DEPARTMENT OF THE NAVY

NAVAL FACILITIES ENGINEERING COMMAND
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Ser CI/007
18 April 19

From: Commander, Naval Facilities Engineering Command

Subj: INTERIM TECHNICAL GUIDANCE (ITG) FY19-01 – NAVY AND MARINE CORPS AIRCRAFT PRECONDITIONED AIR (PCA) SYSTEM DESIGN

Ref: (a) 26 NOV 2018 Email from JSF Program Office "JSF Hangars Lessons Learned on cooling pits"
(b) 04 JAN 2019 Email from MCICOM "F-35 Infrastructure"
(c) UFC 3-410-01 Heating, Ventilating, and Air Conditioning Systems
(d) F-35 Lightning II Facilities Requirements Document (FRD) dated 23 Oct 2018
(e) Engineering and Construction Bulleting (ECB) 2018-03, Technical Oversight and Acceptance Testing of Critical Systems
(f) UFC 4-211-01 Aircraft Maintenance Hangars dated

Encl: (1) UFC 4-211-01 PCA System Revisions
(2) UFGS 23 75 15 AIRCRAFT PRECONDITIONED AIR (PCA) SYSTEM

1. Purpose. To address concerns with F-35 Joint Strike Fighter (JSF) systems described in reference (a) and provide direction to correct designs for awarded and pending MILCON and FSRM projects.

2. Background. Per reference (b), every MCICOM air station reports major issues with JSF PCA systems. Lessons learned show that there are several causes of failure including unnecessary system complexity, misapplication of PCA equipment, inadequate duct insulation, lack of maintenance considerations, underground duct issues, and building designers unfamiliar with PCA systems. Enclosures (1) and (2) were developed based on lessons learned and are intended to ensure PCA systems are fully functional and reliable. These requirements have been coordinated with industry stakeholders including PCA manufacturers, system integrators, and aircraft ground equipment providers.

3. Discussion.

   a. System Complexity: Current designs use multiple automatic control valves to attempt to precool the duct, provide redundancy, and limit PCA equipment cost. Lessons learned indicate that system complexity leads to increased failure rates and downtime. PCA equipment is not designed or recommended to serve multiple aircraft. Complex control systems require significant effort to commission and impose a significant maintenance burden on the activity.

   b. Underground Ductwork: Current designs include extensive underground, thin-walled ductwork. Reference (c) prohibits underground ductwork. There are many reasons underground ductwork is prohibited including potential for water intrusion due to high water table or condensation, insect/rodent infestation, mold growth, heat transfer issues,

corrosion, and lack of access to repair duct. Duct is also susceptible to failure from loads above.

c. PCA Utility Pits: Lessons learned, user feedback, and PCA manufacturers indicate underground cooling utility pits are unnecessary. Enclosure (1) prohibits utility pits and requires a recessed access hatch and a flexible hose cart.

d. Aircraft Air Quality: Reference (d) requires cooling air with no more than 0.02 grams of dust per pound of dry air with a maximum particle size of 50 microns. Enclosure (2) specifies PCA equipment with MERV-8 filtration with a 90% capture efficiency for particles 3 to 10 microns.

e. PCA System Quality Control (QC): Current specifications lack a detailed quality control process. Enclosure (2) implements a comprehensive quality control program requiring qualified personnel and detailed quality control submittals for PCA system design, installation, and commissioning. Government acceptance and quality assurance of PCA systems will be provided in accordance with reference (e).

4. Applicability. This ITG applies to all design and construction, renovation, and repair of new and existing facilities that result in DON real property assets, regardless of funding source. Effective immediately, this ITG replaces paragraphs 3-5.8.2 and 4-2.2 of reference (f) and issues new PCA system requirements in enclosure (2). This ITG is effective until reference (f) is revised or changed with requirements herein.

5. Action. All Naval Facilities Engineering Commands will incorporate the requirements of enclosures (1) and (2) for aircraft PCA systems where project execution is in

   a. Planning and Preliminary Design: Update project budget estimates for PCA system to include requirements of enclosures (1) and (2).

   b. Design:
      i. Beyond Design Start and without Design Release
      ii. Between Design Release and Contract Award (evaluate the impacts of a pre-award amendment versus a post-award modification).

   c. Construction:
      i. Prior to DBB Pre-Construction Meeting/DB Final Design Acceptance (post-award modification)
      ii. Between DBB Pre-Construction Meeting/DB Post-Award Kick-off Meeting and Red Zone Meeting (post-award modification)

6. Point of Contact. For clarification or additional information related to PCA systems, please contact the mechanical engineering Technical Discipline Leader (TDL), Mr. Stephen Ericson, P.E., DSN 262-4242, Com. (757) 322-4242, Fax (757) 322-4142 or e-mail Stephen.Ericson@navy.mil

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3-5.8.2 Preconditioned Air Systems

This criteria provides detailed requirements for the preconditioned air (PCA) system and incorporates lessons learned to ensure PCA systems are fully mission capable. The intent is to make the system accessible, minimize maintenance requirements, and maximize system reliability. Strict adherence to criteria herein is necessary to ensure system functionality and integrity. Provide PCA system in accordance with the requirements of the aircraft. The required flow rate, temperature, pressure, moisture content and particulate content of cooling air at the aircraft connection is specified by the aircraft program documentation and must be confirmed by the end user on a per project basis. See Chapter 4 for F-35 aircraft cooling air requirements. PCA systems are considered process loads in the building energy compliance calculations.

Provide one PCA unit per aircraft parking position. PCA units are not designed to serve multiple aircraft. Manifolded systems create unnecessary complexity. Do not manifold units together. If PCA system backup is required, it is intended that the system is supplemented with user provided ground support equipment (GSE). Do not install any valves between the PCA unit and the aircraft. Design and provide PCA system in accordance with UFGS 23 75 15 AIRCRAFT PRE-CONDITIONED (PCA) AIR SYSTEM and the requirements of this UFC.

3-5.8.2.1 PCA System Operating Procedure

The control points, components, and capabilities specified herein will support the PCA system standard operating procedures (SOP) as follows.

