-time relay.
- g. Automatic-reset compressor motor thermal overload.
- h. Brass service valves installed in compressor suction and liquid lines.
- i. Low-ambient kit high-pressure sensor.
- j. Where specified, furnish Hot-gas reheat solenoid valve with a replaceable magnetic coil.
- k. For units specified to be heat pumps, furnish reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

E. AIR FILTRATION

- 1. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - a. Pleated Media: Minimum 30 percent arrestance, and MERV 8.
 - b. 1" Filter Rack.

F. DAMPERS

- 1. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.
- 2. Fully Modulating Economizer where specified - Furnish Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - a. Damper Motor: Modulating with adjustable minimum position.
 - b. Relief-Air Damper: Gravity actuated or motorized, with bird screen and hood.

G. ELECTRICAL POWER CONNECTION

- 1. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

H. CONTROLS

- 1. Control equipment and sequence of operation are specified in Section "Instrumentation and Control for HVAC."
- 2. Microprocessor Controls: Provides unit control for all heating, cooling and ventilating utilizing input from sensors that measure indoor and outdoor temperature and other zone sensors. Microprocessor controls also prevents short cycling and ensures minimum run time of compressor. Furnish output for interface with building automation system including diagnostics.

3. Electromechanical controls to be factory wired for necessary control functions, transformer, and contactor pressure lugs or terminal block for power wiring.
4. Interface Requirements for HVAC Instrumentation and Control System:
 - a. Interface relay for scheduled operation.
 - b. Provide BACnet compatible interface for central HVAC control workstation for the following:
 - 1) Adjusting set points.
 - 2) Monitoring supply fan start, stop, and operation.
 - 3) Inquiring data to include outdoor-air damper position, supply- and room-air temperature.
 - 4) Monitoring occupied and unoccupied operations.

I. ACCESSORIES

1. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
2. Hail guards of galvanized steel, painted to match casing to protect condenser coil.

2.3 ROOFTOP UNITS 12.5-25 TONS

A. CASING

1. General Fabrication Requirements for Casings: Weather resistant steel cabinet with enamel finish. Roof panels to be pitched. Furnish knockouts for utility and control connections, and lifting lugs. Furnish access panels for inspection and access to controls section, indoor coil, and fan. Access door to filter section to be hinged. Indoor air section to be completely insulated.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. FANS

1. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
2. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
3. Fan Motor: Comply with requirements in Section "Common Motor Requirements for HVAC Equipment."

C. COILS

1. Evaporator Coil:

- a. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - b. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.1.
- 2. Condenser Coil:
 - a. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- 3. Hot-Gas Reheat Refrigerant Coil (where indicated on schedule):
 - a. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- 4. Electric-Resistance Heating:
 - a. Heating Elements: Heavy duty nickel chromium elements with contactors for automatic over temperature protection.
 - b. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.

D. REFRIGERANT CIRCUIT COMPONENTS

- 1. Number of Refrigerant Circuits: Two.
- 2. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- 3. Refrigeration Specialties:
 - a. Refrigerant: R-410A.
 - b. Expansion valve with replaceable thermostatic element.
 - c. Refrigerant filter/dryer.
 - d. Manual-reset high-pressure safety switch.
 - e. Automatic-reset low-pressure safety switch.
 - f. Minimum off-time relay.
 - g. Automatic-reset compressor motor thermal overload.
 - h. Brass service valves installed in compressor suction and liquid lines.
 - i. Low-ambient kit high-pressure sensor.
 - j. Where specified, furnish Hot-gas reheat solenoid valve with a replaceable magnetic coil.
 - k. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
 - l. For units specified as heat pumps, furnish reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

E. AIR FILTRATION

1. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - a. Pleated: Minimum 30 percent arrestance, and MERV 8.
 - b. Furnish 2" filter rack.

F. DAMPERS

1. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.
2. Fully modulating economizer where specified – Furnish Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - a. Damper Motor: Modulating with adjustable minimum position.
 - b. Relief-Air Damper: Gravity actuated or motorized, with bird screen and hood.

G. ELECTRICAL POWER CONNECTION

1. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

H. CONTROLS

1. Control equipment and sequence of operation are specified in Section "Instrumentation and Control for HVAC."
2. Provide unit control for all heating, cooling and ventilating utilizing input from sensors that measure indoor and outdoor temperature and other zone sensors. Controls also prevent short cycling and ensure minimum run time of compressor.
3. Interface Requirements for HVAC Instrumentation and Control System:
 - a. Interface relay for scheduled operation.
 - b. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 - c. Provide BACnet compatible interface for central HVAC control workstation for the following:
 - 1) Adjusting set points.
 - 2) Monitoring supply fan start, stop, and operation.
 - 3) Inquiring data to include outdoor-air damper position, supply- and room-air temperature.
 - 4) Monitoring occupied and unoccupied operations.

I. ACCESSORIES

1. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

2.4 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1-1/2 inches.
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.

- B. Curb Height: 12 inches above top surface of roof.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:

1. Install RTUs on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section "Cast-In-Place Concrete." And Section "Miscellaneous Cast-In-Place Concrete."
 2. Comply with requirements for vibration isolation devices specified in Section "Vibration Controls for HVAC."
- B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- D. Install units according to manufacturer's written instructions.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain, area drain, or gutter. Condensate piping to be Type L copper with soldered fittings.
- B. Install piping adjacent to RTUs to allow service and maintenance.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
1. Install ducts to termination at top of roof curb.
 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section "Duct Accessories."
 4. Install return-air duct continuously through roof structure.
 5. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified with concrete.
- D. Electrical: Conform to applicable requirements in Division 16 Sections.
- E. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to compressor, coils, and fans.
 - 3. Inspect internal insulation.
 - 4. Verify that labels are clearly visible.
 - 5. Verify that clearances have been provided for servicing.
 - 6. Verify that controls are connected and operable.
 - 7. Verify that filters are installed.
 - 8. Clean condenser coil and inspect for construction debris.
 - 9. Remove packing from vibration isolators.
 - 10. Inspect operation of barometric relief dampers.
 - 11. Verify lubrication on fan and motor bearings.
 - 12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 13. Adjust fan belts to proper alignment and tension.
 - 14. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.

- c. Complete startup sheets and attach copy with Contractor's startup report.
- 15. Inspect and record performance of interlocks and protective devices; verify sequences.
- 16. Operate unit for an initial period as recommended or required by manufacturer.
- 17. Calibrate thermostats.
- 18. Adjust and inspect high-temperature limits.
- 19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
- 20. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
- 21. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
- 22. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
- 23. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
- 24. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and firestat alarms.
- 25. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two Insert number visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION