SECTION 23 81 23

COMPUTER ROOM AIR CONDITIONING UNITS

This guide specification covers the requirements for heating, ventilating, and cooling (HVAC) equipment for computer room air conditioning Units (CRACUs).

Equipment typically includes cooling equipment less than 720,000 Btuh (60 Tons), and heating equipment less than 400,000 Btuh.

Use the most efficient, competitively available CRACU for which there are at least two products available for the indicated ranges of comparability. Design parameters for each item of equipment shall be indicated on the drawings including capacity, efficiency, sound ratings, motor speeds, electrical characteristics, and special features.

System requirements must conform to UFC 3-410-02N, "Heating, Ventilating, Air Conditioning and Dehumidifying Systems".

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Current editions of references at time of delivery order shall be used.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	Forced-Circulation Air-Cooling and Air-Heating Coils

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

ANSI/ASHRAE 15 & 34	ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 55	Thermal Environmental Conditions for Human Occupancy

ASHRAE 62.1	Ventilation for Acceptable Indoor Air Quality
ASHRAE 90.1 - IP	Energy Standard for Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME B16.22	Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	Power Piping
ASME B31.5	Refrigeration Piping and Heat Transfer Components
ASME BPVC	Boiler and Pressure Vessels Code

ASTM INTERNATIONAL (ASTM)

ASTM B280	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM D5864	Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM D6081	Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation

ETL TESTING LABORATORIES (ETL)

ETL DLP	(updated continuously) Directory of ETL Listed Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	National Electrical Code
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424	Engineering and Design -- Lubricants and Hydraulic Fluids

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL Elec Equip Dir	Electrical Appliance and Utilization Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide new or modify existing computer room air conditioning unit[s] (CRACU) complete and ready for operation. Size equipment based on Design Manual CS from the Air Conditioning Contractors of America; do not oversize.

1.3 SUBMITTALS

Government approval is required for submittals. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Computer room air conditioning units

Submit documentation for Energy Star qualifications or meeting FEMP requirements. Indicate Energy Efficiency Rating.

Space temperature control system drawings

Filters;

SD-06 Test Reports

CRACU production schedule and factory test schedule (typically for CRACU's with a capacity greater than 180,000 Btuh(15 TONS)).

Manufacturer's factory test plans

Factory test reports

Field test schedule

Manufacturer's field test plans

Field test reports

SD-07 Certificates

Certificate of Specification Compliance

Credentials of the manufacturer's field test representative

SD-08 Manufacturer's Instructions

Installation manual for each type of CRACU

SD-10 Operation and Maintenance Data

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Computer room air conditioning units, Data Package 4

1.4 OZONE DEPLETION FACTOR

Equipment using refrigerants R-11, R-12, R-113, R-114, R-115, R-123, R-500, or any refrigerant with ozone depletion factor (ODF) greater than 0.00, or refrigerants containing CFCs or HCFCs or Halons shall not be permitted. Refrigerant shall be 134a or a TAFB government approved alternative refrigerant per EPA's Significant New Alternative Policy (SNAP) listing.

1.5 ENVIRONMENTAL REQUIREMENTS

For proper Indoor Environmental Quality, maintain positive pressure within the building. Ventilation shall meet or exceed ASHRAE 62.1 and all published addenda. Meet or exceed filter media efficiency as tested in accordance with ASHRAE 52.2. Thermal comfort shall meet or exceed ASHRAE 55.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

PART 2 PRODUCTS

2.1 COMPUTER ROOM AIR CONDITIONING UNITS (CRACU)

Note 1: The indoor components of CRACU are inherently noisy. In noise sensitive areas, designers should take steps to attenuate CRACU generated sound. Determine the maximum acceptable sound level limit for the application in NC level or dbA and add the limit to the CRACU equipment schedule. This sound level compliance may be verified by the CRACU factory and field tests.

Note 2: Designers should locate the floor registers in a raised floor system as far from the CRACU as possible to reduce direct sound transmission from the unit to the conditioned space.