1. Remove dust cap from PCA piping.
2. Start PCA purge mode.
3. Prepare to connect flex duct to aircraft. If present, open manual blow-down valve(s) to purge any trapped condensation.
4. When desired temperature is reached as indicated at temperature gauge, and there is no visible moisture in the duct, stop PCA purge mode.
5. Connect flexible duct to the PCA duct and aircraft, then start PCA normal mode.
6. Stop PCA unit, disconnect flexible duct, and replace dust cap.

3-5.8.2.2 Preconditioned Air Unit Location

Locate PCA units and route associated piping above ground and in accessible trenches to minimize the length of flexible duct required between the PCA piping and the aircraft cooling connection. The heat gain and air leakage in insulated flexible duct is much greater than that of insulated rigid duct. A long hangar with multiple aircraft bays can be served by PCA equipment on each end of the building to minimize PCA pipe length and the time required to cool the system down from ambient temperature. Locate PCA units outdoors in accordance with the requirements of the PCA manufacturer for clearances.

Design PCA equipment and piping supports to minimize vibration and noise levels as recommended by *ASHRAE Practical Guide to Noise and Vibration Control for HVAC Systems, Second Edition*. Do not locate PCA units on roofs above conference rooms, private offices, or training rooms. Do not locate PCA units within 10 feet (3m) of unpaved areas or near potential sources of air particulates/contaminants such as laundry, shop exhaust, sanitary vents, steam traps or relief valves, industrial exhaust, or boiler flue discharge. Locate units in shaded areas where possible.

3-5.8.2.3 Preconditioned Air Unit Maintenance and Airflow Clearances

Provide adequate clearance for PCA unit maintenance and heat rejection in accordance with manufacturer's requirements, OSHA regulations, and standard practices. Periodic maintenance includes changing filters, fan belts, motors, refrigeration components and coil cleaning.

Do not install solid wall enclosures, grates, screens, expanded louvers, or any other impediments to airflow around or above PCA equipment. Equipment may be located within the unobstructed area as defined by UFC 4-010-01 as long as the equipment provides no opportunity for concealment of explosive devices with heights of 6 inches (150 mm) or greater, or the equipment is secured to prevent concealment of the devices. Equipment located within the fenced flight line area is considered secured. If necessary, secure units with chain link fence only.

3-5.8.2.4 Preconditioned Air Unit Sizing

Size PCA units for the greatest enthalpy condition when comparing the 0.4% dry-bulb and mean coincident wet-bulb (DB/MCWB) and the 0.4% humidity ratio and mean coincident dry-bulb (HR/MCDB) design conditions using weather data prescribed by UFC 3-400-02. The greatest enthalpy condition usually occurs at the 0.4% HR/MCDB condition. Include PCA pipe and flexible duct heat losses in PCA unit sizing. Use a safety factor of 10% when sizing PCA equipment. Specify PCA unit filtration to meet the aircraft air quality requirements, with a washable pre-filter and MERV-8 final filter.

3-5.8.2.5 Preconditioned Air Piping

Provide welded stainless steel piping suitable for pressures up to 15 psig (416 in. w.g.) for PCA distribution. Provide water-tight embossed aluminum or high density polyurethane (HDPE) insulation jacket to prevent water from hangar floor wash down, foam system activations, and fuel spills from degrading the insulation or infiltrating the pipe. Perform pipe thermal stress analysis calculations. Piping design including supports must allow and control thermal expansion. Provide bolted and gasketed flanged joints within 18" above the hangar floor and in the trench to preclude the need for hot work in hazardous locations.

A high pressure PCA unit fan can operate at much higher pressures than a typical HVAC fan which allows higher PCA air velocity and pressure. Size air distribution piping using a minimum air velocity of 1,300 ft/min (6.6 m/s). If lower velocity is used, provide a

life cycle cost analysis to justify the cost of larger pipe. Assume 50% of PCA units run 40 hours per week.

3-5.8.2.6 Preconditioned Air Pipe Routing

PCA pipe must be routed outside of the crane operating envelope along interior walls and in accessible trenches. Do not route pipe so that it presents a tripping hazard or obstruction in the main circulation aisle between the aircraft and shop spaces. Route the PCA pipe in a trench in the hangar floor from the hangar walls to a flexible duct connection point at each aircraft parking position. Route PCA duct in a combined trench with AFFF piping and other utilities where possible. Routing PCA pipe underground or buried below the hangar slab is prohibited. All PCA pipe must be fully accessible to allow for repair and replacement. PCA system utility pits are prohibited.

Coordinate PCA pipe and AFFF piping to ensure PCA pipe is continuously sloped to the flexible duct connection point. Ensure adequate horizontal and vertical clearance to access PCA pipe and AFFF piping. Provide a lift-assisted, hinged access cover with safety locking device rated for aircraft loading at each flexible duct connection point. Ensure access hatch weight is no greater than the approved lift weight per occupational safety requirements. PCA pipe must be supported and elevated minimum 6 inches (150 mm) off the bottom of the trench to prevent pipe and insulation from sitting in water and allow insulation to air dry. Slope the trench and pipe with a minimum 0.5% grade, towards a recessed flexible duct connection point. Show PCA pipe slope requirements on drawings. Bottom of PCA duct must be no more than 16” from the hangar floor for ergonomic access to duct connection without entering the trench. Provide a manual blow-down valve at all PCA pipe low points to allow drainage of any trapped condensation.

3-5.8.2.7 Preconditioned Air Flexible Duct and Accessories

Provide a quick-connect system at the connection between PCA piping and flexible duct. Provide 45-degree hard adapters to prevent kinking of flexible hose. Provide insulated flexible hose with a mobile basket or reel to connect from the PCA pipe connection to the aircraft PCA connection in accordance with UFGS 23 75 15 AIRCRAFT PRE-CONDITIONED (PCA) AIR SYSTEM. Provide tapped mechanical temperature and pressure gauges in the PCA pipe immediately upstream of the flexible duct connection point. Provide a water tight, soft rubber cover with lanyard to protect the flexible duct connection opening while not in use.

3-5.8.2.8 Preconditioned Air Pipe Insulation

Provide PCA pipe with factory applied insulation and water-tight jacket. Perform heat transfer calculations. PCA system insulation must be specified to ensure no more than a 5 °F temperature rise between the PCA unit discharge and the aircraft connection at design conditions. Include heat gain within PCA pipe, fittings, and flexible duct in calculations. Heat gain calculations must use the 1.0% DB/MCWB conditions using weather data prescribed by UFC 3-400-02.

