
USACE / NAVFAC / AFCEC / NASA UFGS-23 81 23.00 20 (February 2010)
Change 3 - 08/18

Preparing Activity: NAVFAC Superseding
UFGS-23 81 23.00 20 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2019

SECTION TABLE OF CONTENTS

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

SECTION 23 81 23.00 20

COMPUTER ROOM AIR CONDITIONING UNITS

02/10

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SYSTEM DESCRIPTION
- 1.3 SUBMITTALS
- 1.4 REFRIGERANTS
- 1.5 QUALITY ASSURANCE
 - 1.5.1 Ozone Depleting Substances Technician Certification
- 1.6 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 COMPUTER ROOM AIR CONDITIONING UNITS (CRACU)
 - 2.1.1 Cabinet and Frame
 - 2.1.1.1 Unit Cabinet
 - 2.1.1.2 Cabinet Interiors Sound Attenuation
 - 2.1.2 Fan Section
 - 2.1.3 Cooling Coil
 - 2.1.4 Filters
 - 2.1.5 Reheat Coil
 - 2.1.6 Humidifier
 - 2.1.7 Refrigeration System
 - 2.1.7.1 Compressors
 - 2.1.7.2 Refrigerant Tubing
 - 2.1.8 Condenser
 - 2.1.8.1 Air-cooled Condenser
 - 2.1.8.2 Liquid-cooled Condenser
 - 2.1.8.3 Dry Coolers
 - 2.1.9 Space Temperature Control System
 - 2.1.10 Alarm Panel System
 - 2.1.11 Air Return and Delivery Orientation
 - 2.1.12 Floorstand
- 2.2 Corrosion Protection For Coastal Installations
 - 2.2.1 Polyelastomer Finish Coating System
 - 2.2.1.1 Heat Exchanger Coil (Including Evaporator Coil) Surfaces

- 2.2.1.2 Uninsulated Interior Surfaces and Exterior Surfaces
 - 2.2.1.3 Insulated Interior Surfaces
 - 2.2.2 Phenolic Finish Coating System
 - 2.2.2.1 Heat Exchanger Coil (Including Evaporator Coil) Surfaces
 - 2.2.2.2 Uninsulated Interior Surfaces and Exterior Surfaces
 - 2.2.2.3 Insulated Interior Surfaces
- 2.3 ELECTRICAL
 - 2.3.1 Electrical Motors, Controllers, Contactors, and Disconnects
 - 2.3.2 Electrical Control Wiring
- 2.4 [HVAC WATER PIPING] [AND] [METAL DUCTWORK]
- 2.5 FIRE PROTECTION DEVICES
- 2.6 SOURCE QUALITY CONTROL
 - 2.6.1 Manufacturer's Factory Test Plans
 - 2.6.1.1 Test Procedure
 - 2.6.1.2 Performance Variables
 - 2.6.1.3 Test Configuration
 - 2.6.1.4 Tested Variables
 - 2.6.1.5 Thermal Testing
 - 2.6.1.6 Specialized Components
 - 2.6.1.7 Factory Test For Sound Pressure Level
 - 2.6.1.8 Factory Tests Reporting Forms
 - 2.6.2 CRACU Production Schedule and Factory Test Schedule
 - 2.6.3 Factory Tests
 - 2.6.4 Deficiency Resolution
 - 2.6.5 Factory Test Reports

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 CRACU System
 - 3.1.2 Installation Instructions
 - 3.1.3 Connections to Existing Systems
- 3.2 FIELD QUALITY CONTROL
- 3.3 FIELD TESTING
 - 3.3.1 Manufacturer's Field Test Plans
 - 3.3.1.1 Coordinated Testing
 - 3.3.1.2 Prerequisite Testing
 - 3.3.1.3 Test Procedure
 - 3.3.1.4 Performance Variables
 - 3.3.1.5 Test Configuration
 - 3.3.1.6 Tested Variables
 - 3.3.1.7 Thermal Testing
 - 3.3.1.8 Specialized Components
 - 3.3.1.9 Field Test Reporting Forms
 - 3.3.2 Field Test Schedule
 - 3.3.3 Manufacturer's Test Representative
 - 3.3.4 Field Tests
 - 3.3.5 Deficiency Resolution
 - 3.3.6 Field Test Reports

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEC / NASA UFGS-23 81 23.00 20 (February 2010)
Change 3 - 08/18

Preparing Activity: NAVFAC Superseding
 UFGS-23 81 23.00 20 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2019

SECTION 23 81 23.00 20

COMPUTER ROOM AIR CONDITIONING UNITS 02/10

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

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

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

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

NOTE: Equipment includes cooling equipment less than
211 KW 720,000 Btuh, and heating equipment less than
117 KW 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 3-410-01, "Heating, Ventilating, and Air Conditioning Systems".

PART 1 GENERAL

1.1 REFERENCES

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

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

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

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410 (2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils

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

ANSI/ASHRAE 15 & 34 (2016) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants

ASHRAE 52.2 (2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASHRAE 55 (2010) Thermal Environmental Conditions for Human Occupancy

ASHRAE 62.1 (2010) Ventilation for Acceptable Indoor Air Quality

ASME INTERNATIONAL (ASME)

ASME B16.22 (2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26 (2013) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

ASME B31.1 (2016; Errata 2016) Power Piping

ASME B31.5 (2016) Refrigeration Piping and Heat Transfer Components

ASME BPVC (2010) Boiler and Pressure Vessels Code

ASTM INTERNATIONAL (ASTM)

ASTM B280 (2018) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASTM D5864 (2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components

ASTM D6081 (1998; R 2014) Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation

ETL TESTING LABORATORIES (ETL)

ETL DLP (updated continuously) ETL Listed Mark Directory

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17) National Electrical Code

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

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424 (2016) Engineering and Design -- Lubricants and Hydraulic Fluids

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

40 CFR 82 Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL Elec Equip Dir (2011) Electrical Appliance and Utilization Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide [new][and 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

NOTE: Review Submittal Description (SD) definitions
in Section 01 33 00 SUBMITTAL PROCEDURES and edit
the following list to reflect only the submittals
required for the project.

The Guide Specification technical editors have
designated those items that require Government
approval, due to their complexity or criticality,
with a "G." Generally, other submittal items can be
reviewed by the Contractor's Quality Control
System. Only add a "G" to an item, if the submittal
is sufficiently important or complex in context of
the project.

For submittals requiring Government approval on Army
projects, a code of up to three characters within
the submittal tags may be used following the "G"
designation to indicate the approving authority.
Codes for Army projects using the Resident
Management System (RMS) are: "AE" for
Architect-Engineer; "DO" for District Office
(Engineering Division or other organization in the
District Office); "AO" for Area Office; "RO" for
Resident Office; and "PO" for Project Office. Codes
following the "G" typically are not used for Navy,
Air Force, and NASA projects.

The "S" following a submittal item indicates that
the submittal is required for the Sustainability
eNotebook to fulfill federally mandated sustainable
requirements in accordance with Section 01 33 29
SUSTAINABILITY REPORTING. Locate the "S" submittal
under the SD number that best describes the
submittal item.

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

Government approval is required for submittals with a "G" designation;
submittals not having a "G" designation are [for Contractor Quality
Control approval.][for information only. When used, a designation
following the "G" designation identifies the office that will review the
submittal for the Government.] Submittals with an "S" are for inclusion
in the Sustainability eNotebook, in conformance with Section 01 33 29
SUSTAINABILITY REPORTING. Submit the following in accordance with Section
01 33 00 SUBMITTAL PROCEDURES:

NOTE: For LANTNAVFACENGCOM projects, Contractor
submittals for the CRACU's shall be Contracting
Officer approved by NAVFAC LANT Mechanical Design

Branch, in spite of who is the Designer of Record.
Ensure that Section 01 33 00 SUBMITTAL PROCEDURES,
paragraph SUBMITTALS RESERVED FOR NAVFAC LANT
APPROVAL covers this submittal requirement.

SD-03 Product Data

Computer room air conditioning units; G[, [____]]

Space temperature control system drawings; G[, [____]]

Filters

Refrigerants

SD-06 Test Reports

NOTE: Specify factory tests for CRACU's with a
capacity greater than 52,700 W 180,000 Btuh

[CRACU Production Schedule and Factory Test Schedule; G[, [____]]

Manufacturer's Factory Test Plans; G[, [____]]

Factory Test Reports; G[, [____]]

] Field Test Schedule; G[, [____]]

Manufacturer's Field Test Plans; G[, [____]]

Field Test Reports; G[, [____]]

Aquatic Toxicity

SD-07 Certificates

Certificate of Specification Compliance; G[, [____]]

Credentials of the Manufacturer's Field Test Representative; G[,
[____]]

Ozone Depleting Substances Technician Certification

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; G[, [____]]

SD-11 Closeout Submittals

Indoor Air Quality During Construction: S

1.4 REFRIGERANTS

NOTE: EPA, per the Significant New Alternative Policy rule, reviews refrigerant substitutes on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and unacceptable substitutes are updated several times each year. A chronological list of SNAP updates is available at <http://www.epa.gov/ozone/snap/refrigerants/lists/index.html> or from the stratospheric ozone information hotline at 1 (800) 296-1996. Reducing ozone depletion and global warming potential by reducing or eliminating CFC, and reducing or eliminating HCFC and Halon use in air conditioning equipment is required.

Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of R-123. CFC-based refrigerants are prohibited. [HCFCs] and Halons are not permitted. Provide SDS sheets for all refrigerants.

1.5 QUALITY ASSURANCE

1.5.1 Ozone Depleting Substances Technician Certification

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

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.6 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.

PART 2 PRODUCTS

2.1 COMPUTER ROOM AIR CONDITIONING UNITS (CRACU)

NOTE: 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: 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: 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: Refer to ASHRAE 90.1 Table 6.8.1K for the
minimum efficiency requirements of air conditioners
and condensing units serving computer rooms.

ANSI/ASHRAE 15 & 34. Provide self-contained units, designed, [and]
factory assembled[, and factory tested]. Unit shall be listed in
UL Elec Equip Dir or ETL DLP for computer room application. Equipment
shall [have a minimum sensible coefficient of performance (SCOP-127) of
[____]]. 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

NOTE: A double-sloped pan prevents water from
standing and stagnating in the pan.

Unit frame shall be minimum 2.0 millimeter 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 1.0 mm 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 380 gram of zinc per square meter 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 1.0 millimeter 22 gage [Type 304 stainless steel][plastic], 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][the 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

NOTE: For CRACU interior cabinets located in spaces which require low sound levels because of interaction requirements of the operating personnel, select desired sound attenuation methods specified in this paragraph. In noise sensitive areas, specifiers should take special steps to attenuate CRACU generated sound, such as using the two inch foam requirement, in lieu of the fiber glass insulation.

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

[CRACU cabinet panels interior shall be provided with 25 millimeters of 24 kilogram per cubic meter 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.

][CRACU cabinet panels interior shall be provided with minimum 50 millimeters 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 its' 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.

2.1.1.2 Fan Section

**NOTE: For CRACU units of sizes 6 tons and more,
specify dual V-belt fan drives.**

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. Assess potential effects of lubricant on aquatic organisms in accordance with [ASTM D6081](#) and submit [aquatic toxicity](#) reports. Assess biodegradation in accordance with [ASTM D5864](#). In accordance with [EM 1110-2-1424](#) Chapter 8, aquatic toxicity shall exceed 1,000 ppm at LL50 and biodegradation shall exceed 60 percent conversion of carbon to carbon dioxide in 28 days.

Provide [V-belt drive][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 [0.05 mm 2 mils](#) in any plane.

2.1.1.3 Cooling Coil

**NOTE: Indicate on the design drawings the minimum
required head for the coil condensate pump.**

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 [2200 kPa 320 psi](#) with compressed air under water and verified to be air tight. [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.]

2.1.1.4 Filters

**NOTE: MERV 13 filters are typically at least 6
inches deep with 0.8 inch wg pressure drop or
higher, making them only feasible in applied,
belt-driven central station air handling units.**

Terminal equipment or smaller packaged rooftop equipment cannot achieve this level of filtration or generate the static pressure needed to deliver proper airflow when using this high efficiency filtration. Typically MERV 6 or 8 is the highest efficiency filter that can be applied for that equipment.

Provide UL listed [50] [100] [_____] mm[2] [4] [_____] inches thick deep pleated fiberglass throwaway type filters. [Additionally, provide [50][_____] mm [2] [_____] inches thick deep pleated fiberglass throwaway type pre-filters.] Provide filtration media with a Minimum Efficiency Reporting Value (MERV) of [6][8][13] 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 2200 kPa 320 psi with compressed air under water and verified to be air tight.
-] [Provide electric reheat coils with low watts density. The electric reheat coils shall be enclosed in 304 stainless steel tubes and 304 stainless steel fins. Provide modulating control of the electric reheat coils by [multiple stages][or][Silicon Controlled Rectifier (SCR).] 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.
- [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. [Crankcase heaters are required.] [Provide hot gas bypass.]