Note 3: Designers should indicate the mandatory routing of piping around the floor stand of a downflow CRACU in their piping plan view and piping details. Ensure, by dimensioning of piping details, that no piping interferes with the air flow performance of the CRACU.

Note 4: The Energy Policy Act of 2005 requires new buildings to use 30 percent less energy than the ASHRAE 90.1 - IP level.

Provide self-contained units, designed, factory assembled, and factory tested. Unit shall be listed in UL Elec Equip Dir or ETL DLPfor computer room application. Equipment shall be in accordance with ASHRAE 90.1 - IP, at a minimum][have a minimum Seasonal Energy Efficiency Ratio (SEER) of 14.0. Unit shall include room cabinet and frame, floor stand, fan section, filter section, cooling coil, reheat coil, humidifier, compressors, condensers, controls, and, interconnecting piping internal to the CRACU.

2.1.1 Cabinet and Frame

2.1.1.1 Unit Cabinet

Unit frame shall be minimum 14 gage welded steel tubes or steel angles and shall be mill-galvanized or coated with an epoxy finish, or an approved manufacturer's standard finish, if equivalent.

Exterior panels shall be furniture grade steel sheet, minimum of 20 gage, mill-galvanized or coated with a corrosion-inhibiting epoxy finish, or an approved equivalent finish. Mill galvanized sheet metal shall be coated with not less than 1.25 ounces of zinc per square foot of two-sided surface. Mill rolled structural steel shall be hot-dip galvanized or primed and painted. Cut edges, burns and scratches in hot-dip galvanized surfaces shall be coated with galvanizing repair coating.

Provide removable panel for access to controls without interrupting airflow. Panels shall be gasketed to prevent air leakage under system operating pressure and shall be removable for service access without the use of special tools. Condensate pans shall be minimum 22 gage Type 304 stainless steel, non-corroding, double-sloped, and shall be piped to drain.

Exterior surfaces of cabinets constructed of mill-galvanized steel shall be finished by the manufacturer's standard enamel finish in the specified or indicated color.

CRACU manufacturer's standard cabinet materials and finishes will be acceptable if considered equivalent to the above requirements by the Contracting Officer.

2.1.1.2 Cabinet Interiors Sound Attenuation

Provide a factory-installed sound attenuation system in the interior of the CRACU cabinet.

For CRACU interior cabinets located in spaces which require low sound levels because of interaction requirements of the operating personnel, CRACU cabinet panels interior shall be provided with one inch of 1 1/2 pound per cubic foot neoprene-coated fiber glass insulation on interior of cabinet panels. Insulation shall be applied to the cabinet panels with 100 percent adhesive coverage and both the insulation and the adhesive shall conform to NFPA 90A.

In noise sensitive areas, special steps to attenuate CRACU generated sound. CRACU cabinet panels interior shall be provided with minimum two inch thick acoustical sound absorbing foam with a minimum Noise Reduction Coefficient (NRC) of 0.85.

Compressors located in CRACU interior cabinets shall be either wrapped in a sound absorbing insulating blanket or enclosed in it's own sound absorbing insulated mini-cabinet inside of the larger CRACU interior cabinet.

Fans and compressors located in the CRACU interior cabinet shall be provided with vibration isolators between their respective support frames and the cabinet framing.

CRACU manufacturer's standard interior cabinet sound attenuation materials and finishes will be acceptable if considered equivalent to the above requirements by the Contracting Officer.

]2.1.2 Fan Section

Fans which force air through coils into computer room[s] shall have belt drives and adjustable sheaves sized to ensure achievement of design air flow by field adjustments. Fan system design shall be such that design air flow shall be achieved at the midpoint of sheave adjustment.

The supply air fan shall be AMCA certified, double-inlet/double-width, and equipped with forward-curved blades wheel. The supply air fan shall be statically and dynamically balanced and equipped with V-belt drive. The fan shall have self-aligning, permanently lubricated ball bearings with a minimum life span of 100,000 hours.