Perform a separate calculation determining the length of time it will take the system to achieve aircraft cooling air input specifications from a steady-state ambient condition. The ambient condition is defined as all piping, fittings, and flexible duct at the 0.4% outdoor design dry-bulb outdoor air temperature. Thirty (30) minutes is the maximum allowed time duration to deliver required PCA temperature, moisture content, pressure and airflow at the aircraft connection from ambient condition. Perform calculation under low-pressure purge mode conditions.

3-5.8.2.9 Preconditioned Air Unit Controls

The PCA is considered a critical support system, and the controls must be designed for “least functionality” per UFC 4-010-06. PCA units must be provided with a low pressure purge mode for initial cool down of the system. Provide one remote control panel per PCA unit along the hangar back wall at each aircraft location with start button, stop button, purge mode start button, unit run status, alarm indication, and digital display of PCA unit discharge temperature (°F), humidity ratio (gr/lb), pressure (psig), and flow rate (lb/min). Provide each remote control panel housed in a gasketed NEMA Type 3R enclosure.

Provide a digital touchscreen control panel integral to each PCA unit capable of displaying the unit run status, alarms, discharge temperature (°F), humidity ratio (gr/lb), pressure (psig), and flow rate (lb/min). PCA unit set points must be adjustable at the PCA unit without the need for proprietary control interfaces, dongles, or removable operator interface terminals. PCA unit status and performance data may be monitored by the base EMCS system with expressed approval from the installation.

3-5.8.2.10 Preconditioned Air Unit Testing and Commissioning

Manufacturer’s testing, field performance testing, endurance testing, and season of maximum load performance testing requirements must be performed in accordance with UFGS 23 75 15 AIRCRAFT PRE-CONDITIONED (PCA) AIR SYSTEM.

4-2.2 Mechanical Systems

See paragraph 3-5.8.2 for PCA system design requirements.

PCA requirements of the F-35 are as follows:

Fluid Element	**Aircraft Cooling Air Spec**
Capacity/Minute	46.5 lb/min. (21.14 kg/min)
Temperature	35 °F - 55 ˚F (1.67°C -12.78˚C)
Minimum Pressure at Aircraft, PSIG	5.25 [-0.25/+0.50 psig]
Moisture per pound of air	0-55 grains with no condensed moisture (No Droplets)
Particulates per pound of air	0.02 grams with maximum particle size of 50 microns

PCA air quality specifications are based on the 2018 FRD in accordance with the requirements given in the most recent FRD and are minimum requirements. Validate against the most recent FRD and use the most restrictive requirements. Maximum time duration noted in this UFC to deliver the required PCA must not be increased regardless of any circumstances.

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USACE / NAVFAC / AFCEC / NASA UFGS 23 75 15 (Apr 2019)

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2019.

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SECTION 23 75 15

AIRCRAFT PRE-CONDITIONED (PCA) AIR SYSTEM

04/19

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NOTE: This specification covers the requirements for high-pressure, pre-conditioned air units, air distribution piping and controls for aircraft cooling systems.

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).

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1. PART 1 GENERAL

1.1. SUMMARY

This specification covers the requirements for high-pressure, pre-conditioned air units, air distribution piping and controls for aircraft cooling systems.

1.2. RELATED SECTIONS

1.2.1. Electrical

Electrical installation must be in accordance with section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.2.2. Insulation

Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, applies to this section, with the additions and modifications specified herein.

1.2.3. Foam Fire Extinguishing System

Coordinate PCA system installation with requirements of Section 21 13 20.00 20 FOAM FIRE EXTINGUISHING FOR AIRCRAFT HANGARS. Ensure all ducts subject to foam or water infiltration are sealed and insulation and waterproof jacket installation is complete prior to testing foam fire extinguishing system.

1.2.4. Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory is specified in Section 09 90 00 PAINTS AND COATINGS.

1.3. REFERENCES

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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.

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AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z49.1	(2012) Safety in Welding, Cutting, and Allied Processes

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

ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2017) Fundamentals Handbook, SI Edition
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

ASME INTERNATIONAL (ASME)

ASME MFC-3M	(2004; Addenda A 2007; R 2017) Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi
ASME A13.1	(2015) Scheme for the Identification of Piping Systems
ASME B36.19M	(2004; R 2015) Stainless Steel Pipe
ASME B31.3	(2016) Process Piping
ASME B31.5	(2016) Refrigeration Piping and Heat Transfer Components
ASME B16.25	(2017) Buttwelding Ends

ASTM INTERNATIONAL (ASTM)

ASTM A312/A312M	(2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM A333/A333M	(2016) Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness
ASTM A334/A334M	(2004a; R 2016) Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A1016/A1016M	(2018a; R 2017) Standard Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

AMERICAN WELDING SOCIETY (AWS)

AWS-03	(2011) Welding Handbook, Volumes 1 thru 4
AWS D18.1	(2009) Specification for Welding of Austenitic Stainless Steel Tube and Pipe in Sanitary (Hygienic) Applications
AWS B2.1/B2.1M	(2014; Errata 2015) Specification for Welding Procedure and Performance Qualification

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 281	(2007) Rolling Bearings -- Dynamic Load Ratings and Rating Life

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

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE ARP5374	(2001; R 2016) Method of Testing Pre-Conditioned Air Equipment
SAE AS38386	(1999; R2013) DUCT ASSEMBLY, GROUND, CONDITIONED AIR, INSULATED, FLEXIBLE

UNDERWRITERS LABORATORIES (UL)

UL 1995	(2015) UL Standard for Safety Heating and Cooling Equipment

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2013; with Change 1) Seismic Design of Buildings

1.4. SEQUENCING

Coordinate pre-conditioned air distribution piping work with testing of Section 21 13 20.00 20 FOAM FIRE EXTINGUISHING FOR AIRCRAFT HANGARS. Ensure all ducts subject

to foam or water infiltration are sealed and insulation and waterproof jacket installation is complete prior to testing foam fire extinguishing system.