[2.1.7.1 Compressors

NOTE: 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. Delete this paragraph if there is no probability of acquisition of high energy users or inferior controls at a given capacity. However, if such an acquisition is probable, use the selections below to prohibit the acquisition of inferior designs.

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

NOTE: Insert minimum temperature at which the mechanical cooling equipment will be required to operate.

Provide condenser circuit pre-piped with start-up and head pressure controls to maintain system operation at ambient temperatures down to [[4.4 degrees C](#) [40 degrees F](#)][[minus 6.6 degrees C](#) [20 degrees F](#)][_____] [degrees C](#) [degrees F](#).

[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 [2068 kPa](#) [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

NOTE: In cold climates it is often cost effective to install an economizer coil that is used instead of the evaporator during cold weather. During periods of cold weather "free cooling" can be provided. When the glycol in the condenser can be cooled to about 10 degrees C 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.

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. 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.

]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 2068 kPa 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] [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 00 INSTRUMENTATION AND CONTROL FOR HVAC.] [Provide a controls interface on CRACU to enable the DDC system to monitor the following operating parameters and alarm conditions: high and low computer room temperature, relative humidity, 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

NOTE: 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] shall 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] shall be upflow discharge, [bottom return,] [front return,] [rear return,] draw-thru cooling coil, and shall be fitted with collars for top supply duct connections. Upflow discharge shall discharge air with an 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 with requirements specified hereinafter in paragraph CABINET INTERIORS SOUND ATTENUATION.

][2.1.12 Floorstand

Unit shall be provided with elevating [225] [300] [450] [600] mm [9] [12] [18] [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 Corrosion Protection For Coastal Installations

NOTE: Specify corrosion protection for exterior HVAC equipment, including air handling units, heat exchanger coil surfaces, equipment casings, that are exposed to the weather within 5 miles of a sea (salt) water coast.

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

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

After thorough investigation, if standard off-the-shelf anti-corrosion options are not available, include the corrosion protection requirements specified herein.

NOTE: For installations in MCAS Cherry Point and MCB Camp LeJeune, including New River, specify corrosion protection for all outside, and specific inside HVAC equipment exposed to the weather. Follow the guidance specified in the criteria NOTE above.

Provide either the polyelastomer finish coating system or the phenolic finish coating system on the interior and the exterior surfaces of HVAC

heat exchanging equipment. The coating system shall not reduce the HVAC equipment's performance rating.

Finish coating shall be applied at the premises of the HVAC equipment manufacturer or at the premises of the coating manufacturer or his authorized applicator. Provide finish coating in colors gray, or aluminum, or ivory. All components of the special finish coating systems, including primers and intermediate coats, shall be applied by immersion dip-coating or spray-coating in accordance with coating manufacturer's written procedures.

If special finish coatings are applied at the finish coating manufacturer's (or his authorized applicator's) premises, the equipment to be finish coated shall be transported to and from the finish coating manufacturer's premises by the Contractor. The finish-coating manufacturer shall be responsible for necessary disassembly of the HVAC equipment and re-assembly of final finish coated equipment.

Submit for approval a [Certificate of Specification Compliance](#) furnished by the finish coating system manufacturer. Requirements for certificate include:

- a. Name of firm that provided the finish coating system.
- b. Project title and Navy construction contract number.
- c. Listing of the pieces of equipment that were finish coated by this firm.
- d. Certificate shall certify that the finish coating materials and application procedures employed conform to the contract specifications.
- e. Date of final inspection by this firm and printed name and signature of the inspector.
- f. Printed name and signature of the officer of the firm that is responsible for firm's certification program.

2.2.1 Polyelastomer Finish Coating System

2.2.1.1 Heat Exchanger Coil (Including Evaporator Coil) Surfaces

- a. Acrylic polymer resin primer: 0.025 mm (1 mil) minimum dry film thickness.
- b. Polyelastomer resin top coating: 3 coats, 0.038 mm (1.5 mils) minimum total dry film thickness.
- c. In lieu of coating, provide copper tubes and copper fins

2.2.1.2 Uninsulated Interior Surfaces and Exterior Surfaces

Polyelastomer resin: 3 coats, 0.100 to 0.150 mm (4 to 6 mils) minimum total dry film thickness.