Provide V-belt drive or for units of size 6tons or more provide dual V-belt drive sized for 200 percent of the motor nameplate rating. Fan speed shall be adjustable with cast iron variable pitch pulleys.

Sheaves shall be within the middle one third of the sheave adjustment range.

The fan motor shall be drip-proof with NEMA rated frame, inherent overload protection, and sliding adjustable motor base. The maximum vibrations shall not exceed 2 mils (0.05 mm) in any plane.

2.1.3 Cooling Coil

Provide AHRI 410 coils and slope for drainage. Coil shall be constructed of seamless copper tubes with plate aluminum fins. Indoor and outdoor coils shall be matched and from same manufacturer. Use a low sensible heat ratio for more moisture removal. Each coil, in the production process, shall be individually tested at 320 psi with compressed air under water and verified to be air tight. The following shall be provided depending on application: Provide DX coil complete with a distributor and thermostatic expansion valve with external equalizer. Provide hydronic coils complete with drain and vent connections. Provide condensate drain pan of stainless steel construction with nonferrous connections and internal trap, and a condensate pump system complete with integral pump discharge check valve, integral float switch, reservoir, and pump and motor assembly.

2.1.4 Filters

Provide UL listed pleated fiberglass throwaway type filters. Provide filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 or 13 (depending on application) as determined by ASHRAE 52.2. Provide one complete spare filter bank set for installation prior to final acceptance testing covered in Part 3 of this section.

2.1.5 Reheat Coil

Provide AHRI 410 reheat coils and slope for drainage. Provide coil constructed of seamless copper tubes with plate aluminum fins. Each coil, in the production process, shall be individually tested at 320 psi with compressed air under water and verified to be air tight. Provide UL or ETL listed safety switches to protect system from overheating.

2.1.6 Humidifier

Humidifier section shall include liquid-level control, emergency overflow and automatic water supply system factory pre-piped for final connection. Provide stainless steel evaporator pan with water high level and low level alarms. Arrange system to be cleanable and serviceable.

Allowable Humidification options include the following:

Provide infrared type humidifier, including high intensity quartz lamps mounted above and out of water supply.

Provide low-watts density electric heater immersion type humidifier. Provide entire assembly and removable pan of stainless steel construction. Protect elements with high temperature limit cutout.

Provide steam generator type humidifier. Provide steam generator humidifier cutout. Controls shall include steam generation, and flush cycle. Furnish two extra canisters.

2.1.7 Refrigeration System

Provide compressor[s] complete with vibration isolation, suction and discharge service valves, high and low pressure safety switches, and built-in overload protection. Provide refrigeration circuits including hot gas mufflers, liquid-line filter-drier, refrigerant sight glass and moisture indicator, externally equalized expansion valve, and liquid-line solenoid valve factory connected with refrigeration copper tubing. Provide hot gas bypass or crankcase heaters as required.

2.1.7.1 Compressors

The purpose of the paragraph below is to prevent the acquisition of a refrigerant compressor design that is inferior from an energy efficiency or control standpoint.

Provide single or dual, hermetic or semi-hermetic or scroll compressors. If dual compressors are provided, the refrigeration system shall be equipped with two independent refrigeration circuits. Dual semi-hermetic compressors shall be provided complete with unloading system.

2.1.7.2 Refrigerant Tubing

Field-installed refrigerant tubing for split systems shall be ASTM B280, cleaned, dehydrated, and sealed. Further, provide ASME B16.22 solder joint refrigerant fittings and adapters with silver brazing alloy solder and silver brazing alloy flux. During brazing operations bleed a small amount of dry oil-free nitrogen continuously through the refrigerant tubing. If required for connections to equipment, provide ASME B16.26 flared fittings.

2.1.8 Condenser

Provide condenser circuit pre-piped with start-up and head pressure controls to maintain system operation at ambient temperatures down to the application or design low temperature.