1.5. SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are 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 Notebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

System Supplier’s Qualifications; G[, [____]]

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

Pre-Conditioned Air System Performance Test Plan; G[, [____]]

SD-02 Shop Drawings

Pre-Conditioned Air System Detail Drawings; G[, [____]]

SD-03 Product Data

Pre-Conditioned Air Unit; G[, [____]]

Pre-Conditioned Air Piping; G[, [____]]

Insulation; G[, [____]]

Pre-Conditioned Air Flexible Duct, Storage and Accessories; G[, [____]]

SD-05 Design Data

Insulation Thickness Calculations; G[, [____]]

SD-06 Test Reports

Final Pneumatic Test; G[, [____]]

Performance Test Report; G[, [____]]

SD-07 Certificates

Factory Test Report; G[, [____]]

Manufacturer’s System Certification; G[, [____]]

Certificate of Completion; G[, [____]]

Notification of Pre-Conditioned Air System Performance Testing; G[, [____]]

SD-11 Closeout Submittals

Operation and Maintenance Manual

Training Plan; G[, [____]]

Safety Data Sheets

1.6. QUALITY CONTROL

1.6.1. System Supplier's Qualifications

PCA system supplier must have at least three previous successful PCA system installations in the last five years. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The system supplier must supervise the installing, adjusting and testing of the equipment.

1.6.2. Pre-Conditioned Air System Detail Drawings

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NOTE: Size PCA units for the greatest enthalpy condition when comparing the 0.4% dry-bulb and mean coincident wet-bulb (DB/MCWB) and the 0.4% humidity ratio and mean coincident dry-bulb (HR/MCDB) design conditions using weather data prescribed by UFC 3-400-02. The greatest enthalpy condition usually occurs at the 0.4% HR/MCDB condition. Include PCA pipe and flexible duct heat losses in PCA unit sizing. Use a safety factor of 10% when sizing PCA equipment. Select minimum continuous operation capacity and heating components based on the 99.6% winter design dry bulb for the location using weather data prescribed by UFC 3-400-02. In cold climates, a heater may be required to deliver the minimum aircraft delivery temperature.

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Submit design calculations and detail drawings stamped by a licensed professional engineer showing equipment layout, including assembly and installation details and electrical connection diagrams; piping layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and pressure testing locations. Show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing foundation bolt locations, trench sizes, and access hatch points prior to concrete foundation construction. Submit product data of the equipment, materials and all accessories specified throughout this Section required to deliver a fully functional system. Provide control system drawings which include point-to-point electrical wiring diagrams. Include any information required to demonstrate that the system has been coordinated and functions properly. Include step-by-step operating procedures for all modes of operation with detail drawings.

Provide calculations demonstrating the equipment meets the performance requirements at the design condition [of [_____] grains per pound humidity and [_____] degrees F wet bulb][as scheduled]. Provide calculations demonstrating that equipment meets the performance requirements at the winter design condition [of [_____] degrees F] [as scheduled]. Provide unit capable of continuous stable operation under a minimum load of [10%] [_____] of the rated capacity. If minimum operating temperature is less than the minimum aircraft delivery temperature, provide PCA unit with heating capability and sizing calculations. Include fan heat gain in the calculation of heater size. Provide schedule of equipment supplied. Schedule must provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule must include the total quantity of each item of equipment supplied. Provide recommended spare parts listing for each assembly or component.

1.6.3. Certificate of Completion

As a prerequisite to government witnessed acceptance testing, the Contractor must submit a Certificate of Completion that certifies all PCA System work and quality control documentation has been completed. Certificate of Completion must include all quality

control documentation including preliminary test reports, pneumatic test reports weld inspection reports and NDE testing reports required by 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

Further, the Contractor Quality Control Manager must certify that all required checks, inspections, and preliminary tests have been successfully completed. The Contractor must provide the Contracting Officer at least [45][30] calendar days' notice prior to commencement of acceptance testing.

1.7. SYSTEM DESCRIPTION

Provide aircraft preconditioned air system having the minimum performance requirements indicated. Provision of the equipment, piping, controls, insulation, flexible duct, reel, and other appurtenances, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with this specification section, design drawings and referenced requirements.

1.7.1. Standard Operating Procedure

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NOTE: Do not modify the SOP.

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The control points, components, and capabilities specified herein will support the PCA system standard operating procedures (SOP) as follows.

1. Remove dust cap from PCA piping.
2. Start PCA purge mode.
3. Prepare to connect flex duct to aircraft. If present, open manual blow-down valve(s) to purge any trapped condensation.
4. When desired temperature is reached as indicated at temperature gauge, and there is no visible moisture in the duct, stop PCA purge mode.
5. Connect flexible duct to the PCA duct and aircraft, then start PCA normal mode.
6. Stop PCA unit, disconnect flexible duct, and replace dust cap.

1.8. SYSTEM SUPPLIER INVOLVEMENT

The Contractor and the System Supplier shall work together to prepare the work plan, commissioning plan, test reports and final reports. They shall both be present during all field testing activities and shall coordinate and schedule the work during construction, testing, calibration and acceptance of the system, and operator training. The System Supplier shall be responsible to the Contractor for scheduling all Contractor, sub-Contractor, and manufacturer's service personnel during system startup, commissioning, and acceptance.

1.9. DELIVERY, STORAGE, AND HANDLING

Stored equipment and materials must be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged must be replaced at the Contractor's expense. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

1.10. PROJECT/SITE CONDITIONS

1.10.1. Field Measurements

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

2. PART 2 PRODUCTS

2.1. PERFORMANCE REQUIREMENTS

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NOTE: Obtain performance requirements from aircraft manufacturer. F-35 cooling air performance requirements are found in the Joint Strike Fighter Facilities Requirement Document (FRD).

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PCA System Performance Criteria Measured at Point of Aircraft Connection	
Air Temperature	[_____]degrees F Minimum [_____]degrees F Maximum
Mass flow rate	[_____]pounds per minute (ppm) Minimum
Air Pressure	[_____]psig Minimum [_____]psig Maximum
Moisture Content of Dry Air	[_____]grains per pound Maximum

2.2. STANDARD COMMERCIAL PRODUCTS

Use a product from a manufacturer who is regularly engaged in the design, fabrication, testing, and service of pre-conditioned air units of type and size required for this project. Materials and equipment will be standard commercial cataloged products. These products must have a two year record of satisfactory field service prior to proposal due date. The two year record of service must include applications of equipment and materials under similar circumstances and of similar size.