2.2.1.3 Insulated Interior Surfaces

Vinyl: 0.050 to 0.250 mm (2 to 10 mils) minimum dry film thickness.

2.2.2 Phenolic Finish Coating System

Provide a resin base thermosetting phenolic finish.

2.2.2.1 Heat Exchanger Coil (Including Evaporator Coil) Surfaces

- a. Apply phenolic finish to the entire coil. Provide a minimum of two coats. Total minimum dry film thickness shall be 0.075 mm (3 mils).
- b. In lieu of coating, provide coil of copper tubes and copper fins

2.2.2.2 Uninsulated Interior Surfaces and Exterior Surfaces

Amine cured epoxy phenolic finish: 0.150 to 0.175 mm (6 to 7 mils) minimum total dry film thickness.

2.2.2.3 Insulated Interior Surfaces

Polyester or Vinyl Ester finish: 0.050 to 0.250 mm (2 to 10 mils) minimum dry film thickness.

]2.3 ELECTRICAL

2.3.1 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.

2.3.2 Electrical Control Wiring

[Provide control wiring under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.] [Provide control wiring under Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.] [Provide control wiring under this section in accordance with NFPA 70 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.] Provide Space temperature control system drawings which include point-to-point electrical wiring diagrams.

2.4 [HVAC WATER PIPING] [AND] [METAL DUCTWORK]

NOTE: For NAVFAC LANT projects that use the regional specifications, refer to NAVFAC LANT regional specification NFGS 23 73 33.00 22 HEATING, VENTILATING AND COOLING SYSTEM.

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].

[2.5 FIRE PROTECTION DEVICES

The requirements for duct smoke detectors are specified in [Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

]2.6 SOURCE QUALITY CONTROL

NOTE: Specify factory acceptance tests (source quality control) for CRACU's with a capacity greater than 52,700 W 180,000 Btuh

Provide factory test plan[s], factory test schedule[s], factory test[s] and factory test report[s] on [each of the CRACU[s]]; [CRACU-1 through CRACU-[____]].

2.6.1 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.

2.6.1.1 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.

2.6.1.2 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.

2.6.1.3 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].]

2.6.1.4 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.

2.6.1.5 Thermal Testing

Plans shall provide thermal testing utilizing [chilled water] [40 percent ethylene glycol and 60 percent water solution] [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.

2.6.1.6 Specialized Components

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

[2.6.1.7 Factory Test For Sound Pressure Level

NOTE: Do not include the following sound rating tests in the specification without written permission from the Engineering Field Division's Mechanical Design Branch for a particular project. Prior to including the following sound testing paragraph, coordinate the following aspects of the requirements:

1. Determining the sound ratings of CRACU's requires specific factory testing. This testing may need to be witnessed by a representative of the Contracting Officer to verify compliance since no manufacturer to date has performed these sound rating tests.

2. Sound rating testing will add significant cost to each CRACU and therefore must be covered by the project cost estimate.

3. Ensure that acceptable sound ratings for each CRACU is indicated.

Determine the A-weighted sound pressure level for the indoor portion of each of the CRACU's; [CRACU-1 through CRACU-[____]].

Each unit shall be mounted on a [raised] floor duplicating of the installation configuration indicated on the contract drawings. Unit shall be located at least 1.5 meters 150 mm 5 feet 6 inches from test room walls. No other equipment shall be operating in the test room during sound level testing of subject unit. Background sound levels shall be at least 10 dB below lowest sound pressure level measured on subject unit. Testing shall be conducted by using an ANSI Type 1 or 2 sound level meter located 1.0 meter 3.3 feet from the unit under test and 1.0 meter 3.3 feet above raised floor. Measure and record A-weighted sound pressure level on all four sides of unit.

]2.6.1.8 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.

2.6.2 CRACU Production Schedule and Factory Test Schedule

The Government [will][reserves the right to] witness factory tests for [CRACU-1,][and CRACU-[____] through 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.

2.6.3 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.

2.6.4 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.

2.6.5 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. Perform and document that proper [Indoor Air Quality During Construction](#) procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed.

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 herein before][submit the field test plans 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][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC]].

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] [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.

-- End of Section --