Note: This temperature should be the minimum temperature at which the mechanical cooling equipment will be required to operate.

2.1.8.1 Air-cooled Condenser

Provide remote air-cooled condenser arranged for vertical air discharge. The direct-driven propeller fans shall have factory balanced aluminum blades and shall be equipped with fan guards. The coils shall be constructed from seamless copper tubes with plate type aluminum fins. The coils, in the production process, shall be pressure tested with compressed air 300 psig under water and verified to be leak-free. The air-cooled condensers casings and other components shall be suitable for outdoor location and constructed from aluminum with manufacturer's standard corrosion-resistant finish, or galvanized steel. An integral factory wired and tested control panel shall be provided for the condenser.

2.1.8.2 Liquid-cooled Condenser

Provide cleanable, cast iron or steel shell and copper tubes, counterflow type or water-cooled or glycol-cooled condenser with removable cast iron or steel heads. In cold climates it is often cost effective to install an economizer coil that is used instead of the evaporator during cold weather. The condenser shall be constructed in accordance with ASME BPVC. As an option, a coaxial (copper tube-in-copper tube) type water-cooled condenser may be provided.

During periods of cold weather "free cooling" can be provided. When the glycol in the condenser can be cooled to about 50 degrees F or less, the refrigeration unit is bypassed and the air that is normally passed through the evaporator goes through the economizer coil which contains cold glycol flowing from the condenser.

2.1.8.3 Dry Coolers

The dry cooler shall be factory fabricated and shall comprise of casing, coil, and fan sections. The casing shall be constructed of aluminum sheets with aluminum legs, casing and legs provided with manufacturer's standard corrosion resistant finish.

The cooling fluid (water or water/glycol solution) shall flow through a coil made up of copper tubes and aluminum fins. The coils shall be leak tested at factory at 300 psi.

The fan section of the dry cooler shall comprise of factory balanced, direct driven metal propeller fan(s) complete with slow speed motor(s) and fan guard(s). The fan(s) shall be arranged for vertical discharge. The electrical connections and control connections shall be provided in a weatherproof enclosure mounted integral with the dry cooler.

As indicated on the drawings, the dry cooler shall be equipped with a centrifugal pump (single pump or double pump) package complete with

an open expansion tank. The pump package shall be mounted in a weatherproof enclosure.

Provide special corrosion protection in accordance with the requirements specified in this section in the paragraph, "Corrosion Protection For Coastal Installations".

2.1.9 Space Temperature Control System

Provide microprocessor control system integral with unit including electronic control center, control valves, sensors, wiring, and other appurtenances for workable system. Provide access panel or door in front of unit.

Isolate electronic control center from conditioned airstream to allow service while system is in operation. Provide control sensors in unit for cooling, dehumidifying, and humidifying. High-voltage circuits in system shall have individual leg overload protection. Starters, contactors, and relays shall be controlled by 24 volt control circuit.

High-voltage circuit components shall be protected by safety lock, dead-front panel. Mount nonautomatic, molded-case circuit breaker in high-voltage section of electrical panel. Operating mechanism shall prevent access to high-voltage electrical components until switched to "OFF" position.

Include the following control capabilities:

a. Capable of changing the set points and sensitivity of the space and humidity along with their low and high alarm points.

b. Logging capability of the last 10 alarms and run time.

c. Diagnostics

d. Refrigerant compressor sequencing

Provide controls under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. Provide controls under Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Provide a controls interface on CRACU to enable the DDC system to monitor the following minimum operating parameters and alarm conditions: high and low computer room temperature, relative humidity, and CRACU status.

2.1.10 Alarm Panel System

Provide unit with cabinet-mounted alarm panel which shall monitor high and low space temperature, high and low space humidity, dirty filters, loss of airflow, loss of water or glycol flow, compressor high head pressure, and humidifier problems. Provide underfloor water

detector. Provide field accessible local audible alarm with silence pushbutton. Provide push-to-test lamps or all-lamp test pushbutton. CRACUs shall have local devices which provide signals for remote audible and visual alarming capability for the above specified alarm conditions.