2.3. MANUFACTURER'S STANDARD NAMEPLATES

Nameplates are required on major components if the manufacturer needs to provide specific engineering and manufacturing information pertaining to the particular component. Should replacement of this component be required, nameplate information will insure correct operation of the unit after replacement of this component.

2.4. PRE-CONDITIONED AIR UNIT

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NOTE: For units located near sound sensitive spaces, use noise criteria in brackets. Designer of record shall determine the allowable sound power noise level and select equipment location to ensure interior noise requirements are met.

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Provide high pressure, packaged pre-conditioned air unit designed for 100% fresh air . Unit must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. Unit must operate within capacity range and speed recommended by the manufacturer based on the maximum outdoor enthalpy condition as shown. Unit must be fully UL listed under UL 1995. Certification must be submitted with product data. Unit must be designed to

minimize noise and vibration to adjacent buildings. [Unit must operate at all conditions with a measured sound power noise level less than [85][___] dBA.]

Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, must have lifting eyes or lugs. Include customary auxiliaries for each unit as deemed necessary by the manufacturer for safe, controlled, automatic operation of equipment. Provide unit with single point wiring connection for incoming power supply. Access doors or panels suitably sized and located must be provided for access to filters, coils, valves, and any other items requiring cleaning, repair, or removal. Access doors or panels must be gasketed with synthetic rubber, or equivalent gasket material, and locked in place with thumb screws or catches.

2.4.1. Refrigerant and Oil

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NOTE: Pre-conditioned air units must operate on a refrigerant with an ODP equal to 0. R-134a, R-407C, and R-410A all meet this requirement.

****

Provide factory refrigerant charge and oil. Refrigerants must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0. Provide safety data sheets for all refrigerants.

2.4.2. Structural Base

Provide a structural steel base (welded or bolted) or support legs with factory finish specified in paragraph FACTORY COATING. Unit and individual components must be isolated from the building structure by means of vibration isolators with published load ratings. Vibration isolators must have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.

2.4.3. Receivers

Receivers, if required, must bear a stamp certifying compliance with ASME BPVC SEC VIII D1 and must meet the requirements of ANSI/ASHRAE 15 & 34. Inner surfaces must be thoroughly cleaned by sandblasting or other approved means. Each receiver must have a storage capacity not less than 20 percent in excess of that required for the fully-charged system. Each receiver must be equipped with isolation valve and relief valves of capacity and setting required by ANSI/ASHRAE 15 & 34, and two bull's eye liquid-level sight glasses. Provide sight glass in receiver liquid line.

2.4.4. Compressors

Compressors must be of the hermetically sealed design. Compressors must be mounted on vibration isolators to minimize vibration and noise. Rotating parts must be statically and dynamically balanced at the factory to minimize vibration. Lubrication system must be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater must be provided for cold climates. Provide compressor capable of unloading to 10% of rated capacity.

2.4.5. Motors and Drives

a. Electric motors and motor efficiencies must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. When motors and equipment furnished are

larger than sizes indicated, the cost of providing additional electrical service and related work must be included under this section. Provide variable-speed motors with variable frequency drive as required by the manufacturer and as specified in Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS. Drives speed controls must be programmed to prevent blower and condenser fans from operating in the region of instability on the fan airflow-pressure curve.

b. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Unless otherwise indicated, all motors of one horsepower and above with totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG. Each motor must conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor.

c. Motors must be continuous duty with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. Provide inverter duty premium efficiency motors for use with variable frequency drives.

d. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure where applicable. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided. Motor enclosure type must be either TEAO or TEFC.

2.4.6. Evaporator

****

NOTE: Standard coil construction is copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or copper tubes with pre-plated aluminum fins.

****

Provide AHRI 410 coils constructed of seamless copper tubes with compatible [aluminum] [pre-plated aluminum] fins. Fins must be soldered or mechanically bonded to the tubes and installed in a stainless steel or aluminum casing. Evaporator air velocity must be sufficiently low to prevent moisture carryover into the air distribution piping.

2.4.7. Condenser

****

NOTE: Standard coil construction is copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or copper tubes with pre-plated aluminum fins.

****

Condenser coil must be of the extended-surface fin-and-tube type and must be constructed of seamless copper tubes with compatible [aluminum] [pre-plated aluminum] fins. Fins must be soldered or mechanically bonded to the tubes. Coils must be circuited and sized for a minimum of 5 degrees F subcooling and full pump down capacity.

Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34. Provide coils constructed of aluminum alloys for fins, tubes, and manifolds. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.

2.4.8. High Pressure Blower Assembly

High pressure centrifugal blower, permanently-lubricated high-speed bearings. Integral cooling system for blower assembly. Bearing housing must be conservatively loaded and rated for an L(10) life of not less than 200,000 hours per ISO 281. Precision main bearings with heavy duty bushings in accordance with ABMA 9 or ABMA 11. Shaft seal suitable for high pressure applications.

2.4.9. Filters

Provide washable pre-filter and final filter installed at the inlet of the blower and accessible for maintenance through an access opening. Pre-filter must be constructed of washable mesh media that traps dust, foreign matter, and contaminants and is easily cleaned by flushing with water. Final filter efficiency must be high-efficiency, minimum MERV-8 and approved by manufacturer.

2.4.10. Factory Applied Insulation

PCA equipment must be provided with factory installed insulation on surfaces subject to condensation including the evaporator enclosure, suction line piping, economizer, and cooling lines. Factory insulated items installed outdoors are not required to be fire-rated.

2.4.11. Condensate Removal

Provide a means for condensate removal including an automatic drain valve, stainless steel drain line, stainless steel condensate pan and condensate sensor. Condensate drain valve must open intermittently, as needed, to prevent continuous air leakage from evaporator housing. Include a high condensate level alarm and safety shut down. Insulate condensate drain piping per Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.4.12. Operating Controls

Provide units complete with factory installed, UL-listed microprocessor based operating and safety control system. Controls must process the signals for complete control and monitoring of pre-conditioned air cooling units. Provide safety alarms with automatic shutoff. Provide proportional-integral controls to regulate system capacity and fan speed control to satisfy adjustable set points. Provide a defrost cycle to prevent coil freezing. Defrost cycles will allow discharge temperature from individual units to increase to 35-55 degrees F for up to 90 seconds every 15 minutes.

Provide a dedicated, low-pressure purge mode to allow cool-down of the duct. Purge mode set points including temperature, pressure, and mass flow rate, and automatic shutoff timer (5-30 minutes) must be independently adjustable at the unit control panel.

2.4.12.1. Unit Control Panel and Display

Provide a unit-mounted, touch-screen display to allow adjustment of set points including temperature, pressure, and mass flow rate. Display must show sensor data, set points, operating status of components, monitored points, and alarms. Each safety interlock requiring a manual reset must be displayed at the top-level screen without requiring a password. Non-recycling control interlocks must have the reset located on the control itself

that will identify the lockout information required below. Controls must illuminate the fault indicator at the unit and remote controller upon a power failure.

2.4.12.2. Remote Controller

Provide a remote controller along the hangar back wall for each PCA unit with step-by-step operating procedures posted on the controller cover. The remote controller must be one panel provided by equipment manufacturer. Remote controller must perform the following functions:

a. Blue purge mode start button.

b. Green aircraft cooling mode start button.

c. Red stop button.

d. White unit run status light.

e. Red illuminated fault light.

f. Digital display of PCA unit discharge temperature, humidity, pressure, and mass flow rate.

2.4.12.3. Internal Sensors

The following sensors must be provided internal to the unit. All sensors must have accuracy as indicated.

a. Discharge temperature sensor, 0-150 degrees F, accurate to plus or minus 0.5 degree F.

b. Ambient temperature sensor, 0-150 degrees F, accurate to plus or minus 0.5 degree F.

c. Discharge pressure sensor, -15 to 50 psig, accurate to plus or minus 0.5-percent.

d. Discharge humidity sensor, 0-100% relative humidity, accurate to plus or minus 5% RH.

e. Air velocity measurement sensor, 0-4,000 fpm, accurate to plus or minus 5% over a temperature range of -20 to +120 degree.

2.4.12.4. Adjustable Setpoints

The following points must be capable of being adjusted directly at the unit. A security access code must be entered before parameters can be changed.

a. Leaving air temperature control.

b. Leaving air pressure control.

c. Mass air flow rate.

2.4.12.5. Monitoring Capabilities

During normal operations, the control system must be capable of monitoring and displaying the following operating parameters on the operator interface terminal at the unit. The display must be accessible without opening or removing any panels or doors.

a. Leaving air temperatures.

b. Leaving air pressure.

c. Leaving air mass flow rate.

d. Self-diagnostic.

e. Operation status.

f. Operating hours.

g. Number of starts.

h. Compressor status (on or off).

i. Compressor speed.

j. Condenser fan status.

k. Refrigerant discharge and suction pressures.

2.4.12.6. Safety Controls with Manual Reset

Pre-conditioned air cooling unit must be provided with the following safety controls which automatically shut down the pre-conditioned air cooling unit, display an alarm at unit and remote controller, and which require manual reset.

a. Low airflow detection.

b. High discharge air pressure.

c. High refrigerant pressure.

d. High motor winding temperature protection.

e. Motor current overload and phase loss protection.

f. High condensate level.

2.4.12.7. Safety Controls with Automatic Reset

Pre-conditioned air cooling unit must be provided with the following safety controls with automatic reset, and alarm.

a. Low refrigerant pressure safety shutdown.

b. Over/under voltage protection.

c. Phase reversal protection.

d. Short cycle protection.

e. Load limiting to prevent over-pressurization.

2.4.13. Factory Coating

Equipment casing and structural base, when fabricated from ferrous metal, must be factory coated with a coating rated for 3,000 hours' exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.4.14. Test Apparatus

One testing spool piece, or test bullet, must be provided to support field testing. Test bullet must be provided with calibrated gauges to measure all cooling air performance parameters including, but not limited to, temperature, flow, pressure, and humidity. Provide lab testing for air particulates if required by the contracting officer. Provide test bullet with calibrated orifice plate to simulate aircraft back pressure. Provide test bullet complete with carrying case, and turn over to the contracting officer upon contracting officer acceptance of the PCA system.

2.4.15. Tools

One complete set of special tools, if required for access to PCA equipment panels and routine maintenance, must be provided. Tools must be [provided to the maintenance activity] [provided with a weatherproof toolbox attached to the unit structure].

2.5. ELECTRICAL WORK

2.5.1. Controllers, Contactors, and Disconnects

Furnish with respective pieces of equipment. Electrical equipment, controllers, contactors and disconnects must 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.

2.5.2. Electrical Control Wiring

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NOTE: Choose the control specification applicable to the basis of design. Use 23 09 00 for low voltage remote control panels and use 26 20 00 for line voltage control panels.

****

[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.] Field wiring must be in accordance with manufacturer's instructions.

2.6. SUPPLEMENTAL COMPONENTS

2.6.1. Seismic Requirements

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NOTE: Provide seismic details on the drawings, if performed by the DoR. Delete the bracketed phrase "as shown on the drawings" if no seismic details are provided.

If seismic design is delegated, specify seismic bracing of PCA piping and equipment in accordance with applicable codes and standards. UFC 3-310-04 SEISMIC DESIGN FOR BUILDINGS and Sections 13 48 00 [SEISMIC] BRACING FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC or 22 05 48.00 20 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL properly edited, must be included in the contract documents.

****

Piping and equipment shall be supported and braced to resist seismic loads as specified under UFC 3-310-04 and Sections 13 48 00 [SEISMIC] BRACING FOR MISCELLANEOUS EQUIPMENT and [23 05 48.19 [SEISMIC] BRACING FOR HVAC] [22 05 48.00 20 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL] [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

2.6.2. Pre-Conditioned Air Piping

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NOTE: Choose pressure rating of 150% of maximum operating pressure of the equipment specified.

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Provide fully welded air distribution piping of schedule [5][10], type 304L stainless steel suitable for a working pressure of [15][_____] psig. Stainless fittings and joints must be butt-welded in accordance with ASME B16.25. Installation of piping must conform to the requirements of Section 23 64 26 CHILLED, CHILLED-HOT AND CONDENSER WATER PIPING AND ACCESSORIES. Piping must be supported by the hangar structure or utility trench. Piping design including supports must account for and control thermal expansion. Provide ASME 13.1 compliant piping labels every 20 feet and at each change in direction indicating direction of flow and associated PCA unit equipment designation.