2.1.11 Air Return and Delivery Orientation

Select one of the following two paragraphs to specify air delivery and air return orientation. Indicate the extent of the acoustical lining in the downflow discharge duct.

Computer room air conditioning unit[s] may be downflow discharge, top return, draw-thru cooling coil, and shall discharge air into a raised floor plenum with through an acoustically-lined sweep or acoustically-lined multiple turning vane elbows provided to direct the flow of air away from the back of the unit. Provide acoustical lining on the interior of the discharge air devices and the return air plenum in compliance with with requirements specified hereinafter in paragraph "Cabinet Interiors Sound Attenuation".

Computer room air conditioning unit[s] may be upflow discharge, bottom return, front return , draw-thru cooling coil, and shall be fitted with collars for top supply duct connections. Upflow discharge shall discharge air with a acoustical lined sweep or acoustically-lined multiple turning vane elbows provided to direct the flow of air away from the back of the unit. Supply (discharge air) ducting from the upflow units shall be off of each blower discharge outlet, that is, one duct and duct collar per blower. Provide acoustical lining on the interior of the supply air devices in compliance with requirements specified hereinafter in paragraph "Cabinet Interiors Sound Attenuation".

2.1.12 Floorstand

Unit shall be provided with elevating 9, 12, 18, or 24 inches high floorstand or jacks for freestanding installation on the main building floor. Floorstand or jacks shall elevate the unit to the height of the raised computer floor and shall allow for leveling and locking at the desired height. Floorstand or jacks shall be retractable, or removable, for installing the unit directly on the raised floor. Unit shall be fully gasketed (rubber or neoprene) to prevent air leakage at the raised floor penetration.

2.2 ELECTRICAL

2.2.1 Electrical Motors, Controllers, Contactors, and Disconnects

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, as modified and supplemented by this section. Provide electrical connections under Section 26 20 00

INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. Motors shall be variable-speed. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

2.2.2 Electrical Control Wiring

Provide control wiring under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. Provide control wiring under Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or
provide control wiring under this section in accordance with NFPA 70 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM as applicable . Provide Space temperature control system drawings which include point-to-point electrical wiring diagrams.

2.3 HVAC WATER PIPING AND METAL DUCTWORK

Requirements for HVAC water piping and metal ductwork is specified in Section 23 64 26 CHILLED, CHILLED-HOT AND CONDENSER WATER PIPING AND ACCESSORIES and Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS.

2.4 FIRE PROTECTION DEVICES

The requirements for duct smoke detectors are specified in Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS as applicable .

2.5 SOURCE QUALITY CONTROL

Provide factory test plan[s], factory test schedule[s], factory test[s] and factory test report[s] on each of the CRACU[s] with a capacity greater than 180,000 Btuh (50 Tons).

2.5.1 Manufacturer's Factory Test Plans

For each CRACU, submit a factory test plan which when followed during factory testing shall verify that the performance scheduled on the drawings is met by the produced CRACU models.

The manufacturer shall perform factory tests on the actual CRACU[s] produced for this project. The test reports shall document the performance tests conducted on the factory assembled computer room air conditioning units. Performance testing on the individual computer room air conditioning unit components, not factory assembled, is not acceptable.

Submit the required test plans for review and approval to the Contracting Officer at least 90 calendar days before scheduled factory test date.

2.5.1.1 Test Procedure

Indicate in each test plan the factory acceptance test procedures. Procedures shall be structured to test all modes of operation to confirm that the controls through all modes of control to confirm that the controls are performing in accordance with the intended sequence of control.

Controllers shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

2.5.1.2 Performance Variables

Each test plan shall list performance variables that are required to be measured or tested as part of the field test. Include in the listed performance indicated on the equipment schedules on the contract design drawings.

Manufacturer shall furnish with each test procedure a description of acceptable performance results that shall be verified. Manufacturer shall identify the acceptable limits or tolerances within which each tested performance variable shall acceptably operate.