Do not install valves downstream of the pre-conditioned air unit. Provide duct-mounted, mechanical temperature and pressure gauges at the PCA duct connection point. Provide a water tight, soft rubber cover with lanyard to protect the PCA duct opening while not in use. End cap must connect to piping with the use of hand-operated quick-connect connectors.

2.6.3. Insulation

Insulate pre-conditioned air system piping with factory applied polyisocyanurate insulation and jacket covers meeting ASTM C578. Insulation must meet the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84. Provide a water-tight embossed aluminum or high density polyurethane (HDPE) jacket for all insulation. Installation must conform to requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.6.3.1. Insulation Thickness Calculations

Perform heat loss calculations based on insulation thickness and equipment performance requirements to demonstrate that insulation is sufficient to deliver the prescribed conditions in section titled Performance Requirements at the aircraft. Actual insulation values and maximum PCA piping length for the project must be used in calculations.

2.6.4. Pre-Conditioned Air Flexible Duct, Storage and Accessories

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NOTE: Specify flexible duct length based on the maximum distance between aircraft parking positions and duct connection points.

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Provide [35][_____] -foot flexible duct, [6][_____]-inch diameter, with hand-operated quick-connect connectors for connection between the PCA piping termination and the aircraft. Flexible duct must be fully insulated with a metal helical stiffener core to prevent collapse and suitable for an operating pressure of 150% of the aircraft delivery pressure. Provide manufacturer's certification that the air temperature rise in the flexible duct is less than 0.2 degree F per foot when tested at the maximum outdoor ambient design temperature and median aircraft delivery temperature and pressure conditions.

Provide a hard 45-degree transition attached to the inlet of the flexible duct. Provide all necessary transitions with insulating sleeve. Obtain list of approved aircraft connectors from aircraft program Facilities Requirements Document (FRD). Provide insulated flexible duct

with a mobile basket or reel to connect from the PCA pipe connection to the aircraft PCA connection. Equip flexible duct storage basket or reel with heavy-duty casters and integral storage for transitions.

2.7. FACTORY TESTS

2.7.1. Manufacturer's Factory Test Plan

Perform factory test on PCA equipment prior to delivery to validate the specified full load capacity. Testing must be performed at the factory in accordance with SAE ARP5374 by manufacturer. At a minimum, PCA equipment capacity must be validated to meet the scheduled requirements as indicated. Factory testing to be performed in a controlled environment lab that is capable of simulating extreme ambient conditions witnessed by the installation location. PCA unit must also be tested under minimum load conditions. Stable operation at minimum load of 10% of total capacity must be demonstrated during the factory test. Test reports to include ambient conditions and results from each test.

For each unit, submit a factory test plan which verifies the scheduled performance is met by the produced units. Indicate in each test plan the factory acceptance test procedures. Include a detailed step-by-step procedure 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. Perform calibration of controllers and sensors, ensure set points are programmed, and control variables are tuned to provide stable control of their respective equipment. Include the required test reporting forms to be completed by the Manufacturer’s testing representatives. Submit the required test plans for review and approval to the Contracting Officer at least 90 calendar days before scheduled factory test date.

2.7.1.1. Performance Variables

List performance variables that are required to be measured or tested as part of the factory test plan. Include the actual performance variables during testing as well as the performance requirements indicated on equipment schedules on the contract design drawings on each test form. Provide a description of acceptable performance results and objective quality evidence which will verify performance results. Identify the limits or tolerances within which each tested performance variable is deemed to be acceptable.

2.7.1.2. Test Configuration

Tests must be performed for a minimum of four continuous hours in a wet coil condition. If test period is interrupted, restart the four-hour test period. Each test plan must be job specific and address the particular units and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.

2.7.1.3. Test Variables

Air side testing variables must include recording of the airflow, total static pressure; fan drive motor KW, amperage and RPM; and fan RPM. Perform test with entering air at scheduled design conditions.

2.7.1.4. Specialized Components

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

2.7.2. Production Schedule and Factory Test Schedule

The Government reserves the right to witness factory tests for pre-conditioned air cooling units. Provide the 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 90 calendar days prior to the scheduled factory test date. Track this schedule through the production phases and if scheduled factory tests date changes, give advanced notice to Contracting Officer as soon as possible, but at least 30 calendar days in advance of the scheduled test dates.

2.7.3. Factory Test

Conduct the factory testing in compliance with the Contracting Officer approved Manufacturer's Factory Test Plan, and in accordance with additional field testing requirements specified herein. Conduct the test for each unit for the continuous test period in the approved test plan. If a unit shuts down before the continuous test period is completed, the test procedure must restarted and run for the required duration.

2.7.4. Factory Test Report

Record the required data using the test reporting forms of the approved test plan. Final test report forms must be typed including data entries and remarks. Completed test report forms for each unit must be reviewed, approved, and signed by the Manufacturer's test director. Submit factory test reports, referencing each tested unit's serial number, and receive approval before delivery of unit to the project site.

2.7.5. Deficiency Resolution

Deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections tested as specified in the paragraph titled FACTORY TESTS.

3. PART 3 EXECUTION

3.1. EXAMINATION

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

3.2. INSTALLATION

Provide manufacturer's installation manual for each type of unit. Perform all work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

3.2.1. Refrigeration System

3.2.1.1. Equipment

Refrigeration equipment and the installation thereof must conform to ASHRAE 15. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, condensers, and similar items. Select and size isolators based on load-bearing requirements and the lowest frequency of vibration to be isolated. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.2.2. Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory is specified in Section 09 90 00 PAINTS AND COATINGS.

3.3. FIELD QUALITY CONTROL

3.3.1. Manufacturer's System Certification

Upon completion and before final acceptance testing of work, a factory-trained representative must verify on-site the PCA equipment installation compliance with manufacturer's recommendations. Manufacturer's representative must check each unit under pressure for refrigerant leaks. If leaks are found, evacuate and dehydrate the machine to an absolute pressure of not over 300 microns prior to repair and recharge. Verify and record proper refrigeration charge.

Manufacturer's representative must test controls through every cycle of operation, verify safeties, make necessary adjustments, and balance systems prior to scheduling acceptance testing of completed systems. Controllers must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment. Submit manufacturer's system certification at least 30 calendar days in advance of the scheduled acceptance test date.