2.5.1.3 Test Configuration

Plans shall indicate that tests are to be performed for a minimum of four continuous hours in a wet coil condition. If test period is interrupted, the four hour test period shall be started over. Each test plan shall be job specific and shall address the particular CRACU[s] and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable. Tests shall include a pressurized raised floor discharge configuration at the specified or indicated height above the floor, with or without the air discharge elbows; or a top air discharge configuration and phenolic coated coils as applicable .

2.5.1.4 Tested Variables

Plans shall provide for air side testing which includes verification of the airflow, total static pressure; fan drive motor KW, amperage and RPM; and fan RPM. Provide entering air temperatures equal to those indicated on the CRACU schedules.

2.5.1.5 Thermal Testing

Plans shall provide thermal testing utilizing chilled water, 40 percent ethylene glycol and 60 percent water solution, or hot water as applicable with temperatures equal to those indicated on the CRACU schedules. Thermal testing shall verify CRACU heating, sensible cooling, total cooling, and humidifying performance scheduled on the contract drawings.

2.5.1.6 Specialized Components

Include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

2.5.1.7 Factory Tests Reporting Forms

Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives. Submit factory test reports, referencing each tested CRACU serial number, and receive approval before delivery of CRACU to the project site.

2.5.2 CRACU Production Schedule and Factory Test Schedule

The Government reserves the right to witness factory tests for each CRACU.

Provide the CRACU production schedule and factory test schedule for tests to be performed at the manufacturer's test facility. Submit planned production schedule, and factory test schedule and test location, to the Contracting Officer as soon as it is scheduled but not less than 60 calendar days prior to the scheduled factory test date. Track this schedule through the production phases and if a scheduled factory test date changes, give advanced notice to Contracting Officer as soon as possible but at least 15 calendar days in advance of the scheduled test dates.

2.5.3 Factory Tests

Conduct the factory testing in compliance with the Contracting Officer approved manufacturer's field test plan, and in accordance with additional field testing requirements specified herein. Record the required data using the test reporting forms approved of the approved field test plan. Conduct the test for each CRACU for the continuous test period in the approved test plan. A CRACU shutdown before the continuous test period is completed shall result in the test period being started again and run for the required duration.

2.5.4 Deficiency Resolution

The test requirements shall be acceptably met; deficiencies identified during the tests shall be corrected in compliance with the

manufacturer's recommendations and corrections tested as specified in the paragraph "Factory Test Plans".

2.5.5 Factory Test Reports

Use the test reporting forms approved in the factory test plan. Final test report forms shall be typed including data entries and remarks. Completed test report forms for each CRACU shall be reviewed, approved, and signed by the Manufacturer's test director.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 CRACU System

Installation of each CRACU system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing, shall be in accordance with ASME B31.1, ASME B31.5, NFPA 70, as modified and supplemented by the requirements of this section and the CRACU manufacturer's recommendations.

3.1.2 Installation Instructions

Provide a manufacturer's installation manual for each type of CRACU.

3.1.3 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.2 FIELD QUALITY CONTROL

Upon completion and before final acceptance of work, test each CRACU subsystem in service to demonstrate compliance with the contract requirements, including field testing specified below. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work provided by Contractor and repeat tests. Furnish steam, fuel, water, electricity, instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, and ducts. Prior to commencement of field testing, remove all filters and provide new filters.

3.3 FIELD TESTING

Provide field test plan[s], field test schedule[s], field test[s] and field test report[s] on each of the CRACU[s]. Field test each CRACU for Contracting Officer acceptance in accordance with the CRACU manufacturer's approved field test plan.

3.3.1 Manufacturer's Field Test Plans

Submit field test plans developed by the manufacturer for each CRACU; submit the field test plans along with the factory test plans specified at least 90 calendar days prior to planned date of the field test. Field test plans developed by the installing Contractor, or the equipment sales agency furnishing the CRACU, will not be acceptable.

The Contracting Officer will review and approve the field test plan for each of the listed CRACU's prior to commencement of field testing of the equipment. The approved field test plans shall be followed for the field tests of the CRACU and test reporting.

3.3.1.1 Coordinated Testing

Indicate in each field test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of: CRACU controls which interlock and interface with controls factory prewired; and external controls for the CRACU provided under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS and Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

3.3.1.2 Prerequisite Testing

Each CRACU for which performance testing is dependent upon the completion of the work covered by Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field test plan when such prerequisite work is required.

3.3.1.3 Test Procedure

Indicate in each field test plan the CRACU manufacturer's published start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

Procedures shall be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

Controllers shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

3.3.1.4 Performance Variables

Each test plan shall list performance variables that are required to be measured or tested as part of the field test.

Include, in the listed performance variables, requirements indicated on the CRACU schedules on the design drawings. Manufacturer shall furnish, with each test procedure, a description of acceptable results that have been verified.

Manufacturer shall identify the acceptable limits or tolerances within which each tested performance variable shall acceptably operate.

3.3.1.5 Test Configuration

Plans shall indicate that tests are to be performed for a minimum of four continuous hours in a wet coil condition. If test period is interrupted, the four hour test period shall be started over. Each test plan shall be job specific and shall address the particular CRACU[s] and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable. Tests shall include a pressurized raised floor discharge configuration at the specified or indicated height above the floor, with or without the air discharge elbows; or a top air discharge configuration and corrosion protection.

3.3.1.6 Tested Variables

Plans shall provide for air side testing which includes verification of the airflow, total static pressure; fan drive motor KW, amperage and RPM; and fan RPM. Provide entering air temperatures equal to those indicated on the CRACU schedules.

3.3.1.7 Thermal Testing

Plans shall provide thermal testing utilizing chilled water, 40 percent ethylene glycol and 60 percent water solution as applicable, and hot water with temperatures equal to those indicated on the CRACU schedules. Thermal testing shall verify CRACU heating, sensible cooling, total cooling, and humidifying performance scheduled on the contract drawings.

3.3.1.8 Specialized Components

Include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.3.1.9 Field Test Reporting Forms

Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives.

3.3.2 Field Test Schedule

Notify the Contracting Officer in writing at least 30 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for the review and approval of the Contracting Officer.

3.3.3 Manufacturer's Test Representative

Furnish a factory trained field test representative authorized by the CRACU manufacturer to oversee the complete execution of the field testing. This test representative shall also review, approve, and sign the completed field test report. Signatures shall be accompanied by the person's name typed.

Submit credentials of the manufacturer's field test representative proposed, including current telephone number, to the Contracting Officer for review and approval. Submit these credentials with the written advance notice of the field tests

3.3.4 Field Tests

Conduct the field testing in compliance with the Contracting Officer approved manufacturer's field test plan, and in accordance with additional field testing requirements specified herein. Record the required data using the test reporting forms approved of the approved field test plan. Conduct the test for each CRACU for a continuous 24-hour test period. A CRACU shutdown before the continuous 24-hour test period is completed shall result in the 24-hour test period being started again and run for the required duration.

3.3.5 Deficiency Resolution

The test requirements shall be acceptably met; deficiencies identified during the tests shall be corrected in compliance with the manufacturer's recommendations. Corrections shall be tested again in compliance with the requirements specified in the paragraph "Field Test Plans".

3.3.6 Field Test Reports

Use the test reporting forms approved in the field test plan. Final test report forms shall be typed, including data entries and remarks. Completed test report forms for each CRACU shall be reviewed, approved, and signed by the Contractor's test director and the QC manager.

3.4 WASTE MANAGEMENT

Separate waste in accordance with the Waste Management Plan, placing copper materials, ferrous materials, and galvanized sheet metal in designated areas for reuse. Close and seal tightly all partly used adhesives and solvents; store protected in a well-ventilated, fire-safe area at moderate teperature.

-- End of Section --