3.3.2. Cleaning

Clean piping before placing in operation. Clean equipment, piping, filters, and accessories. Prior to commencement of field testing, remove all filters and provide new filters.

3.3.3. Preliminary Pneumatic Test

Prior to insulating PCA piping joints, apply a 15 psig pneumatic test to PCA piping, not including flexible duct and connector. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest

3.3.4. Final Pneumatic Test

Prior to insulating PCA piping joints, tightness test PCA piping, not including flexible duct and connector, with air at a pressure of 15 psig. Pressurize the system and isolate the source of pressure. No leakage is permitted at the end of one hour as indicated by a drop in system pressure. Test must be witnessed by government personnel, and a final pneumatic test report submitted for approval by the quality control manager (QCM). If any test section fails tightness testing, repair or replace all defective materials and/or workmanship.

3.4. COMPONENT INSTALLATION

3.4.1. Route Control Wiring

Route control wiring in rigid conduit per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.4.2. Preconditioned Air Piping

Support all above ground piping including piping located in trench per Section 23 64 26 CHILLED, CHILLED-HOT AND CONDENSER WATER PIPING AND ACCESSORIES. Provide insulation shields at supports and provide a water-tight embossed aluminum or HDPE jacket over entire service.

3.5. ACCEPTANCE TESTS

Pre-conditioned air system final acceptance tests will be witnessed by the Contracting Officer and other Government representatives. Furnish a factory trained field test director authorized by the PCA equipment manufacturer to oversee the complete execution of the field testing. This test representative must also review, approve, and sign the completed Performance Test Report. Signatures must be accompanied by the person's name.

3.5.1. Pre-Conditioned Air System Performance Test Plan

Submit a performance test plan for each PCA system at least 90 calendar days in advance of the scheduled acceptance test date for Contracting Officer approval. Submit the performance test plan along with the completed factory test plan specified herein. Include field test director’s qualifications and factory training certification.

3.5.1.1. Functional Tests

Test plan must include detailed step-by-step procedures to verify the functional performance of the complete PCA system including all modes of operation and safety controls. Each test step must include the procedure used to simulate conditions, the expected responses, and space for comments. Test plan must include list of participants and equipment needed to perform the test. Describe test set-up to simulate real-world operation of the entire system including flexible duct.

3.5.1.2. Endurance Test

In addition to functional tests, test plan must include an endurance test to verify system performance when the ambient outdoor conditions are within 10% of the design maximum enthalpy condition. Include a form to record performance variables at 15-minute intervals during the test. Performance variables must be measured at aircraft connection point under the same test set-up as the functional tests.

Record the following data during the endurance test:

a. Pre-conditioned air unit discharge temperature (°F)

b. Aircraft connection temperature (°F)

c. Pre-conditioned air unit discharge pressure (psig)

d. Aircraft connection pressure (psig)

e. Aircraft connection humidity ratio (grains moisture per pound of dry air)

f. Pre-conditioned air unit discharge air mass flow rate (pound per minute)

g. Aircraft connection discharge air mass flow rate (pound per minute)

h. Ambient temperature (°F)

i. Ambient humidity (grains moisture per pound of dry air)

3.5.1.3. Instruments

List the instruments used to measure performance data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field, and calibration must be traceable to the measuring standards of the National Institute of Standards and Technology. All instrumentation must bear a valid NIST traceable calibration certificate during field work and during government acceptance testing.

3.5.2. Notification of Pre-Conditioned Air System Performance Testing

Notify the Contracting Officer in writing at least 30 calendar days in advance of all acceptance tests. Notification must include PCA System Certificate of Completion. If partial performance testing is necessary because outdoor conditions are not within the required range, include the anticipated endurance test dates in the Notification of PCA Performance Testing. Test each unit for Contracting Officer acceptance in accordance with the approved test plan.

3.5.3. Performance Testing

Conduct the field testing in compliance with the Contracting Officer approved performance test plan, and in accordance with additional testing requirements specified herein. Record the required data using the test reporting forms approved of the approved field test plan.

Conduct the endurance test for each PCA for a continuous 4-hour test period. If a unit shuts down before the continuous 4-hour test period is completed, the test must be started again and run for the required duration. If any performance variable measured at the aircraft connection falls outside of the acceptable range in paragraph titled PERFORMANCE REQUIREMENTS for more than one measurement interval, the endurance test will be failed. Record the cool down time required for air measurements to be within the required performance parameters. If the cool down time exceeds 30 minutes, the test will be failed. If the system experiences any failures during the endurance test portion of the test, repair the system and repeat the endurance test portion until the system operates continuously and without failure for the specified endurance test period.

3.5.4. Performance Test Report

Within 30 calendar days after acceptable completion of testing, submit each test report for the review and approval of the Contracting Officer. Use the test reporting forms approved in the Performance Test Plan. Final test report forms must be typed, including data entries and remarks. Completed test report forms for each PCA must be reviewed, approved, and signed by the Contractor's test director and the QC manager.

3.5.5. Deficiency Resolution and Re-testing

Deficiencies identified during the tests must be corrected in compliance with the contract requirements and retested as specified in the paragraph titled ACCEPTANCE TESTS. Any deficiencies observed must be corrected by the Contractor without cost to the Government.

3.6. ADJUSTING AND CLEANING

Wipe equipment clean, removing all traces of oil, dust, dirt, or paint spots. Provide temporary filters for all fans that are operated during construction, and install new filters after all construction dirt has been removed from the building. Maintain the system in this clean condition until final acceptance.

Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.7. CLOSEOUT ACTIVITIES

3.7.1. Operation and Maintenance Manual

Submit operation and maintenance manuals meeting requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA and UFGS 01 78 24.00 20 FACILITY ELECTRONIC OPERATION AND MAINTENANCE SUPPORT INFORMATION (eOMSI) no later than 30 calendar days before contract completion. Provide recommended spare parts listing for each assembly or component.

3.7.2. Training

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the PCA system in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA. Instructors must be thoroughly familiar with all parts of the installation and instructed in operating theory as well as practical operation and maintenance work. Submit a training plan for the instruction course including instructor's qualifications and certifications for approval.

Conduct a training course as designated by the Contracting Officer. The training period must consist of a maximum of 16 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --