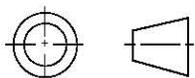


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TOLERANCES ON:**
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THIRD ANGLE PROJECTION



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CAD MAINTAINED. CHANGES SHALL BE INCORPORATED ONLY BY THE DESIGN ACTIVITY.		ORIGINAL DATE OF DRAWING (YY/MM/DD) 11/05/06		JOHN F. KENNEDY SPACE CENTER, NASA KENNEDY SPACE CENTER, FLORIDA			
SOFTWARE MICROSOFT OFFICE WORD 2007		DRAFTSMAN T.L. JOBE/TE	CHECKER	PROCUREMENT SPECIFICATION MPPU REFURBISHMENT DESIGN ENVIRONMENTAL CONTROL SYSTEM			
FILENAME 584FCM01001-01.DOCX		ENGINEER A. JACQUES/TE	CHECKER R. WITHERSPOON/TE				
MATERIAL N/A		ENGINEER D.S. PARKER/NE-L4	STRESS S.D. VAN GENDEREN/NE-M1				
HEAT TREATMENT N/A		ENGINEER R.FRANCO/NE-F2		SIZE A	CAGE CODE 22264	DWG NO 584FCM01001	REV -
FINAL PROTECTIVE FINISH N/A		SUBMITTED T.O. ADAMS/NE-F2		SCALE NTS		UNIT WEIGHT N/A	SHEET OF 1 113
		APPROVED E.A. THAXTON/NE-O					

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SECTION 01000 - DRAWING LIST

Drawing Package	Drawing Number	Description	Rev	Date
ASSEMBLY				
584F0301001	V-1	TITLE & INDEX	-	5/6/11
584F0301001	V-1A	MODIFICATION DETAILS	-	5/6/11
584F0301001	V-2	SYSTEM SCHEMATIC	-	5/6/11
584F0301001	V-2A	HYDRONIC SCHEMATIC	-	5/6/11
584F0301001	V-2B	REFRIGERATION PIPING SCHEMATIC	-	5/6/11
584F0301001	V-3	REAR PERSPECTIVE LOUVER LAYOUT	-	5/6/11
584F0301001	V-4	FRONT PERSPECTIVE LOUVER LAYOUT	-	5/6/11
STRUCTURAL				
584F0301001	S-1	STRUCTURAL FRAMING	-	5/6/11
584F0301001	S-2	STRUCTURAL FRAMING (REFERENCE)	-	5/6/11
584F0301001	S-3	STRUCTURAL FRAMING	-	5/6/11
584F0301001	S-4	STRUCTURAL FRAMING (REFERENCE)	-	5/6/11
584F0301001	S-5	STRUCTURAL FRAMING (REFERENCE)	-	5/6/11
584F0301001	S-6	STRUCTURAL FRAMING	-	5/6/11
584F0301001	S-7	STRUCTURAL FRAMING	-	5/6/11
584F0301001	S-8	STRUCTURAL FRAMING (REFERENCE)	-	5/6/11
584F0301001	S-9	STRUCTURAL FRAMING	-	5/6/11
584F0301001	S-9A	MISC SHEET METAL DETAILS (REFERENCE)	-	5/6/11
584F0301001	S-10	STRUCTURAL FRAMING (REFERENCE)	-	5/6/11
584F0301001	S-10A	MISC SHEET METAL DETAILS (REFERENCE)	-	5/6/11
584F0301001	S-11	STRUCTURAL FRAMING (REFERENCE)	-	5/6/11
584F0301001	S-11A	MISC SHEET METAL DETAILS (REFERENCE)	-	5/6/11
584F0301001	S-12	DESIGN LOADS (REFERENCE)	-	5/6/11
MECHANICAL				
584F0301001	M-1	GENERAL NOTES	-	5/6/11
584F0301001	M-1A	'A" NUMBER COMPONENT LIST	-	5/6/11
584F0301001	M-1B	'A" NUMBER COMPONENT LIST CONTINUED	-	5/6/11
584F0301001	M-1C	'A" NUMBER COMPONENT LIST CONTINUED	-	5/6/11
584F0301001	M-2	PLAN VIEW	-	5/6/11
584F0301001	M-2A	HANGER DETAILS	-	5/6/11
584F0301001	M-3	RIGHT SIDE VIEW	-	5/6/11
584F0301001	M-4	LEFT SIDE VIEW CONTINUED	-	5/6/11
584F0301001	M-4B	CONDENSER GEOMETRY	-	5/6/11
584F0301001	M-5	END VIEWS	-	5/6/11
584F0301001	M-5B	FLAT PANEL DETAILS	-	5/6/11
584F0301001	M-6	PLAN VIEW WITHOUT CONDENSERS LOUVER FRAME	-	5/6/11
584F0301001	M-7	INTAKE FILTER PLENUM	-	5/6/11
584F0301001	M-8	DUCT DETAILS	-	5/6/11
584F0301001	M-9	PLENUM ISOMETRIC	-	5/6/11
584F0301001	M-9A	CONDENSATE DRAIN ISOMETRIC	-	5/6/11
584F0301001	M-9B	TEMPLATES, COILS	-	5/6/11

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584F0301001	M-9E		OUTLET #1 REHEAT COIL	-	5/6/11
584F0301001	M-10		INTAKE PLENUM DETAILS	-	5/6/11
584F0301001	M-11		SECTIONS & DETAILS	-	5/6/11
584F0301001	M-11A		SCREEN & SPACER DETAILS	-	5/6/11
584F0301001	M-11B		CONDENSATE DRAIN DETAILS	-	5/6/11
584F0301001	M-12		FILTER PRESSURE HOUSING ASSEMBLY	-	5/6/11
584F0301001	M-12A		FILTER PRESSURE HOUSING	-	5/6/11
584F0301001	M-12B		FILTER HOUSING DETAILS	-	5/6/11
584F0301001	M-13		BAFFLE PLATE WELDMENT ASSY	-	5/6/11
584F0301001	M-14		HEATER TRANSITION DETAILS	-	5/6/11
584F0301001	M-15		DUCTING DETAILS	-	5/6/11
584F0301001	M-15A		DUCTING DETAILS	-	5/6/11
584F0301001	M-15B		BRACKETS & MACHINED PARTS	-	5/6/11
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584F0301001	M-16		FLANGE & SUPPORT DETAILS	-	5/6/11
584F0301001	M-16A		MISC SHEET METAL DETAILS	-	5/6/11
584F0301001	M-16B		MISC SHEET METAL DETAILS	-	5/6/11
584F0301001	M-17		HOT WATER PIPING ISOMETRIC	-	5/6/11
584F0301001	M-17A		REFRIGERATION SCHEMATIC ISOMETRIC	-	5/6/11
584F0301001	M-18		INSTRUMENT LOCATION PLAN	-	5/6/11
584F0301001	M-19		IDENTIFICATION TAG DETAILS	-	5/6/11
584F0301001	M-19A		STENCILS	-	5/6/11
584F0301001	M-20		SCHEDULES	-	5/6/11
584F0301001	M-21		ELECTRO MECHANICAL CONTROL DIAGRAM EMCD	-	5/6/11
584F0301001	M-22		ELECTRO MECHANICAL CONTROL DIAGRAM EMCD	-	5/6/11
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ELECTRICAL

584F0301001	E-1		SYMBOL LEGEND & NOTES	-	5/6/11
584F0301001	E-2		WIRE & CONDUIT SCHEDULE	-	5/6/11
584F0301001	E-5		PLC BLOCK DIAGRAM	-	5/6/11
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584F0301001	E-10		ELECTRICAL ENCLOSURES PLAN VIEW	-	5/6/11
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584F0301001	E-17		ENCLOSURE LAYOUTS & DETAILS HEATER CONTROLLER	-	5/6/11
584F0301001	E-18		ENCLOSURE LAYOUTS & DETAILS INSTRUMENTATION DISTRIBUTION BOX	-	5/6/11
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584F0301001	E-23		VALVE FEEDBACK & CONTROL DISTRIBUTION BOX	-	5/6/11
584F0301001	E-28		ELECTRICAL BLOCK DIAGRAMS SHEET 1 OF 2	-	5/6/11
584F0301001	E-29		ELECTRICAL BLOCK DIAGRAMS SHEET 2 OF 2	-	5/6/11
584F0301001	E-33		MPPU POWER WIRING SHEET 1	-	5/6/11
584F0301001	E-34		MPPU POWER WIRING SHEET 2	-	5/6/11
584F0301001	E-35		MPPU POWER WIRING SHEET 3	-	5/6/11
584F0301001	E-36		MPPU POWER WIRING SHEET 4	-	5/6/11
584F0301001	E-37		PLC WIRING DIAGRAM - SLOT 4	-	5/6/11
584F0301001	E-38		PLC WIRING DIAGRAM - SLOT 5	-	5/6/11
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584F0301001	E-41		PLC WIRING DIAGRAM - SLOT 8	-	5/6/11
584F0301001	E-42		PLC WIRING DIAGRAM - SLOT 14	-	5/6/11
584F0301001	E-43		PLC WIRING DIAGRAM - SLOT 9	-	5/6/11
584F0301001	E-44		PLC WIRING DIAGRAM - SLOT 10	-	5/6/11
584F0301001	E-45		PLC WIRING DIAGRAM - SLOT 11	-	5/6/11
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584F0301001	E-48		WIRING DIAGRAM FLOW CONTROL VALVES - SHEET 2	-	5/6/11
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584F0301001	E-50		WIRING DIAGRAM TEMP CONTROL VALVES - SHEET 2	-	5/6/11
584F0301001	E-51		WIRING DIAGRAM ANALOG INSTRUMENTATION	-	5/6/11
584F0301001	E-52		TRANSMITTER PANEL LAYOUT	-	5/6/11
584F0301001	E-53		WIRING DIAGRAM TEMPERATURE MEASUREMENTS	-	5/6/11
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584F0301001	E-55		PLC WIRING DIAGRAM - SLOT 15	-	5/6/11

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SECTION 01010 - SUMMARY OF WORK

PART 1 – GENERAL

1.1 DEFINITIONS

- A. Government: NASA Kennedy Space Center (KSC)
Office of Procurement
Mail Code OP-CS
Kennedy Space Center, FL 32899
- B. MPPU Mini Portable Purge Unit – a self contained, air handling and conditioning trailer used to provide cool, dry air to space vehicles. Part of the Environmental Control System (ECS).
- C. MPPU Refurbishment The rehabilitation and upgrades made to the MPPUs in accordance with this specification and the project drawings.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions and other Specification Sections, apply to this Section.
- B. The drawings that apply to the Work as outlined in this specification section are listed in the specification section 01000.

1.3 PROJECT DESCRIPTION

- A. The Project consists of the turnkey supply of refurbishment of existing MPPUs. The MPPUs have been used in support of the current space shuttle program to supply environmentally controlled air to various compartments within the shuttle. The MPPUs are being refurbished in order to increase their performance and extend their service life.
- B. The purpose of the refurbished MPPUs is to provide a supply of conditioned air for maintaining required temperature, pressure, and humidity levels within various Orion and Ares I compartments. The MPPU provides purge air to the Orion Service Module/Spacecraft Adapter (SM/SA), the Orion Crew Module/Crew Cabin (CM/CC), and the CM/Soft Cover (SC) while in the Main Payload Processing Facility while under transport between KSC facilities, and during rollout to the launch pad.
- C. The MPPUs are complete, self-contained air processing units that are housed in tow-around

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trailers. They are electrically powered and computer controlled. The units take in atmospheric air and filter it, compress it, and dehumidify it. The air is then ducted to the Orion or Ares I Upper Stage through three separate duct systems. The air to each duct is independently controlled to supply the required flow rate at the correct temperature and pressure. The operator controls the MPPU locally via a front panel or remotely via a network interface.

- D. The existing MPPUs have been in service for over 15 years. Therefore, many components are no longer commercially available. The structural steel and panels have peeling paint and surface corrosion. The control system is obsolete and replacement parts are becoming difficult to obtain. Also, the refrigeration system uses R-22 which is considered to be an ozone-depleting substance.
- E. Additionally, there are performance limitations associated with the existing MPPUs. First, the capacity of the refrigeration system is insufficient to provide the required level of cooling on hot/humid days. Therefore, the temperature of the purge air that is delivered to the flight vehicle is warmer than desired. Also, the supply temperature fluctuates excessively as compressors are turned off and on. On extremely cold days, the electric heaters are insufficient to deliver air at the required temperature.
- F. This refurbishment project will address the issues listed above by rehabilitating the structural framework, refurbishing or replacing system components, installing a new control system, and installing a new refrigeration system that has increased capacity and uses R410A refrigerant. The size of the electric heaters will also be increased.

1.4 CONTRACTOR'S SCOPE OF WORK

- A. The Contractor, having carefully examined the Contract Documents in order to familiarize himself with all conditions that may affect the Work, and being satisfied that he fully understands them, agrees to provide all labor, materials, tools, construction supplies, construction equipment, plant, facilities, services, safety, insurance, and to pay all taxes, permit costs, fees, and other costs necessary or required in the Contract Documents, to accomplish in a safe, timely, and workmanlike manner the Work shown in the Contract Documents, Technical Specifications herein and the drawings referenced in Specification Section 01000.
- B. The work shall include, but not be limited to the design detailing, disassembly, fabrication, refurbishment, testing and installation of a complete and operational Mini Portable Purge Unit. The unit shall be provided as described in the Contract Documents and Drawings associated with this Contract, and shall be capable of performing the functions which are described. Although each and every item may not be mentioned in the drawings and specifications, it is expected that such items will be included if required to provide a complete and fail-safe system consistent with industry codes and acceptable standard practices.

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- C. The Contractor shall provide a Quality Control Plan, Fabrication and Assembly plans and Shop and On-Site Acceptance Plans. Plans affecting on-site work shall be developed in joint effort with the Government.
- D. The Contractor shall support one design review at his facility during the shop drawing and planning phase of the contract.
- E. The following matrix sets forth the division of responsibilities between the Government and Contractor with regards to design detailing, procurement, fabrication, refurbishment, delivery, receiving and installation of components and equipment.

Work Description	Government	Contractor
General		
1. Prior to commencing work on the MPPU's, a work plan shall be developed by the Contractor and written acceptance of the plan shall be obtained from the Government.		X
2. Dispose of all material in accordance with local codes.		X
Design and Project Requirements		
1. Project management. A project manager shall be assigned to the project.	X	X
2. System Design: The Contractor shall develop detailed shop drawings and documents as required for the system refurbishment, and support a design review at the Contractors facility prior to starting any refurbishment work.		X
a. Provide P&ID's diagrams for MPPU Refurbishment.		X
b. Provide electrical wiring diagrams, power distribution diagrams, and specifications.		X
c. Provide controls diagrams, circuit wiring diagrams, software documents, and specifications.		X
d. Complete design of refrigeration control system according to the project drawings and Section 11820 of this specification.		X
3. Pick up from the site.		X
4. Demolition.		X
5. Structural modifications (if required).		X
6. System fabrication and assembly.		X
7. System and Subsystem Control Software.		X
8. Factory integration and acceptance testing.		X
9. Delivery to site.		X

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Work Description	Government	Contractor
10. Commissioning.		X
11. Training.		X
12. System documentation including: record drawings (red-line), O&M Manuals, and test reports		X
13. Warranty Service		X
Preparation and Shipment		
1. Refrigerant R-22 shall be removed from the system in accordance with the Government approved plan prior to shipment to the Contractor facility.	X	
2. Prepare Lifting and Transportation Plan.		X
3. Prepare MPPUs for shipping to Contractors facility. This shall include as a minimum: a. Close valves and cover all openings b. Secure all loose items and protect items potentially damaged during shipment.		X
4. Provide a crane and rigging equipment for lifting MPPU.		X
5. Provide lifting sling.	X	
6. Load MPPUs on trucks and ship to Contractors facility.		X
7. Ship MPPUs to contractor's facility.		X
8. Off load MPPU at refurbishment facility.		X
9. Provide a crane and rigging equipment for off loading MPPU.		X
10. Ship back the lifting sling back to Kennedy Space Center, FL		X
MPPU Dismantlement and Reconditioning		
1. Drain and dispose of all remaining fluids		X
2. Prepare report on the existing condition and configuration of each MPPU. The report shall have as a minimum: a. Photos of each unit in its original condition b. Model number and nameplate descriptions of each component. c. Special notes or documentation required to aid in reassembling the unit to a functioning system. d. Assessment of the condition of items indicated to be re-used and any special refurbishment activities not specified in this specification or the Government approved work plan.		X
3. Remove all louvers and exterior panels		X

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Work Description	Government	Contractor
4. Remove and refurbish blower. Remove blower from structure and send to the blower manufacturer for refurbishment. Refurbishment activities shall be completed as specified in specification.		X
5. Remove all power and control panels and associated wiring		X
6. Remove and dispose of all wiring, conduit, terminals, and housings		X
7. Remove all insulation from, piping, ductwork and structure		X
8. Remove all piping, tubing, valves, pumps, heaters, instrumentation, supports and ancillary equipment from structure		X
9. Remove condenser and all refrigeration components and tubing from structure		X
10. Remove all coils, filters, filter housings, ductwork, and supports from structure		X
11. Remove and refurbish running gear assembly. Refurbishment of running gear shall include as a minimum a. Replace fasteners b. Replacement of tires c. Replacing bearing assemblies d. Strip, sandblast, repaint e. Replacement of all fluids, bleeding of system f. Replace breaks and turn or replace drums		X
12. Remove and refurbish rear axle assemblies. Refurbishment shall include as a minimum: a. Replace fasteners b. Replace of tires c. Replacing bearing assemblies d. Strip, sandblast, repaint e. Replacement of fluids, bleeding of system f. Replace breaks and turn or replace drums		X
13. Remove all ducting, components and panels from structural framework. Remove all items not welded to structure.		X
14. Dispose of all components that will not be re-used according the government approved work plan, and in accordance with disposition noted on the contract drawings.		X

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Work Description	Government	Contractor
15. Refurbish and modify MPPU structural frame in accordance with approved contract drawings. As a minimum this shall include: <ul style="list-style-type: none"> a. Strip paint from frame b. Sandblast frame to remove corrosion and rust c. Remove moisture wick from frame d. Repair existing welds and structure if required e. Furnish and provide modifications and support structure for all control and power enclosures in accordance with contract drawings and manufacturer recommendations f. Relocate ducting supports in accordance with the contract drawings g. Furnish and install condenser mounting brackets in accordance with the contract drawings h. Furnish and install secondary support structure for compressor skids as indicated on contract drawings i. Furnish and install secondary supports for water heaters in accordance with contract drawings j. Furnish and install pump mounting brackets in accordance with contract drawings and section 11820 of this specification k. Modify intake louver supports in accordance with the contract drawings l. Leak test frame and replace moisture wicks in accordance with contract drawings m. Repaint the structural framework and secondary supports in accordance with the drawings and this specification 		X
16. Modify or furnish new louver panels in accordance with contract drawings. Note: Some panels will be reused.		X
17. Strip paint, sandblast, and repaint all louvers and panels in accordance with this specification.		X

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Work Description	Government	Contractor
18. Refurbish and modify MPPU ducting in accordance with contract drawings. As a minimum this shall include: a. Disassemble ducts, removing coils and separating all individual duct pieces b. Remove and dispose of all gaskets c. Remove and discard all fasteners d. Strip paint and insulation from all ducting e. Sandblast interior and exterior of ducting. f. Repair welds and structure g. Straighten all flanges h. Repaint and insulate ducting according to the drawings and this specification		X
19. Refurbish or rebuild the components as specified on the contract drawings		X
20. Furnish all new, upgraded, or replacement components specified on contract drawings		X
21. Refurbish all coils specified to be reused, disposition of each coil is given on contract drawings and in this specification		X
22. Refurbish all ducting screens and spacers in accordance with contract drawings and this specification		X
Mechanical Work		
1. Furnish gaskets and fasteners in accordance with the contract drawings		X
2. Furnish and install ducting and coils in accordance with contract drawings		X
3. Furnish and install ducting spacer according to final dimensions of ducting, and in accordance with the contract drawings		X
4. Install filter housings and connections in accordance with contract drawings and this specification		X
5. Install all reheat system coils and transition ducting pieces in accordance with contract drawings and this specification		X
6. Install all outlet ducting pieces, valves, actuator, and components in accordance with contract drawings and this specification		X
7. Install dump valve, actuator and silencer in accordance with contract drawings this specification		X
8. Install all inlet ducting in accordance with contract drawings and this specification		X

SECTION 01010

SUMMARY OF WORK

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REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

Work Description	Government	Contractor
9. Install refurbished blower, inlet damper, and actuator in accordance with contract drawings		X
10. Furnish and install all pumps in accordance with the contract drawings and in accordance with this specification		X
11. Furnish and install water heaters and supports in accordance with contract drawings and this specification		X
12. Furnish and install the reheat water system in accordance with the contract drawings and this specification. a. Install all control valves and actuators. b. Install valve support structure c. Fit Tubing d. Install all valves, strainers, ancillary components, and instrumentation indicated on contract drawings and required for a complete system		X
13. Furnish and install the heat absorption and rejection system in accordance with the contract drawings and this specification. a. Install heat rejection coil b. Install heat rejection coil motors and fans c. Install control valve and actuator d. Install all valves, strainers, expansion tanks, ancillary components, and instrumentation indicated on contract drawings and required for a complete system.		X
14. Furnish and install the wrap-around system according to the contract drawings and in accordance with this specification. a. Install all control valves and actuators. b. Install valve support structure. c. Fit Tubing d. Install all valves, strainers, expansion tanks, ancillary components, and instrumentation indicated on contract drawings and required for a complete system.		X

SECTION 01010

SUMMARY OF WORK

SIZE A	CAGE CODE	DWG NO 584FCM01001	REV -
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REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

Work Description	Government	Contractor
15. Furnish and install the replacement refrigeration system in accordance with contract drawings and this specification. a. Furnish and install condenser units b. Furnish and install compressors c. Furnish and install all valves, strainers, ancillary components, and instrumentation indicated on contract drawings and required for a complete system d. Furnish and install tubing e. Furnish and install compressor suction manifold tubing f. Furnish and install compressor discharge manifold tubing g. Furnish and install control enclosures h. Furnish refrigerant and charge refrigeration system		X
16. Furnish and install new filters according to drawing package and in accordance with this specification. i. Inlet Filters j. Carbon Filters k. Pre-filter l. HEPA Filter		X
17. Clean and leak test ducting in accordance with this specification		X
18. Leak test and flush the reheat system in accordance with this specification		X
19. Leak test and flush the wrap around circuit system in accordance with this specification		X
20. Leak test and flush the heat absorption and rejection system in accordance with this specification		X
21. Furnish and install insulation on piping and ducting as described on contract drawings and in accordance with this specification		X
22. Label all equipment and tubing in accordance with contract drawings and this specification		X
23. Furnish and fill heat rejection system with glycol water mixture in accordance with contract drawings and this specification		X
24. Furnish and fill wrap around circuit and reheat system with water and glycol mixture as specified on contract drawings and this specification		X
25. Install all louvers and panels		X
26. Install running gear		X
27. Install rear axles		X
28. Furnish and install operator cover according to reference drawing and this specification.		X

SECTION 01010

SUMMARY OF WORK

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REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

Work Description	Government	Contractor
29. Furnish and install all warnings, labels, and markings as indicated on contract drawings and according to this specification		X
Electrical Work		
1. Furnish and install enclosures onto MPPU structure		X
2. Furnish and install all circuit breakers, junction boxes, and enclosure electrical components as specified on contract drawings and specifications.		X
3. Furnish and install all conduits and according to contract drawings and specification		X
4. Furnish and install all power wiring in accordance with contract drawings and this specification		X
5. Furnish and install water heater power wiring according to contract drawings, manufacturer's instructions, and this specification.		X
6. Furnish and install refrigeration wiring, terminations, fuses, conduit, power wiring, in accordance with engineering approved drawings supplied by the contractor, and in accordance with supplied contract drawings.		X
7. Label all conduits in accordance with this specification		X
8. Furnish MPPU main power cords and connectors as indicated on contract drawings and in accordance with this specification.		X
Instrumentation and Controls Work		
1. Furnish, Refurbish/Replace, and install all control equipment and actuators indicated by contract drawings and in accordance this specification.		X
2. Furnish, Refurbish/Replace, and install all sensors as specified on contract drawings		X
3. Furnish, replace, and install all transducers as specified on contract drawings		X
4. Furnish, replace, and install all controls wiring in accordance with contract drawings and this specification		X
5. Furnish and install Refrigeration Control System, interface boards, terminal blocks, wiring and all components required for a complete refrigeration control system. All components are to be in accordance with approved, contractor supplied contract drawings and this specification.		X
6. Furnish and install MPPU main PLC, associated connections and wiring in accordance with contract drawings.		X

SECTION 01010

SUMMARY OF WORK

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REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

Work Description		Government	Contractor
7.	Furnish and install pneumatic and instrumentation lines in accordance with contract drawings.		X
8.	Label all control wiring in accordance with section 16195 of this specification.		X
Software			
1.	Provide completed MPPU Control Software in accordance with document 584CWR01001 "Contractor Provided Refurbishment Verification Software"		X
2.	Provide a detailed Software Design Document (SDD) incorporating all of the KSC requirements, and specifications contained within document 584CWR01001 "Contractor Provided Refurbishment Verification Software"		X
3.	Provide a Version Description Document for all Contractor provided software.		X
4.	Provide a Software Development Plan for all Contractor provided software.		X
5.	Provide O&M Document Checklist for all Contractor provided software.		X
6.	Provide O&M Documentation for the MPPU system equipment, subsystems, and software.		X
7.	Provide a Sneak Circuit analysis for all Contractor provided software.		X
8.	Furnish a complete Refrigeration Control System in accordance with section 11820 of this specification.		X
Preparation and shipment to KSC:			
1.	Prepare a lifting and transport plan.		X
2.	Provide lifting sling for the MPPU.	X	
3.	Ship the lifting sling to contractor facility.		X
4.	Provide a crane for lifting the MPPU.		X
5.	Provide rigging for lifting the MPPU.		X
6.	Load MPPU's and ship to KSC.		X
7.	Ship back the lifting sling back to Kennedy Space Center, FL.		X
8.	Provide crane for lifting MPPU.		X
9.	Provide rigging equipment for lifting MPPU.		X
10.	Offload MPPU's at KSC.		X
Miscellaneous:			

SECTION 01010

SUMMARY OF WORK

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REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

Work Description		Government	Contractor
1.	Furnish all supporting materials and components not specifically mentioned but required for a completely safe and functional system.		X
2.	All items not specifically mentioned to be replaced, refurbished, new, or no longer used shall be cleaned, repaired and reused		X
3.	Contractor shall be responsible for assessing the condition of all components to be reused as indicated in the contract drawings for the refurbishment of the MPPU's on an individual component basis. Items deemed not acceptable for re-use in refurbishment activities, the contractor shall provide recommendation for replacement to the contracting officer or designated representative, do not replace any component without approval from the contracting officer or designated representative). Items damaged beyond refurbishment shall be shown and documented in their as-installed condition. Items, that are to be replace, reused, which are damaged during removal or refurbishment activities shall be at the responsibility of the contractor for replacement		X
4.	Furnish and install new filter elements and clean all strainers after commissioning is completed.		X
5.	Provide all documentation as required in Section 1300		X
6.	Provide all pressure test reports as indicated in section 11820 of this specification. As a minimum pressure checks must be completed for the following systems. a. Heat absorption and rejection system b. Wrap around system c. Re-heat water system d. Refrigeration control system		X
7.	Provide all required safety services equipment, etc., to comply with all Governmental Regulations and Site Rules.		X
8.	After project completion, provide a complete set of record drawings (red-lines) documenting the as built condition of the MPPU.		X
Startup and commissioning services			
1.	Provide temporary power at Contractor's facility for start-up testing		X
2.	Submit factory acceptance plan in accordance with this specification		X
3.	Demonstrate successful operation of each MPPU unit at Contractor's facility.		X

SECTION 01010

SUMMARY OF WORK

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Work Description		Government	Contractor
4.	Review and approve factory acceptance test (FAT) plan and witness FAT.	X	
5.	Provide on-site support at NASA's KSC facility for Final Acceptance Testing. Assist Government in troubleshooting during Final Acceptance Testing.		X
6.	Provide power at KSC facility for Final Acceptance Testing.	X	
7.	Submit on-site at NASA's KSC facility acceptance plan in accordance with this specification		X
8.	Demonstrate successful operation of each MPPU unit at KSC.		X
9.	Make necessary repairs or adjustments to MPPUs as required during Final Acceptance Testing.		X
10.	Review and approve on-site at NASA's KSC facility acceptance plan and witness on-site test.	X	
11.	Provide final documentation of FAT, on-site final acceptance test and test reports		X
Training			
1.	Provide training that includes software, controls, operation and maintenance for all NASA operating personnel.		X
2.	Provide Operations and maintenance manual		X

F. Although each and every item that may be required is not mentioned in the drawings and Specifications, it is expected that such items will be included if required to provide a complete and fail-safe system consistent with codes and acceptable practices.

1.5 ELECTRICAL INTERFACES

- A. The electrical interfaces for the MPPU are eight flexible cables with connectors that supply 480VAC power to the unit. Also, smaller cable is used to supply auxiliary 120VAC power to the control system for maintenance activities when the MPPU is not in operation.
- B. The electrical power sources for KSC operations will be provided by the Government.
- C. Temporary electrical power for shop testing will be provided by the Contractor.

1.6 GENERAL REQUIREMENTS

- A. The Contractor must conform to the requirements of the Buy American Act when choosing suppliers for components purchased for use in the MPPU Refurbishment. The goods and services purchased by the Contractor for this project shall come from domestic sources whenever possible.
- B. The Government will provide power and facilities at KSC for commissioning testing.

SECTION 01010

SUMMARY OF WORK

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- C. The Contractor will be responsible for his own telephone service while on site. Cellular phones are highly recommended to avoid use of the Owner’s phone system.
- D. The Contractor shall not used scale down drawings.
- E. The Contractor shall supply all facilities and weather protection required for his operations.
- F. Provide work activity summary on a weekly basis.

1.6 SCHEDULE OF WORK

- A. The Contractor agrees to begin work immediately upon award of Contract, and shall plan the Work according to the Activity Schedule Below:

Activity	Days After Notice to Proceed (Calendar days)
Contractor Submittal of Detailed Design, Fabrication, and Submittal Schedule to Government	14
Contractor Submittal of Proposed equipment and initial shop drawings	75
Design review	90
Factory acceptance test of MPPUs complete	300
Delivery of MPPUs to KSC	315
Final Acceptance Testing Complete	345
Final Record “As Built” Drawings and manuals completed and Delivered to Government	365

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION 01010

SECTION 01010

SUMMARY OF WORK

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REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

SECTION 01035 - MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Terms and Conditions, and other Specification Sections apply to this Section.

1.2 SUMMARY

- A. This section specifies administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Section 01300 - "Submittals" for requirements for the Subcontractor's Construction Schedule.

1.3 MINOR CHANGES IN THE WORK

- A. Minor changes in the work not involving changes in the contract price will be requested by the Contractor in writing and permission given by the Government in writing. The Contractor shall submit all requests for changes using the NASA form KSC 8-268 Contractor Request for Information/Clarification (RFI).

1.4 CHANGE ORDER PROPOSAL REQUESTS

- A. Proposal Requests: Proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time will be issued by the Contractor with a detailed description of the proposed change and supplemental or revised Drawings and firm fixed price delta for the change in Work. The Contractor shall submit all proposal requests using the NASA form KSC 8-268 RFI. The Government will determine if a Change Order is required. If a change order is required, it will be issued by the Government. The Contractor is not authorized to proceed with the proposed changes until written notification is received from the Government.

1.5 CHANGES

SECTION 01035

VERIFICATION PROCEDURES

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REVISION HISTORY					
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- A. Direct Changes: The Government may - in writing - direct changes within the general scope of the Contract in any one or more of the following areas:
- (i) Technical requirements and descriptions, specifications, statements of work, drawings or designs,
 - (ii) Shipment or packing methods,
 - (iii) Place of delivery, inspection or acceptance,
 - (iv) Reasonable adjustments in quantities or delivery schedules or both; and
 - (v) Amount of any furnished property.

Contractor shall comply immediately with such direction and avoid unnecessary costs related thereto.

- B. Price and Schedule Adjustments: If any change under this specification causes an increase or decrease in the cost of or the time required for performance of the Contract Agreement, an equitable adjustment in the prices and schedules of the Contract Agreement shall be made to reflect such increase or decrease and the Contract Agreement shall be modified in writing accordingly. Unless otherwise agreed in writing, any claims by Contractor for adjustment must be delivered to the Government in writing within seven (7) calendar days, or sooner if available, after receipt of such direction. Contractor shall make available for the Government's examination relevant books and records to verify claim for adjustment. Failure of Government and Contractor to agree upon any adjustment shall not excuse Contractor from performing in accordance with such direction.
- C. Amendments: This agreement may not be changed, amended, or modified, except by an instrument in writing, executed by the Government's authorized representative and by Contractor's authorized representative.
- D. Other Changes: No change to or deviation from the terms of this Agreement will be effective or binding upon Government unless authorized in writing by Government's authorized representative. If Contractor determines that the conduct of any of Government's employees constitutes a change or deviation from the Specification Section 01010 - "Summary of Work", Contractor shall notify Government immediately in writing as to the nature of such conduct and its effect upon Contractor's performance. Pending direction from Government's representative, Contractor shall take no action to implement any such change or deviation.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

SECTION 01035

VERIFICATION PROCEDURES

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END OF SECTION 01035

SECTION 01035

VERIFICATION PROCEDURES

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REVISION HISTORY					
PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

SECTION 01095 - REFERENCE STANDARDS AND DEFINITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Terms and Conditions, and other Specification Sections apply to this Section.

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. The term indicated refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as shown, noted, scheduled, and specified are used, it is to help the reader locate the reference; no limitation on location is intended.
- C. Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Government.
- D. The term approved, where used in conjunction with the Government's action on the Contractor's submittals, applications, and requests, is limited to the Contractor's duties and responsibilities as stated in the Conditions of the Contract.
- E. The term Regulations includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. The term Contractor means the organization and/or person(s) awarded this Agreement. A Subcontractor is hired directly by and works directly for Contractor, whether it be a supplier, manufacturer, or a subcontractor, etc.
- G. The Project is the total scope of work, as defined by the contract documents.
- H. P.O. -- Purchase Order.
- I. The term Work includes all labor necessary to accomplish the refurbishment work required by the Contract Documents, all materials and equipment incorporated or to be incorporated in such work and all costs, installed in place, complete and tested, for this Work Package. A detailed Scope of Work is included herein as Specification Section 01010 for this Contract Agreement.

SECTION 01095

REFERENCE STANDARDS AND DEFINITIONS

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- J. The Contract Documents consists of the Contract Agreement General Conditions, the Construction Drawings, Technical Specifications, and other documents listed in the Specifications, and change orders properly executed as specified in Section 01035 - "Modification Procedures."
- K. An Application for Payment is Contractor's monetary request presented to the Government.
- L. A Change is defined as an occurrence that alters the responsibilities of the parties signatory to this Contract. A change can dictate an increase or decrease to the contract price, as well as result in no change to the contract price. A change could also affect the schedule for the work. All changes shall be incorporated into the Contract via a fully executed change order.
- M. A Change Order is a binding contract document issued in writing after a change item is identified and approved.
- N. The word Day shall mean calendar day unless otherwise stated.
- O. The term furnish is used to mean "supply and deliver".
- P. The term install is used to describe operations at Contractor's site including the actual "unloading, unpacking, assembly, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
- Q. The term provide means "to furnish and install, complete and ready for the intended use."
- R. The term punch list means a list of items to be furnished and items of work to be corrected and/or completed by the Contractor prior to Final Acceptance in order to complete The Work as specified in the Contract Documents.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with the standard in effect as of the date of the Contract Documents.
- C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards may establish different or conflicting requirements for minimum

SECTION 01095

REFERENCE STANDARDS AND DEFINITIONS

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quantities or quality levels, refer requirements that are different, but apparently equal, and uncertainties to the Government for a decision before proceeding.

- D. Copies of Standards: Each entity engaged in fabrication on the Project is required to be familiar with industry standards applicable to that entity's activity. Copies of applicable industry standards are not will not be provided with the Contract Documents.
- E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

1.4 ADMINISTRATIVE DOCUMENTS

- A. Permits, Licenses, and Certificates: For the Government's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of The Work.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01095

SECTION 01095

REFERENCE STANDARDS AND DEFINITIONS

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SECTION 01200 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Terms and Conditions, and other Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to, the following:

1. Preconstruction conferences.
2. Coordination meetings.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 01300 - "Submittals" for submitting the Contractor's Construction Schedule.

1.3 KICKOFF MEETING

A. A Project Kickoff Meeting shall be held within 2 weeks after award of contract, between the Government and the Contractor for the purpose discussing project organization, schedule, logistics and delivery. The kickoff meeting shall be held at **NASA Kennedy Space Center**.

1.4 COORDINATION MEETINGS

A. The Contractor will conduct biweekly project coordination meetings or teleconferences at regular intervals convenient for all parties involved. Project coordination meetings are in addition to specific meetings held for other purposes.

B. The Contractor shall be represented at each meeting or teleconference. The Contractor's representative shall be authorized to make binding commitments and decisions for the Contractor. The purpose of the meeting is to plan and coordinate construction activities and discuss other issues important to the success of the current phase.

SECTION 01200

PROJECT MEETINGS

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- C. The Contractor will record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01200

SECTION 01200

PROJECT MEETINGS

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SECTION 01300 - SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract General Conditions, and other Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals required for performance of the Work, including:
 - 1. Contractor's design/fabrication/delivery schedule
 - 2. Submittal Schedule
 - 3. Submittal Log
 - 4. Shop Drawings
 - 5. Product Data
 - 6. Samples

- B. Administrative Documents: Refer to other Sections and other Contract Documents or requirements for administrative documents. Such documents may include, but are not limited to:
 - 1. Applications for payment.
 - 2. Performance and payment bonds.
 - 3. Insurance certificates.
 - 4. List of Contractors.
 - 5. Lien Waivers.

1.3 SUBMITTAL PROCEDURES

- A. Coordination: Transmit each submittal by way of courier service sufficiently in advance of performance of related fabrication activities to avoid delay.
 - 1. The Government reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
 - 2. Processing: Allow sufficient review time so that delivery will not be delayed as a result of the time required to process submittals, including time for re-submittals.
 - a. Allow two weeks for initial review. The Government will promptly advise the Contractor when a submittal being processed must be delayed.

**SECTION 01300
SUBMITTALS**

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- b. If an intermediate submittal is necessary, process the same as the initial submittal.
 - c. No extension of Contract Time will be authorized because of failure to transmit submittals to the Government sufficiently in advance of The Work to permit processing.
- B. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
- 1. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of Government.
 - d. Name and address of Contractor.
 - e. Name and address of Supplier.
 - f. Name of manufacturer.
 - g. Number and title of appropriate Specification Section.
 - h. Drawing number and detail references, as appropriate.
- C. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal to Government using Contractor's standard transmittal form. Submittals received from sources other than the Contractor will be returned without action.
- 1. Include Contractor's certification that the Contractor has reviewed and approved the documents and that the information complies with Contract Document requirements.
 - 2. Transmit submittals to the following address:

NASA
Mailcode OP-ES-A
Kennedy Space Center, FL 32899
 - 3. Re-submittals: If the submittal package has resubmitted material, the original submittal number shall be used with a suffix indicating the revision number. Each re-submittal will sequentially change the suffix number to note the revision sequence.

1.4 CONTRACTOR'S DESIGN/FABRICATION/DELIVERY SCHEDULE

- A. Bar Chart Schedule: Submit Contractor's design/fabrication/delivery schedule in accordance with the schedule contained in the Summary of Work section.

SECTION 01300
SUBMITTALS

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1. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other fabrication/delivery activities through the Government; include minor elements involved in the sequence of The Work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of The Work.
2. Coordinate the Contractor's design/fabrication/delivery schedule with the Government including the schedule of values, list of Contracts, submittal log, progress reports, payment requests and any other schedules.

1.5 SUBMITTAL SCHEDULE

- A. The Contractor will prepare a complete schedule of submittals and submit this schedule along with an updated design/fabrication/delivery schedule. This schedule shall be updated on a monthly basis during the design, fabrication and delivery period.
- B. The Contractor shall coordinate the submittal schedule with the Government's project schedule, list of Contractors, schedule of values and the list of products as well as the Contractor's design/fabrication schedule.
- C. The submittal schedule shall be prepared in chronological order and provide the following information:
 1. Related Specification Section number.
 2. Description of the part of the Work covered.
 3. Submittal category (e.g. Shop Drawing, Product Data, O&M Manual or Data, etc.).
 4. Name of Contractor or Supplier.
 5. Scheduled date (or estimate) for submitting.
 6. Scheduled date for the Government's final release or approval.
- D. The submittal schedule shall be updated and forwarded to the Government when significant revisions have been recognized or made.
- E. Contractor shall submit all shop drawings, samples, and other submittals which are required by the Contract Documents or are necessary to the performance of Contractor's obligations hereunder. Such submittals shall bear the Contractor's approval stamp and shall be submitted to the Government in accordance with the Contractor submittal schedule and in any case in time to permit adequate review by the Government and in sequence as to cause no delay in the Project or in the work of Government or Contractor.
- F. By approving and forwarding submittals, Contractor represents that it has determined and verified all materials, field measurements, and field fabrication criteria related thereto, and that it has checked and coordinated the information contained within such submittals with the requirements of The Work and of the Contract Documents.

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- G. Contractor shall not be relieved of responsibility for any deviation from the requirements of the Contract Documents or for errors or omissions in the submittals by Government's approval thereof.
- H. Contractor shall direct specific attention, in writing or on resubmitted submittals, to revisions other than those requested by the Government on previous submittals.
- I. No portion of The Work shall be commenced until the submittals required by the Contract Documents have been reviewed and approved by the Government for conformance with the design concept of The Work and information given in The Documents unless permission to commence certain portions of the Contract work is given in writing by an authorized representative of Government.

1.6 SHOP DRAWINGS AND CALCULATIONS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Standard information prepared without specific reference to the Project is not considered a Shop Drawing. Failure to provide adequate data may result in a requirement to resubmit shop drawings.
- B. Shop Drawings include fabrication drawings, schedules, patterns, templates and similar drawings. Include the following information:
 - 1. Dimensions
 - 2. Identification of products and materials included
 - 3. Compliance with specified standards
 - 4. Notation of coordination requirements
 - 5. Notation of dimensions established by field measurement
 - 6. Initial Submittal: Submit two (2) black line prints and one (1) electronic (pdf) for the Government's review; one will be returned. The returned prints shall be marked-up and maintained as a "Record Document".
 - 7. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with fabrication. Refer to "Action Stamp" in Paragraph 1.8 B, of this Specification.
- C. Except for templates and patterns, submit Drawings on F size sheets.
- D. Shop Drawings are not required for proprietary components. Drawings of detailed interface with the systems will be required.
- E. Following the fabrication of the new refrigeration tubing for the MPPU condenser supply, the contractor shall provide an analysis of the new tubing in the as-built configuration. Analysis shall include determination of the tubing stresses due to combined internal pressure and thermal expansion loading as specified in ASME B31.5, section 502.3.3. All

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applicable load scenarios listed in section 501 shall be reviewed and included in the analysis or given ample rationale as to the exclusion of certain load cases. Specific consideration shall be given to the analysis of the constrained thermal displacement stress and the associated risk of buckling in the system. Additional consideration shall be given to analyzing the cyclic loading from the vibration of the compressor units if no means for vibration isolation has been fabricated.

1.7 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of fabrication or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as "Shop Drawings."
 - 1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, mark copies to indicate which are not required. Include the following information:
 - b. Manufacturer's printed recommendations
 - c. Compliance with recognized trade association standards
 - d. Compliance with recognized testing agency standards
 - e. Application of testing agency labels and seals
 - f. Notation of dimensions verified by field measurement
 - g. Notation of coordination requirements
 - h. Sequentially numbered for individual identification
 - 2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
 - 3. Submittals: Submit two (2) hard copies and one electronic (pdf text searchable) of each required submittal.
 - 4. Distribution: Do not proceed with installation until an approved copy of Product Data is in the installer's possession. Do not permit use of unmarked copies of Product Data in connection with fabrication.
 - 5. If available, electronic copies of product data are requested for the final "Maintenance and Operations Manual" submittal.

1.8 GOVERNMENT'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Government will review each submittal, mark to indicate action taken, and return fourteen days (14).

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1. Compliance with specified characteristics is the Contractor's responsibility.
- B. Action Stamp: The Government will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
1. **Approved:** Where submittals are marked "Approved," that part of The Work covered by the submittal may proceed - provided it complies with requirements of the Contract Documents; Final Acceptance will depend upon that compliance.
 2. **Approved as Noted:** When submittals are marked "Approved as Noted," that part of the Work covered by the submittal may proceed - provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; Final Acceptance will depend on that compliance.
 3. **Not Approved:** Submittal is not acceptable and must be resubmitted. Immediately upon receipt, the vendor shall contact the Government to discuss the deficiencies and determine the schedule for re-submittal.
 4. **Work May Proceed:** Where submittals are marked "Work May Proceed," that part of The Work covered by the submittal may proceed provided it complies with requirements of the Purchase Order Documents; Final Acceptance will depend upon that compliance.
 5. **Revise and Resubmit:** When submittal is marked "Not Approved," or "Revise and Resubmit," do not proceed with that part of The Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark. Immediately upon receipt, the vendor shall contact the Government to discuss the deficiencies and determine the schedule for re-submittal.
 - a. Do not permit submittals marked "Not Approved," or "Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.
 6. **Submit Final Certified:** Provide all documents required for Final Certification.
 7. **Review Not Required by Contract Documents:** Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned.

PART 2 - PRODUCTS (Not Applicable)

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PART 3 - EXECUTION - (Not Applicable)

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SECTION 01700 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Terms and Conditions, and other Specification Sections apply to this Section.
- B. Section 1720 "Project Record Documents"

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for project closeout, including but not limited to:
 - 1. Inspection procedures.
 - 2. Project record document submittal.
 - 3. Operating and maintenance manual submittal.
 - 4. Submittal of warranties.

1.3 ACCEPTANCE INSPECTION

- A. An individual acceptance inspection is required for each of the four MPPUs.
- B. Before requesting inspection for certification of Acceptance, complete the list of exceptions and include the list as a "Punch List" in the request.
- C. The Contractor shall assist the Government in inspection of the project, or a designated portion thereof, for verification of Acceptance. The punch list will be modified to the satisfaction of both the Government and Contractor, based on inspection results.
- D. The Contractor and Government shall agree on the punch list items which must be completed to constitute Acceptance. The Government will issue an deficiency list, documenting the punch list and items which must be completed for Acceptance, to the Contractor for concurrence.
- E. If necessary, inspection will be repeated.

1.4 ACCEPTANCE AND COMMENCEMENT OF WARRANTIES

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- A. The date of Acceptance of an individual MPPU is the date when fabrication is complete in accordance with the drawings and specifications and acceptance testing has been successfully completed that units. The date of Acceptance for the project is the date when acceptance testing has been successfully completed for all units.
- B. The date of Acceptance shall be established by a Certificate of Acceptance signed by the Government.
- C. The Government shall have the right to use individual MPPUs after their date of acceptance even before the date of Acceptance of the Project.
- D. Warranties or guarantees called for by this Contract, or by the drawings and specifications shall commence for the period specified from the date of Final Acceptance of the Project.
- E. Maintenance Manuals: Provide two (2) hard copies and one (1) electronic (pdf text searchable) of the operation and maintenance manuals. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:
 - 1. Emergency instructions
 - 2. Spare parts list
 - 3. Copies of warranties
 - 3. Wiring diagrams
 - 4. Inspection procedures
 - 5. Shop Drawings and Product Data
 - 6. Fixture lamping schedule
 - 7. Operating instructions

1.5 FINAL ACCEPTANCE

- A. Submit the final payment request with releases and supporting documentation not previously submitted and accepted.
- B. Submit supporting documentation with Government sign-off that all punch list items have been accomplished.
- C. Submit an updated final statement, accounting for final additional changes to the Contract Sum.

1.6 RECORD DOCUMENT SUBMITTALS

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- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Government's reference during normal working hours.
- B. Record Drawings: Maintain a clean, undamaged set of black line white prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
- C. Mark new information that is important to the Government, but was not shown on Contract Drawings or Shop Drawings.
- D. Note related Change Order numbers where applicable.
- E. Record Specifications: Maintain one complete copy of the Project Manual, including addenda, and one copy of other written construction documents such as Change Orders and modifications issued in printed form during construction. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation. Note related record drawing information and Product Data.
- F. Upon Acceptance of The Work, submit record Specifications to the Government for the Owner's records.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 CLOSEOUT PROCEDURES

- A. Operating and Maintenance Instructions: Meet with the Government's personnel to provide instruction in proper operation and maintenance. If Contractor is not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
 - 1. Maintenance manuals.
 - 2. Record documents.

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- 3. Spare parts and materials.
- 4. Tools.
- 5. Lubricants.
- 7. Control sequences.
- 8. Hazards.
- 9. Cleaning.
- 10. Warranties and bonds.
- 11. Maintenance agreements and similar continuing commitments.

END OF SECTION 01700

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SECTION 01720 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Terms and Conditions, and other Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for Project Record Documents.

B. Project Record Documents required include:

1. Marked-up copies of Contract Drawings.
2. Marked-up copies of Shop Drawings.
3. Newly prepared Drawings.
4. Marked-up copies of Specifications, addenda and Change Orders.
5. Marked-up Product Data submittals.
6. Record Samples.
7. Record information on Work that is recorded only schematically.

C. Specific record copy requirements that expand requirements of this Section are included in the applicable individual Sections of Divisions-2 through -16.

D. All plans, diagrams, drawings, specifications, and the like furnished to Contractor pursuant to this Contract contain Sensitive But Unclassified (SBU) information which is the property of the Government. Contractor shall take all precautions to protect the confidentiality thereof and shall not disclose the contents thereof without the prior written consent of the Government.

E. Record Drawings: Contractor shall maintain one reproducible record copy of the drawings, specification, product data, samples, shop drawings, Change Orders and other modifications in good order. They shall be marked currently to record changes made during construction. They shall be delivered to and become the property of the Government upon completion or termination of the Contract Work.

F. Reports and Communication: Contractor shall furnish the Government with periodic progress reports on The Work as requested, including information on the status of materials and equipment which may be in the course of preparation, manufacture or delivery.

G. General project closeout requirements are included in Section 1700 - "Project Closeout."

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PROJECT RECORD DOCUMENTS

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H. General requirements for submittal of Project Record Documents are included in Section 01300 - "Submittals."

1.3 RECORD DRAWINGS

- A. Mark-up Procedure: During the construction period, maintain a set of black-line white-prints of Contract Drawings and Shop Drawings for Project Record Document purposes.
- B. Mark these Drawings to indicate the actual installation where the installation varies appreciably from the installation shown originally. Give particular attention to information on concealed elements which would be difficult to identify or measure and record later. Items required to be marked include but are not limited to:
 - 1. Dimensional changes to the Drawings.
 - 2. Revisions to details shown on the Drawings.
 - 3. Revisions to routing of piping and conduits.
 - 4. Revisions to electrical circuitry.
 - 5. Actual equipment locations.
 - 6. Duct size and routing.
 - 7. Changes made by Change Order.
 - 8. Details not on original Contract Drawings.
- C. Where Shop Drawings are marked, show cross references on Contract Drawings.
- D. Mark record sets with red colored pencil or ink.
- E. Mark important additional information which was either shown schematically or omitted from original Drawings.
- F. Note construction change directive numbers, alternate numbers, Change Order numbers and similar identification.
- G. Identify and date each Drawing; include the printed designation "PROJECT RECORD DRAWINGS" in a prominent location on each Drawing.
- H. Refer instances of uncertainty to the Government for resolution.
- I. Copies and Distribution: After completing the preparation of record drawings, print 6 black-line prints of each Drawing, whether or not changes and/or additional information were recorded. Organize the copies into manageable sets. Bind each set with durable paper cover sheets, with appropriate identification, including titles, dates and other information on cover sheets.

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- J. Organize and bind original marked-up set of prints that were maintained during the construction period in the same manner.
- K. Submit the marked up record set and 6 copy sets to the Government.

1.4 RECORD SPECIFICATIONS

- A. During the construction period, maintain one copy of the Project Specifications, including addenda and modifications issued, for Project Record Document purposes.
- B. Mark the Specifications to indicate the actual installation where the installation varies substantially from that indicated in Specifications and modifications issued. Note related Project Record Drawing information, where applicable.
- C. Record the name of the manufacturer, supplier and installer, and other information necessary to provide a record of selections made and to document coordination with record Product Data submittals and maintenance manuals.
- D. Upon completion of mark-up, submit record Specifications to the Government for records.

1.5 RECORD PRODUCT DATA

- A. During the construction period, maintain one copy of each Product Data submittal for Project Record Document purposes.
- B. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
- C. Note related Change Orders and mark-up of record Drawings, where applicable.

1.6 MISCELLANEOUS RECORD SUBMITTALS

- A. Refer to other Specification Sections for miscellaneous record- keeping requirements and submittals in connection with various construction activities.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.1 RECORDING

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- A. Post changes and modifications to the Documents as they occur. Do not wait until the end of the Project. The Government will periodically review record documents to assure compliance with this requirement.

END OF SECTION 01720

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SECTION 01730 - OPERATING AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Terms and Conditions, and other Specification Sections apply to this Section.
- B. Project Record Documents are included in Section 01720 - "Project Record Documents."

1.2 SUMMARY

This Section specifies administrative and procedural requirements for operating and maintenance manuals including the following:

- A. Preparation and submittal of operating and maintenance data for systems and equipment.
- B. Instruction for the Government's operating personnel in operation and maintenance of systems and equipment.
- C. Special operating and maintenance data requirements for specific pieces of equipment or operating systems are included in the appropriate Sections of Divisions-11 through -16.
- D. Preparation of Shop Drawings and Product Data are included in Section 01300, "Submittals."
- E. General closeout requirements are included in Section 01700 - "Project Closeout."

1.3 OPERATION & MAINTENANCE MANUALS

- A. Operator Manual. Data for the operator manual will describe the system operation procedures in sufficient detail to assist first-time operators in becoming proficient in the minimum amount of time yet provide a usable reference to experienced operators. The data will include an introduction, system functional description, operating procedures, and warning indications. The operator's data will address automatic and data operation of systems.

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OPERATING AND MAINTENANCE DATA

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- B. Maintenance and Diagnostics Manual. Data for the maintenance and diagnostic manuals will be provided which will lead the technician through the periodic maintenance procedures as well as provide a troubleshooting guide.
- C. The data will be organized by major subsystem promoting ease of access to information. All manufacturers' service manuals supplied with the equipment will be included. Preventive maintenance schedules will be presented.
- D. Provide original Project Record Documents as part of the Operating and Maintenance data.
- E. Warranties, Bonds and Service Contracts: Provide a copy of each warranty, bond or service contract for the appropriate manual for the information of the Government's operating personnel. Provide written data outlining procedures to be followed in the event of product failure. List circumstances and conditions that would affect validity of the warranty or bond.
- F. Servicing Schedule: Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.
- G. Circuit Directories: For electric and electronic systems, provide complete circuit directories of panel boards.
- H. If drawings are too large to be used practically as a fold- out, place the drawing, neatly folded, in the front or rear pocket of the binder. Insert a typewritten page indicating the drawing title, description of contents and drawing location at the appropriate location in the manual.
- I. Submit two (2) hard copies and one (1) electronic of final Operation and Maintenance manuals.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION 01730

SECTION 01730

OPERATING AND MAINTENANCE DATA

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SECTION 01740 – WARRANTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Terms and Conditions, and other Specification Sections apply to this Section.

1.2 SUMMARY

- A. This Section specifies general administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers’ standard warranties on products and special warranties.
- B. General closeout requirements are included in Section 01700 - "Project Closeout."
- C. Specific requirements for warranties for the Work and products and installations that are specified to be warranted are included in the individual Sections of Divisions-15 through -16.
- D. Certifications and other commitments and agreements for continuing services to Government are specified elsewhere in the Contract Documents.
- F. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and Subcontractors required to countersign special warranties with the Contractor.

1.3 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Contractor warrants to Government that all materials and equipment furnished under this Contract will be new, unless otherwise specified, and that all construction work will be of good quality, free from improper workmanship and defective materials, and fit for the purpose intended.
- C. Contractor agrees to correct all The Work performed and material supplied by it under this Contract which proves to be defective in material or workmanship within a period

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WARRANTIES**

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of one (1) year from the date of Final Acceptance of the project. Any warranty or guarantee obtained by Contractor from any manufacturer shall be deemed to have been obtained for the benefit of the Government. This warranty shall be in addition to all other warranties and remedies, expressed or implied, under the law.

- D. Contractor shall collect all equipment manuals and deliver them to the Government upon completion, together with all written warranties or guarantees from equipment manufacturers.
- E. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Government has benefited from use of the Work through a portion of its anticipated useful service life.
- F. Government's Recourse: Written warranties made to the Government are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Government can enforce such other duties, obligations, rights, or remedies.
- G. Rejection of Warranties: The Government reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- H. The Government reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.5 SUBMITTALS

- A. Submit written warranties to the Government prior to the date certified for Substantial Completion. If the Government's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Final Acceptance for the Work, or a designated portion of the Work, submit written warranties upon request of the Government.
- B. When a designated portion of the Work is completed and used by the Government, by separate agreement with the Government during the construction period, submit properly executed warranties to the Government within fifteen days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the Contractor, or supplier or manufacturer, prepare a written document that contains appropriate terms and

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WARRANTIES

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identification, ready for execution by the required parties. Submit a draft to the Government for approval prior to final execution.

- D. Refer to applicable individual Sections of Divisions-11 through -16 for specific content requirements, and particular requirements for submittal of special warranties.
- E. Form of Submittal: At Final Completion compile two copies of each required warranty properly executed by the Contractor, supplier, or manufacturer.
- F. Bind warranties in heavy duty, commercial quality, and durable 3-ring vinyl covered loose leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½" x 11" paper.
- G. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
- H. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES", the Project title or name, and the name of the Government.
- I. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01740

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WARRANTIES

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SECTION 11820 – MPPU REFURBISHMENT

PART 1. GENERAL

- A. The MPPU provides purge air to the Orion Service Module/Spacecraft Adapter (SM/SA), the Orion Crew Module/Crew Cabin (CM/CC), and the CM/Soft Cover (SC) while: in the Main Payload Processing Facility; under transport between KSC facilities, and; during rollout to the launch pad. The MPPU Refrigeration System shall provide dehumidification control of the air delivered by the MPPU to the required levels within various Orion and Ares I compartments.

- B. The MPPU Refurbishment includes: removing all components and equipment from the existing units; structural modifications to the structure; refinishing the structure; refurbishment of the blower; replacement of the intake filters; refurbishment and modification of the heat rejection system; refurbishment of the wrap around coil system; replacement of the refrigeration system; replacement of the charcoal and HEPA filters, and; refurbishment and upgrade of the reheat system. The work also includes the equipment, valves, piping, electrical power distribution, controls, software, instrumentation, and ancillary equipment and hardware necessary to provide a complete system in accordance with the requirements of the contract drawings and specifications. The work shall include the demolition, refurbishment, upgrade, fabrication, , installation, delivery, startup, commissioning, training, and warranty service.

C. Acronyms

MPPU	Mini Portable Purge Unit
CM	Crew Module
CC	Crew Cabin
SC	Soft Cover
GSE	Ground Support Equipment
MCS	Main Control System
PLC	Programmable Logic Controller
KSC	Kennedy Space Center
OEM	Original Equipment Manufacturer
SPST	Single Pole Single Throw
SPDT	Single Pole Double Throw
ACFM	Actual Cubic Feet per Minute
MOPD	Maximum Operating Pressure Differential
MRP	Maximum Relief Pressure
EEV	Electronic Expansion Valve
ODS	Outside Diameter, Solder
RCS	Refrigeration Control System
SMS	System Mechanical Schematic
EMCD	Electromechanical Control Diagram
CPRVS	Contractor Provided Refurbishment Verification Software
HGBV	Hot Gas Bypass Valve
DB	Dry Bulb

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WB Wet Bulb

1.1 RELATED DOCUMENTS:

- D. Drawings, General Terms and Conditions and other Specification sections which apply to this section are presented in the Division 1 Specification Sections.
- E. All drawings, materials, commercial hardware, and manufacturing shall conform to the applicable sections of the latest editions of the following listed standards:
 - ANSI: American National Standard Institute
 - ARI: Air-Conditioning and Refrigeration Institute
 - ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers
 - ASME: American Society of Mechanical Engineers
 - ASTM: American Society for Testing and Materials
 - AWS: American Welding Society
 - NEMA: National Electric Manufacturer's Association
 - NETA: National Electrical Testing Association (Acceptance Testing Specification)
 - NFPA: National Fire Protection Association
 - OSHA: Occupational Safety and Health Administration, U.S. Department of Labor
 - UL: Underwriter's Laboratories, Inc.
 - NASA
 - Welding NASA-STD-5004
 - GSE equipment NASA-STD-5005
 - Brazing NASA-SPEC-Z-0005
 - Cleanliness KSC-C-123
 - Paint KSC-STD-5008 (Zone 3)
 - Marking of GSE KSC-STD-E-0015
 - Identification of piping KSC-STD-F-0004

1.2 SUMMARY

- A. The MPPU will be located at NASA KSC, Florida.

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- B. Basis of design, performance criteria, size requirements, configurations, arrangements, and miscellaneous installation information for the MPPU Refurbishment are provided via this specification and the contract drawings.
- C. The systems are designed for operating in the outdoor environment specified herein.
 - 1. Environmental Operating Conditions
 - a. Summer:
 - 1) Temperature: 95°F
 - 2) Pressure: 14.125 psia
 - 3) Specific Humidity: 0.02517 lbm/lbm-dry air
 - b. Winter:
 - 1) Temperature: 30.2°F
 - 2) Pressure: 15.04 psia
 - 3) Specific Humidity: 0.0034 lbm/lbm-dry air
 - 2. Environmental Storage Conditions
 - 1) Summer: 100°F
 - 2) Winter: 21.2°F

1.3 SUBMITTALS

- A. General: Submit each item in this Article to the Conditions of the Contract and 01300 Specification Sections.
- B. The following items shall be submitted for Government review/approval two weeks prior to the design review:
 - 1. Manufacturing quality assurance procedures
 - 2. Material tracking and scheduling procedures
 - 3. Material and equipment inspection, test, and cleaning procedures
 - 4. Factory test/verification procedures.
 - 5. Training plans and course outlines.
 - 6. A description of planned shop tests/verifications
 - 7. Grant and/or Pert charts showing the design, build, test, and delivery schedules for the Refrigeration System.
 - 8. Provide three (3) hard copies and two (2) electronic copies of documentation including manuals, procedures drawings and software design for the MCS. The documentation required for approval is listed below:
 - a. Any modifications to contract drawings
 - b. Detailed shop drawings for:
 - 1) Compressor support structure
 - 2) Refrigeration control enclosure support structure
 - 3) Condenser fan enclosure support structure

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- 4) Wire and conduit routing drawings
- 5) Main MPPU control system
- 6) Refrigeration control schematic
- 7) Refrigeration power one-line diagrams
- 8) Pipe and tube routing
- 9) Mounting supports and modifications for all enclosures
- c. Software Documentation for:
 - 1) MPPU Main Control System (MCS) PLC that includes: Commands set, PIDs, communication protocol for all interfaces, HMI displays, Health and Status and fault detection isolation and recover process as required by software requirements design document 584CWR01001.
 - 2) Refrigeration control system that includes: command set, PIDs communication protocol for all interfaces, displays, health and status, and fault detection, isolation and recover process.
- d. Preliminary installation plan
- e. Additional information pertaining to any provisions for obtaining required performance under project service conditions
- 9. Product Data including dimensions, materials, rated capacities of the selected models with performance specifications, weights, specialty equipment, accessories, and controls.
- 10. Detail wiring diagrams for power, signal, and control differentiating clearly between manufacturer-installed and field-installed wiring.

C. Within 30 days after the design review, the following installation and commissioning procedures shall be submitted for review/approval:

- 1. Contractor Work Plan
- 2. Equipment installation procedures
- 3. Equipment checkout and startup procedures
- 4. Final acceptance test procedures
- 5. O&M Manuals
- 6. Recommended spare parts list
- 7. Training Course materials

D. The following documents shall be submitted within 7 days upon completion of the MPPU commissioning for review/approval.

- 1. Commissioning completion test report
- 2. Training completion summary report
- 3. Certificate of substantial completion report
- 4. Record drawings (red line)
- 5. Operations & Maintenance (O&M) Manual including
 - a. Operational instructions and procedures
 - b. Software operations and maintenance procedures
 - c. Vendor specifications for all equipment
 - d. Vendor maintenance information for components
 - e. Maintenance procedures

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- f. Recommended maintenance intervals
- g. Recommended Spare Parts List
- 6. Device list of all instrumentation including tag number, manufacturer, model number, range, limit settings, engineering conversion and supporting process equations.
- 7. Software design for refrigeration control system and the Main MPPU control System. Source code and software project files for MCS shall be provided in native electronic format. Source code and software project files for RCS may be provided in native electronic format. Supporting/sustaining software shall be provided for the RCS maintenance.

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of this Specification Section and other sections forming this Contract Agreement.
- B. In the performance of the work, comply with the requirements of this Technical Specification and those of purchased component manufacturers. In cases where the requirements of these components are more stringent than those of the Technical Specification, the purchased component requirements will apply.
- C. Perform factory testing in accordance with the requirements given in this Section.
- D. The materials and equipment supplied shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate products that have been in satisfactory use for at least 5 years prior to the issue date of the Contractor Agreement. The Contractor shall provide information on mobile refrigeration systems in current use of similar, capacity, and function, which they have provided as a complete system including the successful use of electronic control valves.
- E. The manufacturers and products listed in these specifications or contract drawings are provided as a recommended source for the indicated system(s). This listing shall not prevent other manufacturers, which meet the requirements specified herein from providing these items, nor does it limit bidding to these manufacturers, nor does it pre-qualify those manufacturers listed. All final products provided shall meet post award submittal requirements and approvals before being incorporated into construction.
- F. All upgraded, new, or replacement equipment furnished by the contractor as part of this system shall be new and unused.

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PART 2. PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The MPPU shall be refurbishment at the contractor’s facility.
- B. The MPPU shall have a final weight no greater than 26,900 pounds
- C. The MPPU Structural Refurbishment shall include: removing all wiring, control equipment, instrumentation, power panels, control panels, equipment, hardware, ducting, piping, valves, and wheels from the unit to the bare metal structure; structural modifications, and refinishing in accordance with the contract drawings.
- D. The Air Supply System shall consist of the intake filter unit, inlet ducting, blower with inlet guide vanes, outlet ducting, inlet plenum, screens and spacer, instrumentation, power and control panels, power and control wiring, and ancillary equipment and hardware required to provide a complete system in accordance with the requirements of the contract drawings and specifications.
- E. The Heat Rejection and Absorption System shall consist of the heat rejection and absorption coils and fans, ducting, circulation pump, valves, expansion tank, piping, instrumentation, power and control wiring, and ancillary equipment and hardware required to provide a complete system in accordance with the requirements of the contract drawings and specifications.
- F. The MPPU Wrap-Around Coil System shall consist of the circulation pump, precool coil, reheat coil, secondary condensate drain assembly, valves, expansion tank, piping, instrumentation, power, power and control wiring, and ancillary equipment and hardware required to provide a complete system in accordance with the requirements of the contract drawings and specifications.
- G. The MPPU Refrigeration System shall consist of the compressors, condensers, evaporator coils, hot gas bypass valves, isolation and service valves, filter/dryers, strainers, sight glasses, condensate drains, piping, electrical power distribution, controls, software, instrumentation, power and control panels, power and control wiring, and ancillary equipment and hardware required to provide a complete system in accordance with the requirements of the contract drawings and specifications.
- H. The Carbon Filter Unit shall consist of the carbon filters, ducting section, and ancillary equipment and hardware required to provide a complete system in accordance with the requirements of the contract drawings and specifications.

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- I. The HEPA Filter Unit shall consist of the HEPA filter elements, ducting section, instrumentation, and ancillary equipment and hardware required to provide a complete system in accordance with the requirements of the contract drawings and specifications.
- J. The Reheat System shall consist of the duct plenum, outlet ducting, blow-off ducting with silencer, air heaters, air flow measuring elements, flow control valves, glycol circulation pump with strainer, glycol heaters, expansion tank, bypass control valve, temperature control valves, piping, insulation, instrumentation, power and control panels, power and control wiring, ancillary equipment and hardware required to provide a complete system in accordance with the requirements of the contract drawings and specifications.
- K. Verification of Dimensions
 - 1. The space available for the MPPU components is limited as shown on the contract drawings.
 - 2. The Contractor shall verify all critical dimensions shown on the contract drawings and any other dimensions required to fully define the system installation.
 - 3. The Contractor shall become familiar with the details of the work, verify dimensions in the field, and shall advise the Government of any discrepancy before performing the work.
- L. Prevention of Corrosion
 - 1. Fasteners and nameplates shall be of corrosion-resistant materials. Surfaces of products, such as pumps, motors, and similar components, of ferrous metal, where not otherwise specified, shall be given a corrosion protective external coating. Coatings shall show no signs of wrinkling, cracking, or loss of adherence, and the specimen shall show no signs of corrosion creepage.
- M. Equipment Guards and Access
 - 1. Gears, couplings, projecting setscrews, keys, and other rotating parts shall be fully enclosed or properly guarded to preclude personnel contact
- N. Structural Welding
 - 1. The MPPU structural frame members shall be welded in accordance with the contract drawings
- O. Brazing
 - 1. All copper tubing shall be brazed and tested in accordance with the contract drawings
 - 2. All brazing shall be performed in accordance with NASA SPEC-Z-0005

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P. Copper tubing (Non Refrigeration)

1. All tubing shall be Type K copper in accordance with ASTM B-88, supplied in hard drawn straight lengths
2. All piping shall be installed and tested in accordance with ASTM B31.5
3. The piping shall include all pipe, tubing, hoses, manifolds, and fittings on the components and the interface piping between components.
4. All piping shall be cleaned in accordance with KSC-C-123 level 500 cleanliness
5. Supports shall be polypropylene split block type clamps. Tube-Mac Industries or equal.
6. Piping routing and nominal line size shall be in accordance with the supplied contract drawings

Q. Joints:

1. All tubing joints shall be brazed in accordance with NASA-SPEC-Z-0005.
2. Pipe thread connections shall not be used, unless stated otherwise on contract drawings
3. Filler material:
 - a. Copper to copper: material selected shall meet AWS BCuP-5
 - b. Copper or steel to stainless steel: material selected shall meet AWS BAg-24
 - c. Bending shall be used instead of fittings unless the space available does not permit bending
 - d. Fittings shall be wrought copper in accordance with ASME B16.22 "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings"

R. Use of ASBESTOS or ASBESTOS-containing materials, in any manner, is STRICTLY PROHIBITED.

S. The Contractor shall assemble piping, valves, gauges, and visual indicators such that proper access and visibility to all components is guaranteed. The Government shall be able to perform maintenance and service work with a minimum of inconvenience to the persons performing the service.

2.2 ELECTRICAL

A. General

1. All electrical components shall be Underwriters Laboratory (UL) listed.
2. All electrical components and work shall be in accordance with the latest edition of NFPA 70

B. Electrical Service

1. Electrical service to the MPPU shall be 480 VAC, 60 Hz, 3-phase 3-wire.

C. Motor Controllers

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1. Motor controllers shall be provided in accordance with the contract drawings. Reduced voltage solid state starting shall be provided for motors greater than 75 HP. Controllers shall be installed in a NEMA 4X enclosure.

D. Motors

1. Motors shall be high efficiency, AS induction motors with a TEFC enclosure unless otherwise stated. Motors shall be a sufficient size for the duty to be performed and shall not exceed the full load rating when the equipment is operated at specific capacity under the most severe conditions likely to be encountered. Motor insulation shall be NEMA class B or better. Motors shall conform to the requirements of NEMA MG 1.

2.3 AIR SUPPLY SYSTEM REQUIREMENTS

A. Working pressure: 4 psig

B. Design and Test pressure: 6 psig

C. All replacement ductwork and materials shall be constructed in accordance with contract drawings. The inside of the ductwork shall be visually clean in accordance with KSC-C-123 and the outside to general clean in accordance with KSC-C-123.

D. Flow Screens

1. The flow screens shall be located in accordance with the contract drawings. The screens shall to be mounted in accordance with the contract drawings and include all gaskets and fasteners. The flow screen shall be mechanically cleaned, visibly free of debris, contamination, rust, oxidation, scale, or deposits. There shall be no gaps or voids in the mesh pattern. The screen shall be firmly affixed to the frame as specified by the contract drawings. Damaged screens shall be replaced.

E. Gasket interfaces.

All bolted flanges must use new continuous length gasket between flanges as specified on contract drawings.

F. Duct flanges

1. All duct flanges shall be planar within 1/16".

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G. Blower/Vane (Refurbish)

1. The blower shall be refurbished by the Blower Original Equipment Manufacturer, and shall have the following refurbishment activities performed as a minimum:
 - a. Replacement of head gasket
 - b. Replacement of rope packing
 - c. Replacement of all interstage packing
 - d. Replacement of division head packing
 - e. Blower shall be sandblasted (outside of the housing only)
 - f. Blower shall be steam cleaned
 - g. Replace all bearings
 - h. Motor shall be repaired at the discretion of the OEM
 - i. Rebalance impellers to 1.5mil total amplitude on bearing housing at 3600 rpm
 - j. Repair linkages including bearings, and replacement of damaged or worn parts
 - k. Paint in accordance with factory standards

2. Upon completion of refurbishment activities, the refurbished blower shall be supplied with the following documentation certifying performance:
 - a. Performance curve, detailing pressure rise and inlet volume flow
 - b. Temperature performance curve, detailing temperature rise of standard air through the blower for varying volume flows
 - c. Impeller balancing test report

H. Inlet Vane Actuator (Replace)

1. The inlet vane actuator shall include actuator, adapters, fittings, supports, wiring and associated fasteners
2. The valve actuator shall be directly mounted to the inlet vane stem and body in accordance with the manufacturer recommendation and with the manufacturer recommended adaptation hardware
3. Control and power wiring shall be in accordance with the supplied contract drawings
4. The actuator shall be subject to the following requirements:
 - a. Travel: Quarter turn
 - b. Supply voltage 110 VAC
 - c. Control input: 4-20 mA
 - d. Position Feedback: 4-20 mA
 - e. Torque: 1300 in-lb
 - f. Upper travel limit: Limit switch (Normally Open)
 - g. Lower travel limit: Limit switch (Normally Open)
 - h. Enclosure protection: NEMA 4X

5. Recommended manufacturer and part number: per contract drawings

I. Outlet Venturi (Refurbish)

1. The outlet air flow sensor shall be in accordance with the contract drawings.

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2. The sensor shall be cleaned on all exterior and interior surfaces.
3. All internal sensor passages shall be ultrasonically cleaned, devoid of burrs, debris, deposits, scale, and oxidation.
4. The exterior shall be devoid of surface gouging, burrs, scales, oxidation, and deposits.

J. Exit air flow control valve actuators (Replace)

1. The exit air flow control valve actuators shall include actuator, mounting hardware, manufacturer recommended adapter, and associated fasteners.
2. The actuator shall be located in accordance with the contract drawings, and mounted in accordance with the manufacturer recommended supports and adapter hardware.
3. The actuator control and power wiring shall be in accordance with the contract drawings.
4. The actuator shall be subject to the following requirements:
 - a. Startup Torque: 1300 in-lbf
 - b. Supply voltage: 120 VAC, single phase, 60 Hz
 - c. Motion: Quarter Turn
 - d. Environmental protection: Nema 4X
 - e. Output Contacts: 4 adjustable SPST limits
5. Recommended manufacturer and part number per the contract drawings

K. Pressure Transducers (Replace)

1. Differential pressure transducers shall include, transmitter, display, process connections, and mounting hardware.
2. The pressure transducers shall be furnished in accordance with the contract drawings, and mounted in accordance with manufacturer recommendations.
3. The control and power wiring shall be in accordance with the contract drawings.
4. The pressure transducers shall be individually labeled by 1/4" high lettering on stainless steel tags with the following information:
 - a. Transducer A number
 - b. System Location Description
 - c. Tags shall be labeled in accordance with lettering, materials, and visibility defined in KSC-STD-SF-0015
5. Transducer shall be furnished with factory calibration test report to the pressure range specified on the contract drawings.
6. Recommended manufacturer and part number per the contract drawings

L. Ancillary equipment. Furnish all items in accordance with contract drawings

1. Band (duct work flex connction)
 - a. Materials: NBR coated Nylon Fabric,
 - b. Circumference: Indicated on drawings"
 - c. Thickness: .031"
 - d. Width 4"
2. Clamp
 - a. Latch: T-bolt, with nylon locking nut
 - b. Bolt Material: Stainless Steel

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- c. Band Material: Stainless steel
- d. Band Width: 2"

2.4 HEAT REJECTION AND ABSORPTION SYSTEM

A. Heat Transfer Fluid: 20% Propylene glycol, 80% water mixture, by volume.

B. Operating Pressure 11psig

C. Design Pressure: 50 psig

D. Air working pressure: 4 psig

E. Air design and Test pressure: 6 psig

F. Maximum Operating Temperature: 147°F

G. Maximum off coil air temperature: 117°F

H. Heat Absorption Coil (Replace)

- 1. The heat absorption coil shall be furnished in accordance with the contract drawings.

I. Heat Rejection Coil (Refurbish)

- 1. The heat rejection coil shall consist of the coil, casing, gaskets, connections, mounting hardware, and interface connections. The coil shall be subject to the following requirements:

- a. Coil shall be mechanically cleaned and flushed.
- b. Fins shall be combed to restore them to their original condition.
- c. Coil casing, fins, and tubes to be clean, free of rust, scale, deposit, or oxidation (internal and external)
- d. Coil flanges shall be mechanically flat within 1/16"
- e. All fluid passageways and connections shall be leak tested to 50 psi
- f. Coil casing shall be airtight to 6 psig

J. Heat Rejection Fans (Replace)

- 1. Forced air cooling over the heat rejection coil shall be provided by three circulation fans. The circulations fans shall include fan blades, hub, and associated hardware.
- 2. The fan blades shall be mounted to the fan motors by means of a broached hub and key.
- 3. The fans shall have the following construction requirements:

- a. Rotation direction: Right Hand
- b. Diameter: 14 inch
- c. Blades: 6
- d. Pitch: 35°
- e. Blade material Aluminum
- f. Hub Material: Aluminum
- g. Hub Bore diameter: 7/8"
- h. Keyway: 3/16"

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4. The fans shall have the following performance requirements: (Taken from MultiWing selection software)
 - a. Speed: 3450 rpm
 - b. Static Pressure: 1.7 inches water (minimum)
 - c. Flow: 3100 ACFM at rated static pressure
5. Recommended manufacturer and part number as per contract drawing

K. Circulation Pump (Replace)

1. The Heat Absorption System circulation pump-motor unit shall consist of a horizontal, end suction, centrifugal pump unit which includes motor, pump, and connection flanges.
2. The pump unit shall be base mounted to the existing structure in accordance with the contract drawings and vibration isolated from adjoining piping.
3. The pump shall meet the following performance and construction requirements:
 - a. Pump Construction: All Bronze
 - b. Minimum Efficiency 50%
 - c. Flow: 14 gpm
 - d. Head: 40ft of water
 - e. Power: ½ Hp
 - f. Voltage: 120VAC, Single Phase, 60 Hz
 - g. Maximum Pressure: 175 psi
 - h. Motor: 3500 RPM, TEFC, 316 Stainless steel shaft
 - i. Seals: Buna-N
 - j. Connections: Screwed ends
 - k. The pump and motor shall be designed to minimize vibration
4. Recommended manufacturer and part number as per contract drawing

L. Control Valve (Replace)

1. The heat absorption control valve shall be a three-way, mixing type ball valve in accordance with the contract drawings.
2. The valve shall divert part of the flow to the suction inlet as required to control airside temperature. The control valve shall be subject to the following performance and construction requirements:
 - a. Valve size: 1 inch
 - b. Valve Body: Brass
 - c. Ball and Stem: 316 Stainless Steel
 - d. Seats: TFE
 - e. Seals: TFE
 - f. Connections: 1 5/8" ODS Copper Sweat
 - g. CV: 10 (when full open in one direction)
3. Recommended manufacturer and part number as per contract drawing

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M. Control Valve Actuator (Replace)

1. The control valve actuator shall include actuator, adapters, and supports, wiring and associated fasteners.
2. The valve actuator shall be directly mounted to the valve stem and body in accordance with the manufacturer recommendation and with the manufacturer supplied adaptation hardware.
3. Control and power wiring shall be in accordance with the supplied contract drawings.
4. The actuator shall be subject to the following requirements:
 - a. Travel: Quarter turn
 - b. Supply voltage 110 VAC
 - c. Control input: 4-20 mA
 - d. Position Feedback: 4-20mA
 - e. Torque: 1300 in-lb
 - f. Upper travel limit: Limit switch (Normally Open)
 - g. Lower travel limit: Limit switch (Normally Open)
 - h. Enclosure protection: NEMA 4X
5. Recommended manufacturer and part number as per contract drawing

N. Off Coil Temperature Sensor: (New)

1. The off-coil temperature sensor shall be a T-Type thermocouple assembly including sensor, housing, sheath, and leads.
2. The thermocouple and construction shall be subject to the following performance and construction requirements.
 - a. Sheath Diameter: ¼” OD
 - b. Type: ANSI Type T
 - c. Sheath Material: 304 Stainless Steel
 - d. Grounded: Ungrounded and insulated
 - e. Length: 18”
 - f. Mounting Connector: ½” NPT, Stainless steel
 - g. Operating temperature range 30°F -117°F
 - h. Max. Temperature: 300°F
3. Sensor wiring shall be in accordance with the contract drawings
4. Recommended manufacturer and part number as per contract drawing

2.5 WRAP AROUND COIL SYSTEM

- A. Heat Transfer Fluid: 20% Propylene glycol, 80% water mixture, by volume.
- B. Operating Pressure: 11psig
- C. Design Pressure: 50 psig
- D. Air working pressure: 4 psig
- E. Air design and Test pressure: 6 psig

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F. Maximum Operating Temperature: 117°F

G. Pre-Cool Coil (Refurbish)

1. The pre-cool coil shall consist of the coil, casing, gaskets, connections, mounting hardware, and interface connections. The coil shall be subject to the following requirements:
 - a. Coil shall be mechanically cleaned and flushed.
 - b. Fins shall be combed to restore them to their original condition.
 - c. Coil casing, fins, and tubes to be clean, free of rust, scale, deposit, or oxidation. (Internal and external)
 - d. Coil flanges shall be mechanically flat within 1/16"
 - e. All fluid passageways and connections shall be leak tested to 50 psi
 - f. Coil casing shall be airtight to 6 psig

H. Re-Heat Coil (Refurbish)

1. The re-heat coil shall consist of the coil, casing, gaskets, connections, mounting hardware, and interface connections. The coil shall be subject to the following requirements:
 - a. Coil shall be mechanically cleaned and flushed.
 - b. Fins shall be combed to restore them to their original condition.
 - c. Coil casing, fins, and tubes shall be clean, free of rust, scale, deposit, or oxidation. (Internal and external)
 - d. Coil flanges shall be mechanically flat within 1/16"
 - e. All fluid passageways and connections shall be leak tested to 50 psi
 - f. Coil casing shall be airtight to 6 psig

I. Circulation Pump (Replace)

1. The Wrap-Around System circulation pump-motor unit shall consist of an inline, oil lubricated, horizontal centrifugal pump unit which includes motor, pump, and connection flanges.
2. The pumps shall be of the horizontal, oil-lubricated type. Specifically designed and guaranteed for quiet operation.
3. The pumps shall have a ground and polished steel shaft with a hardened integral thrust collar. The shaft shall be supported by two horizontal sleeve bearings designed to circulate oil. The pumps shall be equipped with a mechanical seal with carbon seal face rotating against a ceramic seat.
4. The motor shall be non-overloading at any point on pump curve.
5. The motor shall be of the drip-proof, sleeve-bearing, quiet operating, rubber-mounted construction. Motors shall have built-in thermal overload protectors.
6. The pump unit shall be base mounted to the existing structure in accordance with the contract drawings and vibration isolated from adjoining piping and structure.
7. The pump shall meet the following performance and construction requirements:
 - a. Motor Construction: All bronze (casing), oil lubricated

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- b. Flow: 9.5 gpm
- c. Head: 11.5ft of water
- d. Power: 1/6 Hp
- e. Voltage: 115VAC, Single Phase, 60 Hz
- f. Maximum Working Pressure: 125 psi
- g. Motor: 1750 RPM, TEFC
- h. Connections: Screwed (NPT)

8. Recommended manufacturer and part number as per contract drawing

J. 50 psig Drain and vent piping: Brazed copper construction (Replace)

- 1. Tubing shall be copper, Type K in accordance with ASTM B88, in nominal sizes as indicated on the contract drawings.
- 2. Bending shall be used instead of fittings unless the space available does not permit bending.
- 3. Fittings shall be wrought copper in accordance with ASME B16.22 "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings"
- 4. Supports shall be block-style, two piece, aluminum clamps mounted in accordance with the contract drawings. The tubing shall be supported at branch connections, valves, and 90 degree bends in accordance with the contract drawings. Representative manufacturer: Girard Development Inc.

K. Flow Sensing Switch (New)

- 1. Description: Vane type.
- 2. The flow sensing switches shall meet the following specifications:
 - a. Service: Gas or liquid
 - b. Body Material: 304 Stainless steel
 - c. Magnet: Ceramic
 - d. O-ring: Buna-N
 - e. Temperature limits: -4°F - 220°F
 - f. Pressure Range: 1450 psig
 - g. Enclosure Rating: Weatherproof
 - h. Switch Type: SPDT, NO
 - i. Electrical Rating: 5A at 125 VAC
 - j. Adjustment: Field adjustable
 - k. Activation Flow rates: 0.18-2.70 SCFM (air)
0.04 - 0.75 Gpm (water)
- 3. Recommended manufacturer and part number as per contract drawing

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2.6 REFRIGERATION SYSTEM PERFORMANCE REQUIREMENTS

A. General

1. The Refrigeration System is designed to replace the existing MPPU refrigeration system as shown on the contract drawings.
2. All refrigeration system components shall be new
3. The Refrigeration System consists of two (2) circuits design for use with refrigerant R410A. The major components in each circuit includes an electronic expansion valve with a stand- alone superheat controller, an evaporator coil, two (2) compressors, and two (2) condenser coils with variable speed fan drives. Each circuit will also include an electronic type hot gas bypass valve.
4. The compressors shall be provided as tandem units with piping as shown on the contract drawings. Each tandem unit will include two (2) compressors of the same capacity. There shall be one (1) tandem unit per refrigeration circuit. The system shall include all the ancillary components shown on the contract drawings.
5. Any deviation from this design shall be approved by the Government.

B. Refrigerant: R 410A, in accordance with A-A – 58060A

C. Refrigerant Design Pressure:

1. High pressure side: 550 psia
2. Low pressure side: 465 psia

D. Refrigerant Design Temperature:

1. High side temperature: 200F
2. Evaporator operating temperature: 35F
3. Low side non-operating temperature: 125F

2.7 COMPRESSOR UNITS (REPLACE)

- A. Each compressor unit shall consist of two (2) scroll type compressors factory installed in tandem onto a structural steel base incorporating vibration isolation grommets in accordance with manufacturers’ recommendations. The unit shall include fully integrated factory piping for the suction, discharge, vibration and equalization line between the compressors.
- B. The compressor wiring junction box shall be located and oriented as shown on the contract drawings.

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C. The compressor unit shall meet the following requirements as a minimum:

1. Performance:

- a. Inlet Operating Temperature: 50F
- b. Inlet Operating Pressure: 122 psia
- c. Inlet non-operating pressure: 460 psia
- d. Inlet non-operating temperature: 125F
- e. Discharge Temperature: 194F at 460 psia
- f. Condensing Temperature: 125F
- g. Evaporator Temperature: 35F
- h. Return Gas Temperature: 50F
- i. Evaporator superheat: 10F
- j. Total subcooling: 10F
- k. Compressor capacity: 457,000 Btu/hr minimum rating
- l. Refrigerant flow rate: 6950 lb/hr
- m. Power: 46300 watts at 460 V/3phase/60Hz
- n. Current: 68.1 amps
- o. Isentropic efficiency: 73 %
- p. Liquid temperature: 114.8F
- q. Condenser heat rejection: 615,971 Btu/hr minimum rating
- r. Lubricant: Polyol Ester (POE) oil

2. Pressure rating:

- a. Maximum working pressure: 650 psig at 150F with accompanying UL certification
- b. Maximum abnormal working pressure: 650 psig
- c. Design pressure for the Compressor Unit: 615 psig

3. Features:

- a. Oil level sight gage in oil equalization line
- b. Oil level sensor
- c. Connections: The connections on the compressor housing are defined below.
 - 1) Suction connection pressure rating: 465 psig at 125F (This is a non-operating condition from which the compressor must start)
 - 2) Suction. 2-1/4"-12UN external thread for Rotolock fitting.
 - 3) Discharge. 1-3/4"-12UN external thread for Rotolock fitting.
 - 4) Equalization line connections: 1-3/4"-12UN external thread for Rotolock fitting.
 - 5) Fitting material shall be stainless steel with corrosion protection.
- d. Modified Manifold Tubing on Compressor Unit shall conform to:
 - 1) All tubing shall be Type K copper in accordance with ASTM B-88.
 - 2) The 1-1/2" suction manifold shall be rated for 465 psig at 125F.
 - 3) Suction connection adapter: 2 1/4"-12 UN x 1 5/8" ODS

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4) Discharge connection adapter: 1-3/4"-12 UN x 1 1/8" ODS

4. Representative Manufacturers

- a. Copeland
- b. Bitzer
- c. Trane

2.8 EVAPORATOR COIL

A. See contract drawings for performance and construction specifications.

2.9 CONDENSER UNIT

A. The Condenser Unit for each circuit shall consist of two forced air cooled coils mounted in an aluminum frame as shown on the contract drawings. Forced air cooling shall be provided by two (2) variable speed fans arranged as shown on the contract drawings. The unit shall include fully integrated factory piping for the inlet, and discharge lines between the coils that terminate at a single inlet and discharge interface connection as shown on the contract drawings. The condenser unit shall meet the requirements given on the contract drawings.

2.10 VARIABLE SPEED CONDENSER FAN DRIVES

A. Each condenser unit shall receive fan control from a single variable speed drive. The fan drive shall include drive module, short circuit protection, overload protection, mounting hardware, and all associated switches, relays, and required hardware. Each drive shall control two condenser fans to the same speed. The variable speed drives shall interface with the refrigeration controller as indicated in the contract drawings. Harmonics generated shall be in accordance with IEEE 519. The variable speed fan drives are subject to the following requirements:

- 1. Input Voltage: 480VAC, 3 phase, 60 Hz
- 2. Horsepower: 10Hp
- 3. Operator Interface: Integral keypad, led indicators
- 4. Frequency range: 0-400Hz
- 5. Control Input: 4-20mA
- 6. Communications: Integral RS485
- Features: Sensorless vector control

B. Recommended manufacturer and model: Allen Bradley 22B-D017N104

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2.11 CONDENSER FAN RELAY/DRIVE ENCLOSURE:

- A. The enclosure shall be a separate unit. The enclosure shall be sufficiently sized to house the variable speed condenser fan drives, as well as any associated terminals, readouts, relays, switches, displays, starters, and other power components required to provide variable speed fan control.
- B. The fan relay/ drive shall be mounted to the existing MPPU frame in the location described on the contract drawings. The enclosure shall be flush mounted with the exterior of the MPPU. Supports shall be provided in accordance with the contract drawings and in accordance with manufacturer recommendations.
- C. The relay and drive enclosure shall receive power in accordance with the contract drawings.
- D. The speed of the condenser unit fans shall be controlled from the refrigeration control system which shall be located in the RCS Control enclosure.
- E. The enclosure shall be subject to the following requirements.
 - 1. Environmental protection rating: Nema 4X
 - 2. Maximum dimensions: In accordance with contract drawings
 - 3. Construction: Stainless steel
 - 4. Cover: Continuous hinge,
 - 5. Closure: Stainless clamps
- F. The enclosure shall be equipped to provide adequate dissipation of heat generated within the enclosure.
- G. Suggested manufacturer: Hoffman Company

2.12 HIGH SIDE PRESSURE TRANSDUCER

- A. The high side pressure transducer shall include sensor, connection port, and mounting hardware. The pressure transducer shall interface with the refrigeration CONTROLLER as indicated in the contract drawings. The pressure transducer shall meet the following requirements:
 - 1. Accuracy: 1% of span
 - 2. Pressure rating: 750 psig
 - 3. Current output: 4-20mA
 - 4. Pressure connection: 1/4" MNPT Stainless steel
 - 5. Termination: Flying leads (Nema 4X)
- B. Recommended manufacturer and model: see contract drawings

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2.13 CONTROL VALVES (NEW)

A. Electronic Expansion Control Valve (EECV):

1. Inlet pressure: 460.5 psia
2. Inlet temperature: 115F based on 10F subcooling
3. Pressure drop: 296 psi
4. Capacity:
 - a. Maximum compressor capacity per circuit (2 compressors): 38.02 tons
 - b. Minimum compressor load: 9.0 tons
 - c. Rated capacity of EECV: 48.53 tons
5. Specifications:
 - a. Motor type: 2 phase, bipolar wet stepper motor
 - b. Voltage: 12 volt DC, -5%, +10% measured at valve leads
 - c. Leads: 10' long, hermetic 4 lead, 18 AWG, PVC insulation
 - d. Phase resistance: 75 ohms +/- 10%
 - e. Current range: 160 ma/winding
 - f. Maximum power input: 3.8 watts
 - g. Recommended step rate: 200/sec
 - h. Number of steps: 3193
 - i. Resolution: 0.00008"/step
 - j. Stroke: 0.250 in
 - k. Maximum internal leakage: 100 cc/min at 100 psig, dry air
 - l. Maximum external leakage: .10 oz/yr at 300 psig
 - m. MOPD: 500 psi
 - n. MRP: 620 psig
 - o. Operating temperature range: -55F to 155F
 - p. Construction:
 - 1) Angle type
 - 2) Brass body with copper connections
 - 3) Seals: synthetic
 - 4) Trim: stainless steel
 - 5) Inlet connection: 1-1/8" ODS
 - 6) Outlet connection 1-3/8" ODS
6. Manufacturer: Sporlan, Part No. SEI-30-1-1/8x1-3/8-ODS-10-S

B. Electronic Hot Gas Bypass Valve (EHGBV)

1. Inlet pressure: 460.5 psia
2. Inlet temperature: 170F
3. Pressure drop: 338 psi
4. Actuation type: Electronic
5. Capacity:
 - a. Minimum operating capacity: 9.964 tons
 - b. Maximum operating capacity: 29.0 tons
 - c. Rated capacity of EHGBV: 50 tons nominal

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- 6. Specifications:
 - a. Motor type: 2 phase, bipolar wet stepper motor
 - b. Voltage: 12 volt DC, -5%, +10% measured at valve leads
 - c. Leads: 10' long, hermetic 4 lead, 18 AWG, PVC insulation
 - d. Phase resistance: 75 ohms +/- 10%
 - e. Current range: 131 ma to 215 ma per winding; .262 t0 439 ma with 2 windings energized
 - f. Maximum power input: 4 watts
 - g. Inductance per winding: 62 +/- 20% mH
 - h. Required step rate: 200/sec
 - i. Number of steps: 6386
 - j. Resolution: .0000783"/step
 - k. Stroke: 0.500 in
 - l. Maximum internal leakage: less than 100 cc/min at 100 psig, dry air
 - m. Maximum external leakage: .10 oz/yr at 300 psig
 - n. Maximum Rated Pressure: 700 psig
 - o. Operating temperature range: -40F to 240F fluid
 - p. Ambient: -40 to 140F
 - q. Construction:
 - 1) Angle type
 - 2) Materials: Brass body, motor housing, and adaptors; copper fittings; synthetic materials-seating and seals
 - 3) Inlet connection: 1-1/8" ODS
 - 4) Outlet connection 1-1/8" ODS
 - r. Installation:
 - 1) Install HGBV into the auxiliary side connector, which is between the EEV and the evaporator as shown on the contract drawings.
 - 2) Connect wiring to controller in accordance with manufacturer's instructions.
 - 3) Setup shall be performed in accordance with the manufacturer's instructions.
- 7. Manufacturer: Sporlan, Part No. SDR-4-1 1/8x1 1/8-10-S

C. High Side Pressure Relief Valves

- 1. Type: Direct spring-acting.
- 2. Service media: Refrigerant R410A gas
- 3. Minimum capacity: 6950 lb/hr
- 4. Maximum orifice area: 0.149 square inches
- 5. Set Pressure: 550 psig
- 6. Inlet relieving temperature: 195 F
- 7. Backpressure: less than 10%
- 8. Overpressure: 10%
- 9. Construction:
 - a. Brass body

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- b. Stainless steel trim
 - c. Seat: Kel-F /PCTFE
 - d. Size: 3/4" MNPT x 1" FNPT
10. Features:
- a. Snap acting performance
 - b. Bubble type, soft seat design
 - c. Built to ASME Section VIII requirements with Board Certified capacities
 - d. ASME "UV" Stamp
 - e. Bubble tight to 98% of set point
 - f. Blowdown: 7-10%
 - g. Full lift at set pressure
 - h. Full OPEN until reseal
 - i. Temperature rating: -423 to 400 F
 - j. Pressure range: 500 to 3000 psig
11. Recommended manufacturer and part number: See contract drawings

D. Low Side Pressure Relief Valves

- 1. Type: Direct spring-acting.
- 2. Service media: Refrigerant R410A gas
- 3. Minimum capacity: 6950 lb/hr
- 4. Maximum orifice area: 0.149 square inches
- 5. Set Pressure: 465 psig
- 6. Inlet relieving temperature: 125 F
- 7. Bubble tight up to 98% of set point.
- 8. Backpressure: less than 10%
- 9. Overpressure: 10%
- 10. Construction:
 - a. Brass body
 - b. Stainless steel trim
 - c. Seat: EPR
 - d. Size: 3/4" MNPT x 1" FNPT

11. Features:
- a. Snap acting performance
 - b. Bubble type, soft seat design
 - c. Built to ASME Section VIII requirements with Board Certified capacities
 - d. ASME "UV" Stamp
 - e. Bubble tight to 98% of set point
 - f. Blowdown: 7-10%
 - g. Full lift at set pressure
 - h. Full OPEN until reseal
 - i. Temperature rating: -423 to 400 F
 - j. Pressure range: 500 to 3000 psig

12. Installation shall be performed in accordance with manufacturer's instructions and the contract drawings.

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13. Recommended manufacturer and part number: See contract drawings

2.14 ELECTRONIC VALVE CONTROL BOARDS

A. Superheat controller. (Controls Expansion valve)

1. The controller shall be a standalone unit. The unit shall have input connections to give remote access to pressure and temperature readings in addition to viewing and editing the controller's setpoints. The specifications are as follows:
 - a. Stand-a-lone superheat controller unit
 - b. Input Voltage: 24VDC (+/- 10%), 40 VA minimum to board with external transformer.
 - c. Operating ambient temperature: -40F to 120F
 - d. LED: one power LED
 - e. Communications: 1 RS485 Port, 1 USB port
 - f. 4 Digit 7 segment display
 - g. Inputs:
 - 1) Optical encoder (knob)
 - 2) Pressure input:
 - (i) Sporlan 952505 (as shown on contract drawings)
 - 3) Three (3) temperature inputs. Only one input will be required.
 - (i) Sporlan 92662 (as shown on contract drawings)
 - h. Features:
 - 1) Manual valve position
 - 2) Alarms
 - 3) Display networking
 - 4) Factory reset
 - i. Installation:
 - 1) Install Controller Unit in the Refrigeration Unit Control Panel.
 - 2) Connect wiring to controller in accordance with manufacturer's instructions.
 - 3) Setup shall be performed in accordance with the manufacturer's instructions.
 - j. Manufacturer: Sporlan, Kelvin II Refrigeration Controller (R410A)

B. HGBV controller.

1. The HGBV controller shall interface with the refrigeration controller as shown on the contract drawings. The specifications are as follows:
 - a. Inputs: 4-20 mA
 - b. Outputs: 6386 steps (Pulse width modulation)
 - c. Input Voltage: 24VDC (+/- 10%), 30 VA
 - d. Operating ambient temperature: -10F to 160F
 - e. Size: 3 1/2" wide x 4" high x 1" deep. Standoff distance: 3/16" minimum
 - f. Installation:
 - 1) Install Controller in the refrigeration control enclosure.

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- 2) Connect wiring to controller in accordance with manufacturer's instructions.
- 3) Setup shall be performed in accordance with the manufacturer's instructions.
- 2. Recommended manufacturer and part number Sporlan PN 952660

C. Temperature Sensor:

- 1. The off coil temperature sensor shall be used to control the position of the hot gas bypass valves, ensuring that the air achieves the required temperature setpoint.
- 2. The thermocouple and construction shall be subject to the following performance and construction requirements.
- 3. Sensor wiring shall be in accordance with the contract drawings.
 - a. Sheath Diameter: ¼" OD
 - b. Type: ANSI Type T
 - c. Sheath Material: 304 Stainless Steel
 - d. Grounded: Ungrounded and insulated
 - e. Length: 18"
 - f. Mounting Connector: ½" NPT, Stainless steel
 - g. Max. Temperature: 300°F

2.15 ANCILLARY COMPONENTS

A. Manual isolation valves

- 1. Ball valve
- 2. Size:
 - a. High pressure side: 1 1/8" ODS, Cv=62.3
 - b. High pressure side: 1 5/8" ODS, Cv = 212
 - c. Low pressure side: 2 5/8" ODS, Cv=301
- 3. Media: Refrigerant R410A
- 4. Working pressure rating: 700 psig, UL listed
- 5. Service temperature rating: -40 F to 325 F
- 6. Construction:
 - a. Forged brass body construction with extended copper fittings and access fitting. Welded body joint factory tested to ensure positive, leak free performance.
 - b. Full size ports
 - c. Connections: ODS
 - d. Dual Teflon seals
 - e. Polished brass ball
 - f. Stem seal and stem washer.
 - g. Bottom load stem
 - h. Stainless steel stop plate to ensure fully OPEN to fully CLOSED with ¼ turn
 - i. Ball internal relief port design for positive shut-off in either flow direction, even during system evacuation.

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- j. Bi-directional and may be installed in any position.
- k. UL listed.
- l. Date code stamped into valve body.
- 7. Installation shall be performed in accordance with manufacturer’s instructions
- 8. Recommended manufacturer and part number: See contract drawings

B. Check Valves

- 1. Description: Normally closed magnetic check valve that prevents reverse flow in compressor discharge lines.
- 2. 1 5/8” ODS copper connections
- 3. Maximum working pressure: 680 psig (UL Listed)
- 4. Opening pressure differential: 0.71 psi
- 5. Hermetic spun copper design
- 6. Leak rate rating: 0.272 CIM at 60 psi
- 7. Magnetic checking action
- 8. Built-in 30 mesh stainless steel strainer
- 9. Installation orientation: any position
- 10. Installation shall be performed in accordance with manufacturer’s instructions
- 11. Recommended manufacturer and part number: See contract drawings

C. Filter/Dryer

- 1. Type: Replaceable core design with filter within a filter construction.
- 2. Media: Refrigerant R410A
- 3. Pressure rating: 650 psig
- 4. Refrigerant flow capacity: 47.5 tons at 1psi delta P (ratings at ARI standard conditions)
- 5. Surface filter area: 128 square inches
- 6. Water capacity drops at 50 PPM
 - a. At 75 F: 962
 - b. At 125 F: 722
- 7. Installation shall be performed in accordance with manufacturer’s instructions. The unit shall be bracket mounted to the MPPU structural frame without imparting any support loading to the piping. The core and elements shall be replaced after initial clean-up and checkout.
- 8. Construction:
 - a. Flanged housing with independent piping connections that permit core and filter access without disconnecting any refrigerant piping.
 - b. Housing material: heavy steel shells with high bursting strength and listed by Underwriters’ Laboratories Inc.
 - c. Bolt and nut endplate attachment with nuts locking against the housing for ease of assembly
 - d. Brazed copper connections
 - e. 1 1/8” ODS copper connection fittings.
 - f. Internal parts shall be plated steel. No plastic parts shall be permitted.
- 9. Features:

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- a. Elements and core sealed to prevent by-passing any particulate matter.
- b. Shell exterior shall be finished with an epoxy powder coating to prevent corrosion.

10. Manufacturer: Sporlan

- a. Housing: PN C-969-G
- b. No. of cores or filter elements: 2
- c. Core Part No.: RCW-48
- d. Filter Element Part No.: RPE-48-BD
- e. Bracket Part No.: A-685

D. Suction Strainer

- 1. Description: Replaceable suction filter shell, used with pleated filter element.
- 2. Media: Refrigerant R410A
- 3. Pressure rating: 500 psig
- 4. Refrigerant flow capacity: 48.2 tons at 2psi delta P (ratings at ARI standard conditions)
- 5. Surface filter area: 776 square inches
- 6. Installation shall be performed in accordance with manufacturer's instructions. The unit shall be bracket mounted to the MPPU structural frame without imparting any support loading to the piping. The core and elements shall be replaced after initial clean-up and checkout.
- 7. The elements shall be replaced after initial clean-up and checkout.
- 8. Construction:
 - a. Flanged angle housing with independent piping connections that permit filter access without disconnecting any refrigerant piping. The angle construction shall be suitable for flow in either direction.
 - b. Housing material: heavy steel shells with high bursting strength and listed by Underwriters' Laboratories Inc.
 - c. Bolt and nut endplate attachment with nuts locking against the housing for ease of assembly
 - d. Brazed copper connections
 - e. 2 1/8" ODS copper connection fittings.
- 9. Features:
 - a. Access valve provided on flange for pressure drop measurements or charging
 - b. Elements spring loaded and sealed to prevent by-passing any particulate matter
 - c. Shell exterior shall be finished with an epoxy powder coating to prevent corrosion.
- 10. Manufacturer: Sporlan
 - a. Housing: See contract drawings
 - b. No. of cores or filter elements: 2
 - c. Filter Element Part No.: RPE-48-BD
 - d. Bracket Part No.: A-685

E. Sight Glass

- 1. Description: Moisture and liquid indicator.

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2. Media: Refrigerant R410A
3. Pressure rating: 650 psig (UL Listed)
4. Operating temperature: 20F to 125F
5. Installation shall be performed in accordance with manufacturer’s instructions. The unit shall be in a vertical or horizontal orientation.
6. Construction:
 - a. Copper plated steel body
 - b. Plated steel and copper fittings brazed to the body. The fittings shall be long enough to permit brazing piping without any disassembly of the unit.
 - c. Viewing glass disc shall be fused to the body for a permanent leak-free joint.
 - d. Indicator paper (retained in a small brass ferrule) shall be inserted from the back and held in-place with a slotted cylinder. The slotted cylinder and indicator assembly is mounted on a post that screws into the bottom of the body, and seals with a knife-edge joint.
 - e. Brazed copper connections
 - f. 1 1/8” ODS copper or copper plated steel connection fittings.
7. Features:
 - a. Calibrated color change points in parts per million.
 - b. Unit exterior shall be painted with an epoxy coating to prevent corrosion.
8. Recommended manufacturer and part number: See contract drawings

F. Auxiliary Side Connector (ASC)

1. Description: Interface connector between the expansion valve outlet and the evaporator distributor with a branch connection to be used for hot gas bypass. The ASC includes a nozzle and annular passage to ensure uniform mixing of the expansion valve discharge flow and the hot gas bypass flow.
2. Size:
 - a. Inlet: 1-3/8” ODM
 - b. Outlet: 1-3/8” ODS
 - c. Auxiliary (Hot gas bypass): 7/8” ODS
3. Construction: Brass body
4. Installation: The ASC inlet shall be brazed directly to the expansion valve discharge connection. The outlet connection shall be brazed to the interface tubing between the evaporator coil interface connection and the ASC as indicated on the contract drawings.
5. Recommended manufacturer and part number: See contract drawings.

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2.16 PIPING/TUBING

A. General

1. The piping shall include all pipe, tubing, hoses, manifolds, and fittings on the components and the interface piping between components. It also includes the condensate drain piping.
2. All piping shall be installed and tested in accordance with ASTM B31.5.
3. No Type 303 or Type 303Se stainless steel shall be used, unless directly specified
4. All piping shall be cleaned in accordance with the procedure described in Part 3 Execution.
5. Seals.
 - a. Acceptable O-ring materials: Neoprene (Chloroprene Rubber), Ethylene Propylene Rubber (EPR, EPDM), copper, or stainless steel.
 - b. Acceptable metal gasket/seal materials: copper or stainless steel.
 - c. Acceptable plastic gasket/seal materials: Reinforced nylon or Teflon.
6. Pipe thread connections larger than 1" shall not be used. All thread connections shall be solder sealed
7. Supports shall be polypropylene split block type clamps. Tube-Mac Industries or equal.

B. Piping Requirements

1. 550 psig High pressure side: Brazed construction
 - a. Tubing diameters and wall thickness shall be as indicated on contract drawings
 - b. Tubing shall be in accordance with the following requirements:
 - 1) Outside Diameter: 1.625"

(i) Copper Alloy:	UNS C12200
(ii) Temper:	Hard Drawn
(iii) Outside Diameter Variation:	+/- 0.002"
(iv) Nominal wall thickness	0.095"
(v) Wall thickness variation	+/-0.007"
(vi) ASME Allowable pressure	550psig
 - 2) Outside Diameter: 1.375"

(i) Copper Alloy:	UNS C12200
(ii) Temper:	Hard Drawn
(iii) Outside Diameter Variation:	+/- 0.0015"
(iv) Nominal wall thickness	0.080"
(v) Wall thickness variation	+/-0.006"
(vi) ASME Allowable pressure	550psig
 - 3) 1" Nominal Tube:
 - (i) Type K copper, in accordance with ASTM B88
 - (ii) Shall be supplied as hard drawn straight lengths
 - c. Joints: All tubing joints shall be brazed in accordance with ASTM B31.5. The filler material shall meet AWS BCuP-5.
 - d. Fittings and bends:

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- 1) Bending shall be used instead of fittings unless the space available does not permit bending.
 - 2) Fittings shall be Heldon R400 Series or an engineered approved equal, with a minimum safe working pressure of 725 psig and a rated burst pressure no less than 4 times the safe working pressure.
2. 465 psig Low pressure side: Brazed construction
- a. Tubing diameters and wall thickness shall be as indicated on contract drawings
 - b. Tubing shall be in accordance with the following requirements:
 - 1) Outside Diameter: 2.625"
 - (i) Copper Alloy: UNS C12200
 - (ii) Temper: Hard Drawn
 - (iii) Outside Diameter Variation: +/- 0.002"
 - (iv) Nominal wall thickness: 0.125"
 - (v) Wall thickness variation: +/-0.008"
 - (vi) ASME Allowable pressure: 515psig
 - 2) Outside Diameter: 2.125"
 - (i) Copper Alloy: UNS C12200
 - (ii) Temper: Hard Drawn
 - (iii) Outside Diameter Variation: +/- 0.002"
 - (iv) Nominal wall thickness: 0.1"
 - (v) Wall thickness variation: +/-0.008"
 - (vi) ASME Allowable pressure: 500psig
 - c. Joints: All tubing joints shall be brazed in accordance with ASTM B31.5. The filler material shall meet AWS BCuP-5.
 - d. Fittings and bends:
 - 1) Bending shall be used instead of fittings unless the space available does not permit bending.
 - 2) Fittings shall be Heldon Large Diameter High Pressure Copper Fittings (or an engineered approved equal), with a minimum safe working pressure of 465 psig and a rated burst pressure no less than 4 times the safe working pressure.
- C. 50 psig Drain and vent piping: Brazed copper construction (Replace)
- 1. Tubing shall be copper, Type K in accordance with ASTM B88, in nominal sizes as indicated on the contract drawings.
 - 2. Bending shall be used instead of fittings unless the space available does not permit bending.
 - 3. Fittings shall be wrought copper in accordance with ASME B16.22 "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings"
 - 4. Supports shall be block-style, two piece, aluminum clamps mounted in accordance with the contract drawings. The tubing shall be supported at branch connections, valves, and 90 degree bends in accordance with the contract drawings. Representative manufacturer: Girard Development Inc.

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2.17 REFRIGERATION CONTROL SYSTEM ENCLOSURES (REPLACE)

- A. The Refrigeration Control System (RCS) unit enclosure shall be a separate enclosure which contains the refrigeration control system, the local and remote control interfaces, the instrumentation interfaces, and all of the power conditioning equipment required by the RCS. This enclosure shall be used as the main interface point for command and control of the refrigeration system.
- B. The RCS unit enclosure shall be divided into power and control sections:
 - 1. The power section, shall contain a local disconnect, control power transformers, circuit protection devices, compressor starters, and all other power control components required to provide power to the refrigeration system equipment.
 - 2. The controls section, shall contain the RCS controller, the refrigeration instrumentation interface, control relays and timers, communications interfaces, and all other equipment used for controlling the refrigeration system equipment
- C. The refrigeration control enclosure shall have dimensions sufficient to house the control system, the local and remote control interfaces, the instrumentation interfaces, and all of the power conditioning equipment required by the RCS. The enclosure assembly shall fit within the maximum dimensions identified on the contract drawings
- D. Power wiring shall be routed to the enclosure in accordance with the contract drawings.
- E. The enclosure assembly shall meet the following requirements:
 - 1. Environmental protection: NEMA 4x
 - 2. Maximum Dimensions: See contract drawings
 - 3. Construction: Stainless steel
 - 4. Cover: Removable hinges or clamps.
- F. The enclosure shall be equipped to dissipate heat generated within the enclosure.
- G. Supporting structure for control enclosure shall be submitted to the government by the contractor prior to installation.
- H. Suggested manufacturer: Hoffman Company

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2.18 REFRIGERATION SYSTEM CONTROLS

A. GENERAL

1. The Contractor shall have total responsibility for the design, procurement, production, quality control, testing, and documentation, as necessary to furnish a completed refrigeration control system conforming to the requirements of this specification.
2. This specification details the controls criteria for the Mini Portable Purge Units (MPPU) Refrigeration Control System (RCS).
3. The RCS shall be a separate subsystem within the MPPU Control System. This document, in conjunction with 584F0301001 (Sheet V-2 and M21 to M-24) shall be used as the primary mechanical and process references for designing the RCS.

B. Instrumentation Equipment

1. All Refrigeration instrumentation shall be sized per the refrigeration system design requirements.
2. Contractor shall furnish all interface boards and communicators required to interface refrigeration control valves with RCS and standalone controllers.
3. The refrigeration system shall utilize pressure transmitters with 4-20mA feedback capability. These pressure transmitters shall be wired to the RCS.
4. The refrigeration system shall use type T thermocouples to measure the refrigeration process temperatures. These thermocouples shall be wired to the RCS.
5. All discrete pressure, temperature, and level switches shall be wired to the RCS.
6. Contractor shall provide all measurement communicators used in configuring any "Smart" transmitters supplied with the refrigeration system.
7. The compressors shall have oil level detection instrumentation.
8. Nameplates shall be provided for each device on the control console, valve panels and gauge panels. Nameplates shall clearly indicate the function of each device. In the case of manually-operated controls, each shall indicate the condition established for each position of the control

C. Electrical

1. General
 - a. All electrical components shall be Underwriters Laboratory (UL) listed.
 - b. All electrical components and work shall be in accordance with the latest edition of NFPA 70
2. Motor Controllers
 - a. Motor controllers shall be provided in accordance with the contract drawings. Reduced voltage solid state starting shall be provided for motors greater than 75 HP. Controllers shall be installed in a NEMA 4X enclosure

D. Electrical Interfaces

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1. The refrigeration system shall receive two (2) 480 VAC feeds as shown on the contract drawings. The first feed shall supply the condenser unit fans. The second 480VAC feed shall supply the compressor units and starters, the refrigeration control system, and all valves actuators and instrumentation that will make up the complete refrigeration system.
2. All other voltages required by the refrigeration system equipment shall use the supplied 480VAC feeds. These voltages shall be transformed and distributed locally to power the refrigeration auxiliary devices such as the RCS, cooling fans, control valves, instrumentation, etc.

E. Gauge and Valve Panel

1. Gauge Panels shall be constructed of stainless steel, or aluminum plate thick enough to provide rigid support for the valves and other components mounted thereon. All piping shall be terminated with bulkhead type connections in a position convenient for the connection of external lines.
2. Nameplates shall be provided for each device. Nameplates shall clearly indicate the function of each device and, in the case of manually-operated controls, shall indicate the condition established for each position of the control. Instruction plates shall clearly indicate the proper procedures and sequences of operations to activate the system, to operate the system, and to secure the system after completion of operation.

2.19 REFRIGERATION UNIT CONTROLLER

- A. The RCS shall be a stand-alone system that interfaces to the MPPU Main Control System (MCS). All RCS functions shall be performed by a local controller upon request from a local control interface or the MPPU MCS PLC. Request and response timing shall be at no less than a 10Hz rate. Control mode (local or remote) shall be selectable only at the RCS local control interface.
- B. The RCS controller shall be based on an Allen Bradley Control RSLogix 5000 PLC platform or equivalent industry standard refrigeration controller.
- C. The RCS controller shall communicate with the MPPU MCS PLC via Ethernet/IP using Object Linking and Embedding for process control (OPC) standard. The RCS controller shall be maintained via an Ethernet/IP interface.
- D. The RCS shall provide an interface consisting of a touch screen. The touch screen interface shall be a minimum of 10 inches, protected from water and hydraulic fluid, and clearly visible on bright sunlit days. The interface shall be located within the refrigeration control enclosure.
- E. The RCS controller shall perform all control, monitoring, indicating, and human interface functions as specified including operation of the compressors, condenser fans, electronic valves, system interlocks, monitoring and display functions, set points and alarms of all refrigeration system sub-systems.

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- F. The RCS controller shall be capable of operation in the ambient temperatures, vibrations, and other conditions for which it will be exposed.
- G. The RCS controller shall be fitted with all hardware, power supplies, input/output cards, enclosures, programming, etc. to make the system fully functional.
- H. The RCS controller shall be fitted with all firmware, software, software drivers to provide a fully operational communications link between the MPPU MCS PLC and the RCS controller.

2.20 RCS CONTROL SOFTWARE PERFORMANCE

- A. All controls software and supporting software documentation (RCS Software Operations and Maintenance Guide, RCS Software design, RCS Controls Design (with PIDs), RCS Code listing) developed for the RCS controller shall be a deliverable in electronic format and become the property of NASA KSC.
- B. The RCS controls design shall reference document 584CWR01001, "CPRVS Software Requirements and Design Specifications" for detailed information on the interface between the RCS and the MPPU MCS.

1. Local Control Mode

- a. Local control shall be capable of controlling the function of individual compressors, condenser fan speeds, hot gas bypass valves, and view all refrigeration system feedback via the RCS local control interface
- b. Local control shall be capable of reporting faults and Health & Status (H&S) of end items and RCS controller.
- c. Local control mode shall be entered only by password protection. This password shall delivered by Ethernet connection from the MPPU MCS
- d. Local control shall provide the operator with system safety and reliability interlocks to prevent system damage or potentially unsafe operation.

2. Remote Control Mode

- a. The RCS shall be capable of safe, autonomous operation.
- b. The RCS shall be capable of reporting faults and Health & Status of end items and RCS controller to the MPPU MCS.
- c. The RCS shall control all refrigeration system components to maintain the air temperature at the set point received from the MPPU MCS within +/-2 deg F.
- d. The RCS shall receive the following inputs from the MCS for operation while in remote mode:
 - 1) Air temperature setpoint
 - 2) No of compressors (initial value used for startup only)
- e. The system shall be capable of managing both refrigeration circuits independently from a single air temperature feedback value.

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- f. The system shall be capable of monitoring hot gas bypass valve (HGBV) command signal.
- g. Compressors shall be turned on and off based upon HGBV command for changing ambient conditions, as indicated in Figure 1.

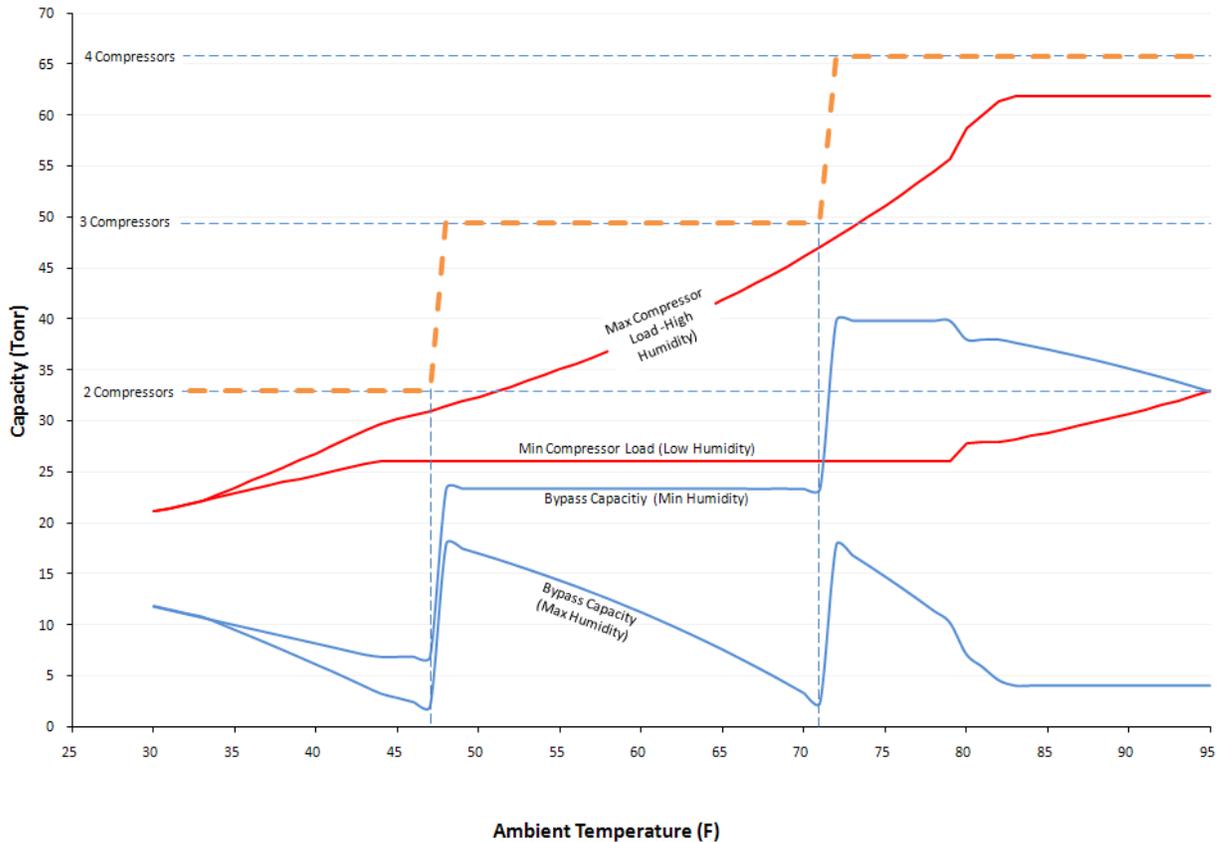


Figure 1. Compressor startup conditions based upon Hot Gas Bypass Valve position

- h. Compressors shall limit starting cycling in accordance with manufacturer recommendations.
- i. The system shall be capable of maintaining condenser pressure within 5% of set point by use of variable speed condenser fans.
- j. The system shall provide monitoring of the superheat controller output, but shall not interfere with safe operation.
- k. The system shall close the electronic expansion valve upon shutdown.
 - 1) The system shall provide an automated startup and shutdown sequence. This sequence shall have all features necessary for protecting compressors, valves, coils, fans, transducers and all features required for safe startup and shutdown.
 - 2) Startup and shutdown shall be initiated by a command from the MCS.

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C. RCS Touch screen Interface

1. The RCS shall provide a local interface consisting of a touch screen interface or equivalent manual controls. The interface panel shall display as a minimum, the following information during all control modes:
 - a. Fan speed and status for each of the condenser units
 - b. Refrigeration system control status (Local/Off/Remote)
 - c. Evaporator off coil air temperature
 - d. Evaporator off coil air temperature set point
 - e. Evaporator refrigerant outlet temperature
 - f. Refrigeration equipment warning and fault indicators
 - g. Individual compressor operating hours

2. The RCS interface panel shall provide the following control functions in local control mode:
 - a. Fan speed set point
 - b. Evaporator off coil air temperature set point
 - c. Individual compressor start/stop commands
 - d. Control buttons required to reset refrigeration equipment faults

D. Interface to MPPU MCS

1. Information exchange between the RCS and the MPPU MCS shall be via Ethernet network and hardwired I/O. The RCS shall be capable of transmitting and receiving alarm conditions, trip conditions, and refrigeration real and discrete parameters as required for successful remote control of the refrigeration system.

2. The RCS Ethernet interface shall provide and allow at a minimum for the following RCS feedbacks (H&S) to be transmitted to the MCS.
 - a. Local control permissive
 - b. The fan speeds and On/Off/Fault status for each of the condenser fans.
 - c. On/OFF status for each of the compressors
 - d. Refrigeration System On/Off/Fault/Alarm Status
 - e. Refrigeration control valve commands
 - f. All refrigeration system pressure transducer and switch feedbacks.
 - g. All refrigeration system temperature transducer feedbacks
 - h. All refrigeration system level transducer feedbacks
 - i. All compressor motor current feedbacks
 - j. All refrigeration equipment alarms and warnings
 - k. Individual compressor operating hours

3. The RCS Ethernet interface shall provide and allow at a minimum for the following RCS commands and set points to be transmitted from the MCS.
 - a. Number of compressors required at startup
 - b. Ambient temperature and humidity

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- c. Refrigeration system On/Off command
- d. Compressor “Disable” control for each compressor.
- e. Condenser pressure set point
- f. Refrigeration system off coil temperature set point
- g. Refrigeration system reset
- h. Refrigeration system emergency shutdown
- i. Refrigeration Local control

- 4. The RCS hardwired I/O interface shall include the following control signals.
 - a. Refrigeration system On/Off command

E. Safety systems

- 1. The RCS shall not be allowed to operate in local or remote control mode without process airflow thru the evaporator.
- 2. The RCS shall contain safety logic which initiates a system shutdown in the event a problem occurs with any of the refrigeration equipment or an Emergency Stop is issued to the RCS by the MCS. The RCS shall report fault condition to MCS and local interface panel.
- 3. Loss of electrical power to any or all of the components of the refrigeration system shall result in shutdown.
- 4. Upon receipt of an Emergency Stop command from the MCS, the RCS shall shutdown all compressors and condenser fan motors.
- 5. After an Emergency Stop, the refrigeration system shall not restart until all alarms and faults are cleared and a normal startup sequence is initiated.
- 6. Condenser fans shall be used for a minimum of 10 minutes before operating compressors, to ensure saturated liquid at the expansion valve.
- 7. The minimum required Refrigeration Unit alarm/shutdown parameters are described below:
 - a. Refrigerant temperature as measured on the discharge line from each compressor:
 - 1) Temperature range: 0 to 300 degrees F;
 - 2) Alarm – 200 degrees F
 - b. Reservoir Oil Temperature monitored by the reservoir oil tank temperature transmitter:
 - 1) Temperature range: 0 to 200 degrees F
 - 2) Alarm: 120 degrees F
 - 3) Shutdown: 130 degrees F
 - c. Compressor Oil Level Transmitter:
 - 1) Level transmitter range: 0 to 100%
 - 2) Alarm: 50%
 - 3) Shutdown: 35%
 - d. R410A Compressor Discharge Pressure Transmitter:
 - 1) Pressure range: 0 to 1000 psig
 - 2) Low Alarm: 4 psig;
 - 3) High Alarm: 475 psig

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- 4) High Shutdown: 500 psig
- e. Compressor Suction Pressure Transmitter:
 - 1) Range: 0 to 1000 psig
 - 2) Alarm: 130 psig
 - 3) Shutdown: 200 psig

Note: Suction pressure limits shall be bypassed for 10 seconds after compressor startup and any time the compressor is not operating.
- f. Compressor discharge line Low Pressure Switch. Typical for each compressor
 - 1) Compressor Discharge Line Switch range: 0 to 1000 psig
 - 2) Low Alarm: 400 psig
 - 3) Shutdown – N/A
- g. Compressor Motor Current Transmitter:
 - 1) Range 0 to 100 amps;
 - 2) Alarm – 5 amps delta between any operating compressors

The Contractor may provide any additional alarm and/or shutdown features he deems necessary to operate the Refrigeration Unit in a safe manner

2.21 RE-HEAT COIL SYSTEM

- A. Heat Transfer Fluid: 20% Propylene glycol, 80% water mixture, by volume.
- B. Operating Pressure 9psig
- C. Design Pressure: 50 psig
- D. Air working pressure: 4 psig
- E. Maximum Design pressure: 6 psig
- F. Operating Temperature: 195°F
- G. Maximum off coil air temperature: 105°F
- H. Outlet 1 Coil (Replace)
 - 1. The outlet 1 reheat coil assembly shall include the coil, gasket, casing, headers, connections, and associated mounting fasteners.
 - 2. The replaced coil shall be subject the construction and performance parameters as supplied on the contract drawings.
 - 3. Recommended manufacturer and part number as per contract drawing
- I. Outlet 2 Coil (Refurbish)
 - 1. Outlet 2 coil consists of the coil, casing, gaskets, connections, mounting hardware, and interface connections. The coil shall be subject to the following requirements:
 - a. Coil shall be mechanically cleaned and flushed.
 - b. Fins shall be combed to restore them to their original condition.
 - c. Coil casing, tubes, and fins to be clean, free of rust, scale, deposit, or oxidation (Internal and external)
 - d. Coil flanges shall be mechanically flat within 1/16”

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- e. All fluid passageways and connections shall be leak tested to 50 psi
- f. Coil casing shall be airtight to 6 psig

J. Outlet 3 Coil (Refurbish)

1. The Outlet 3 coil consists of the coil, casing, gaskets, connections, mounting hardware, and interface connections. The coil shall be subject to the following requirements:
 - a. Coil shall be mechanically cleaned and flushed.
 - b. Fins shall be combed to restore them to their original condition.
 - c. Coil casing, tubes, and fins to be clean, free of rust, scale, deposit, or oxidation (Internal and external)
 - d. Coil flanges to be mechanically flat within 1/16"
 - e. All fluid passageways and connections shall be leak tested to 50 psi
 - f. Coil casing shall be airtight to 6 psig

K. Circulation Pump (Replace)

1. The Reheat System circulation pump-motor unit shall consist of a horizontal, centrifugal pump unit which includes motor, pump, and connection flanges.
2. The pump unit shall be base mounted to the existing structure in accordance with the contract drawings and vibration isolated from adjoining piping.

The pump shall meet the following performance and construction requirements:

- a. Motor Construction: All bronze
- b. Flow: 29 gpm
- c. Min. Head at rated flow 16 ft of water
- d. Power: 1/3 Hp
- e. Voltage: 115VAC, Single Phase, 60 Hz
- f. Rated Working Pressure: 125 psi
- g. Motor speed: 1750 RPM
- h. Suction Connection: 1 5/8" ODS sweat
- i. Discharge connection: 1 5/8" ODS sweat

3. Recommended manufacturer and part number as per contract drawing

L. Circulation Heaters (Replace)

1. The circulation waters heaters shall include all controls, fittings, mounting hardware and power connections.
2. The circulation heaters shall be located in accordance with the contract drawings, and supported from the structure according to sound engineering practice and in accordance to the contract drawings.
3. The heaters shall be subject to the following requirements:
 - a. Heating Capacity: 40kW (each)
 - b. Construction: Stainless steel chamber
 - c. Power: 460V
 - d. Phase: 3 phase, 60 Hz
 - e. Inlet Connection: 2" MNPT
 - f. Outlet Connection: 2" MNPT

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4. Recommended manufacturer and part number as per contract drawing
5. Wiring: The factory supplied thermostat shall not be utilized
6. All connections shall be shall be protected in accordance NEMA 4x :

M. Fluid Temperature Thermocouple (Replace)

1. The fluid temperature thermocouple shall include: thermocouple, wiring leads, connection port, and process piping.
2. The thermocouple shall be subject to the following requirements:
 - a. Sheath Diameter: ¼” OD
 - b. Grade: Type T
 - c. Sheath Material: 304 Stainless Steel
 - d. Grounded: Ungrounded and insulated
 - e. Length: 1 3/8”
 - f. Mounting Connector: ½” NPT, Stainless steel
 - g. Temperature Range: -328 - 662°F
 - h. Error: 0.75%
 - i. Max. Internal Pressure: 50 psig
3. Recommended manufacturer and part number as per contract drawing

N. Reheat Water Flow Control Valve (Replace)

1. The reheat loop flow control valves shall be stem actuated ball valves furnished in accordance with the contract drawings.
2. The control valve shall be subject to the following performance and construction requirements:
 - a. Valve size: 3/4 inch
 - b. Valve Body: Brass
 - c. Ball and Stem: 316 Stainless Steel
 - d. Seats: TFE
 - e. Seals: TFE
 - f. Connections: 1 1/8” ODS Copper Sweat
3. Recommended manufacturer and part number as per contract drawing

O. Bypass Loop Control Valve (Replace)

1. The bypass loop control valve shall be a stem actuated ball valve furnished in accordance with the contract drawings.
2. The control valve shall be subject to the following performance and construction requirements:
 - a. Valve size: 1 inch
 - b. Valve Body: Brass
 - c. Ball and Stem: 316 Stainless Steel
 - d. Seats: TFE

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- e. Seals: TFE
- f. Connections: 1 5/8" ODS Copper Sweat
- 3. Recommended manufacturer and part number as per contract drawing

P. Control Valve Actuators (Replace)

- 1. The control valve actuator is to include actuator, adapters, and supports, wiring and associated fasteners.
- 2. The valve actuator shall be directly mounted to the valve stem and body in accordance with the manufacturer recommendation and with the manufacturer supplied adaptation hardware.
- 3. Control and power wiring shall be in accordance with the supplied contract drawings.
- 4. The furnished actuator shall be subject to the following requirements:
 - a. Travel: Quarter turn
 - b. Supply voltage: 110 VAC
 - c. Control input: 4-20 mA
 - d. Position Feedback: 4-20 mA
 - e. Torque: 1300 in-lb
 - f. Upper travel limit: Limit switch (Normally Open)
 - g. Lower travel limit: Limit switch (Normally Open)
 - h. Enclosure protection: NEMA 4X
- 5. Recommended manufacturer and part number as per contract drawing

2.22 OPERATOR COVER (REPLACEMENT)

- A. The furnished operator cover shall include, overhead cover, support struts, mounts, temporary weather screens, and all associated mounting hardware.
- B. The operator cover shall be a permanent part of the MPPU unit, permanently mounted. When not in use, the cover and all hardware shall not extend more than 3 inches beyond the exterior of the MPPU.
- C. In its folded position, the cover and all accessories and hardware shall be securely fastened to the MPPU.
- D. The operator covers shall be mounted to the MPPU by means of four removable (4) stainless steel (316) hinge pins. The pins shall be captured by means of stainless steel cotter pin.
- E. The mounting clevis shall be welded to the vertical primary structure of the MPPU so that the clevis or support struts shall not interfere with the access of any electrical enclosures or louvered panels.
- F. The support struts shown on the contract drawings shall terminate on the MPPU within easy reach of all operating personnel, during storage conditions and when in use.

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- G. The cover shall be subject to the following requirements:
 - 1. Minimum Clearance: 6' 6"
 - 2. Minimum width: 4' 2"
 - 3. Material: 6063 Aluminum,
 - 4. Paint: NASA-STD-5008 (Zone 3)
 - 5. Color: White, FED-STD-595 color number 17925
 - 6. Hinge type: Removable pin.
- H. Final design of operator cover, and detailed drawings shall be submitted to the government for approval before fabrication

2.23 RUNNING GEAR (REFURBISHMENT)

- A. The running gear includes front and rear assemblies, braking systems, latches, tires, and associated hardware.
- B. Both front and rear running gear assemblies shall be refurbished subject to the following minimum requirements:
 - 1. Replace tires with OEM equipment or manufacturer approved equal
 - 2. Replace bearings in wheels and pivots
 - 3. Strip, sandblast, and repaint all painted surfaces in accordance factory standards
 - 4. Replace cylinder seals
 - 5. Bleed braking system
 - 6. Repair linkages including bearings, and replacement of damaged or worn parts.
 - 7. Turn or replace drums and replace brake shoes

PART 3. EXECUTION

3.1 PROJECT MANAGEMENT

- A. A project manager shall be appointed by the contractor for the duration of the project. The tasks to be accomplished shall include the following:
 - 1. Managing the project day to day
 - 2. Serving as the primary contractor interface and the Contracting Officer or designated representative.
 - 3. Ensuring project staffing is consistent with requirements.
 - 4. Ensuring the project remains on schedule and systems are delivered as promised.
 - 5. Ensuring the management and reporting requirements of the Contract are met.

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3.2 SYSTEM DESIGN

- A. Design activities shall start upon Contract award or after receipt of the Authorization to Proceed. The system design phase shall be completed following final approval of all design documentation. A project kickoff meeting and design review shall be conducted. The design documentation required is listed in the “Submittals” paragraph of this Specification.
- B. Commissioning test procedures shall be developed within 30 days following completion of the design documentation. A commissioning planning review shall be scheduled during this period. The procedures to be developed are listed in the “Submittals” portion of this Specification.
- C. All MPPU systems shall be designed for outdoor conditions in accordance with the requirements given in this Specification. All equipment and components shall be designed to operate in this environment.
- D. Life Cycle and Duty. The system shall be designed for a life cycle of 20 years with a duty cycle of 4000 operating hours per year.
- E. Maintainability: System availability shall be considered as a major factor during the design process. Components shall be selected to minimize maintenance requirements over the specified life cycle specified herein. The system shall also be designed with easy access to all components for maintenance and repair.
- F. The Refrigeration Unit installation shall be designed for easy access to all piping and components.

3.3 FABRICATION AND ASSEMBLY

- A. The MPPU Refurbishment shall be fabricated and assembled in accordance with approved drawings and procedures.
- B. The inside of the ductwork shall be visually clean in accordance with KSC-C-123 and the outside to general clean in accordance with KSC-C-123.
- C. Tapped holes and threads shall be in accordance with ASME B1.1
- D. Fasteners shall be Stainless Steel, 304 or 316 Stainless in accordance with the standards identified on Drawing M-1 of contract drawings.

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- E. Installation of Refrigeration Unit components shall be in accordance with the manufacturers' written instructions and under the direction of a certified refrigeration technician.
- F. The Refrigeration Units shall be assembled and installed into the MPPU's at the Contractor's refurbishment facility in accordance with the contract drawings.
- G. Components shall be marked to indicate pertinent operational requirements, warnings, and limitations such as maximum allowable operating pressure, temperature, range of adjustment, flow capacity, stroke, direction of flow, rotation or motion, safety precautions, and materials compatibility. The markings shall be by stamping or embossing on the component or on an attached plate or tag which shall, barring mutilation, remain affixed and legible for the life of the component.
- H. Components and Subassemblies shall be securely mounted to the existing MPPU supporting structure. Care shall be exercised that fasteners are not over tightened to the extent that component bodies are distorted or damaged. Pivot type mountings shall be carefully aligned to ensure free operation throughout the entire range of movement. Subassemblies shall be mounted and supported independently of the connecting lines.
- I. Pumps and motors shall be carefully aligned using motor adapters and couplings to maintain angular and radial misalignment between the mating shafts within the pump manufacturer's requirements. Lubricant free shaft couplings shall be selected.
- J. Refrigeration tubing shall be securely mounted and anchored to structural members in accordance with the reference standards, drawings and accepted industrial practice. Supports shall be provided at all equipment, branch line, elbow, and valve connections.
- K. Seals shall not be removed from tubing assemblies or from ports on components until the lines are ready for connection. Provisions, including but not limited to providing portable screens and shelters, shall be taken to minimize the entrance of abrasives, dirt, metal chips, and other foreign materials into the refrigeration system through open ends of lines and ports of components.
- L. Valves shall be installed with adequate supports to prevent deflection of line during static and dynamic operation. Valves shall be oriented such that operators are readily accessible.

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- M. Tubing shall be cut square using tube cutters specifically designed for the material to be cut. The use of hacksaws or other chip – producing equipment shall not be permitted. Burrs shall be completely removed after the tubing is cut and the inside diameter of the tube shall be chamfered slightly. After the cutting and deburring operations, all metal fragments shall be removed from the tubing interior and from sealing surfaces. Tube benders designed and recommended by the manufacturer shall be used for bending copper and stainless steel tubing of the wall thicknesses and sizes required for the installation. Bends shall be accurately made to the proper angle so that fittings align properly and mate without application of force or springing of the tube or fitting and alignment shall be true enough so that threads may be engaged and hand turned not less than three turns. Bends shall be completely free from wrinkling, and flattening shall not exceed 5 percent of the outside diameter. Tube benders shall be provided with the necessary radius blocks, slide blocks, and special close radius blocks, as required to adapt the bending tools to the requirements of the work. Where necessary to ensure properly fabricated bends, internal mandrels of proper diameter for the size and wall thickness of the tubing shall be used.

- N. Refrigeration copper tubing brazing requirements: See Specification Section 2.16 for Piping/Tubing material requirements.
 - 1. Brazing shall be performed in accordance with KSC-SPEC-Z-0005.
 - 2. Inspection shall be in accordance with KSC-SPEC-0005 with the following requirements:
 - a. Visual inspection shall be performed on 100 percent of joints brazed by the contractor.
 - b. Acceptance shall be in accordance with KSC-SPEC-0005 for brazing.
 - c. Leak test per ASME B31.5 section 538.

- O. Insulation. All tubing and piping to be insulated shall be tested, inspected and approved prior to concealment.

- P. Compressors, tubing, and accessories shall be grounded and bonded to the existing MPPU structure per KSC-STD-E-0012.

- Q. Supports shall be block-style, two-piece, polypropylene, heavy-duty clamps which function as guided restraints for the pipe. The supports shall be mounted in a slotted track support as shown on the contract drawings, which will permit the pipe to expand and contract without producing excessive strain in the pipe and/or support system.

- R. All manifolds, valves, gages, etc., shall be identified with permanently attached metal tags that identify the specific component on the piping schematic in accordance with the contract drawings.

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S. Painting.

1. Factory/manufacturer's coatings are acceptable.
2. Unpainted components and structural items shall be painted in accordance with NASA STD-5008. Machined contact surfaces shall not be painted. The colors shall be according to FED STD-595:

<u>Color</u>	<u>Components to be Painted</u>
Yellow no. 13655	Dangerous parts of the test stand which may cut, crush, shock, or otherwise injure. Guards and physical hazard labels and signs to caution against striking, falling, tripping, or being caught in between
White no. 17925	Base machine and electrical equipment including any panels mounted on the MPPU's.
White no. 17925	Interiors of control boxes, fuse boxes, panels, etc.
Coordinate with Government	Controls, consoles, instrumentation, and associated electrical cabinet exteriors.
Coordinate with Government	Control panel faces.

T. Mechanical Identification

1. All tags, placards, warnings, panels, instruments, and equipment requiring identification shall be marked with labels, materials, and visibility in accordance with KSC-STD-E-0015. All identification shall be applied after final paint and insulation has been applied.
2. Tubing and Piping shall be marked in accordance with KSC-STD-SF-0004. Piping and tube shall clearly indicate hazards, flow directions, and maximum pressures.
3. Components identified by A numbers (excluding filters) shall be identified by stainless steel tags as identified on the contract drawings.
4. Total weight and Center of Gravity shall be marked with labels and visibility in accordance with KSC-STD-E-0015.

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3.4 FACTORY TESTING

- A. The Refrigeration Unit shall be part of the refurbished MPPU and the factory testing shall be included within the MPPU Factory Test Plan. The Contractor shall support the testing and rework the refrigeration system as required until its performance is accepted.
- B. Prior to shipment of the MPPU to the site, the factory acceptance test shall be completed to ensure quality performance of the MPPU.
- C. The factory acceptance test procedures shall be prepared by the Contractor and approved by the contracting officer or designated representative at the conclusion of the design phase activities.
- D. Notification: Notify the contracting officer or designated representative at least two weeks in advance of performing final shop tests so that contracting officer or designated representative may witness any or all tests.
- E. The factory test for each MPPU skid shall include the following, as a minimum:
 - 1. Material/component inspection
 - 2. Dimensional inspection
 - 3. Weight measurement and location of MPPU Center of Gravity
 - 4. Continuity of all internal signal and power wiring
 - 5. Rotation direction of all motors and actuators
 - 6. Safety and measurement sensor testing
 - 7. Safety logic testing
- F. Pressure test requirements are as follows:
 - 1. An approved test procedure to start and operate subsystems, components and accessories through complete cycles is required before beginning a test.
 - 2. The test shall be a pneumatic leak test in accordance with the ASME B31.5, Refrigeration Piping and Heat Transfer Components.
 - 3. Test medium: Clean, dry air with dew point less than -10F.
 - 4. Pressure source: Laboratory Grade, compressed air in K bottles at 2200 psig.
 - 5. The piping on each unit shall be isolated as required and subjected to a static air pressure of 50 psig. A leak test shall be performed over a period of two hours, with connections and joints checked with leak detection fluid. Leaks and loss in test pressure due to leaks will constitute defects that must be repaired and approved before proceeding.
 - 6. The high side piping shall be isolated and subjected to a static pressure of 605 psig, which is 1.1 times the design pressure of the piping. The test source shall be isolated and allowed to stand for a period of four hours. Leaks and loss in test pressure will constitute defects that shall be repaired and approved before proceeding.

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7. Defective or damaged pumps, accessories, and controls shall be replaced with new materials.
8. Leaks and defects shall be replaced with new materials and the system retested until satisfactory results are obtained.
9. Portions of piping that vent the relief side of pressure safety relief valves to atmosphere need not be tested.
10. The low pressure side piping shall be isolated and subjected to a static pressure of 511 psig, which is 1.1 times the design pressure of the piping. The test source shall be isolated and allowed to stand for a period of four hours. Leaks and loss in test pressure will constitute defects that shall be repaired and approved before proceeding.
11. Defective or damaged components, accessories, or controls shall be replaced with new materials.
12. Leaks shall be repaired and defective or damaged components replaced with new materials and the system retested until no leaks are detected within the test period.
13. Portions of piping that vent the relief side of pressure safety relief valves to atmosphere need not be tested
14. Records of each pressure test shall be made. These records shall include the following:
 - a. Date of test
 - b. Identification of piping assemblies tested.
 - c. Test medium used.
 - d. Test pressure and holding time.
 - e. Signed, marked-up set of flow diagrams indicating sections of piping tested.
 - f. After completing the pressure test, the piping shall be evacuated to a pressure of 29.9-in Hg and filled with Refrigerant R410A.

G. The system shall be cleaned as part of the In-Service Leak Test described below.

1. An in-service leak test shall be performed on each refurbished refrigeration system.
 - a. Initial Service Leak Test: The system shall be fitted to its operating configuration. Perform an initial service leak test to verify that all connections are leak tight at the design operating conditions. The system shall run for two hours at the design operating conditions without observing or measuring any leaks.
 - b. Defective or damaged components, accessories, and controls shall be replaced with new materials.
 - c. Leaks and defects shall be replaced with new materials and the system retested until satisfactory results are obtained.
 - d. Take samples of refrigerant from test ports upstream and downstream of the strainers on each compressor.
 - e. Piping shall be cleaned to KSC-C-123 level 500 cleanliness.
 - f. Continue the test until the maximum number of particles per 0.1 square meters meets the following requirement:

Class 500	
Size, microns	No. per/0.1m ²
<100	unlimited

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100 to 250	1073
>250 to 500	27
>500	0

- g. The system shall be left fully charged with new elements installed in all strainer and filter housings.

H. Factory Acceptance Testing

1. Scope: This specification paragraph covers the Factory Acceptance Test requirements for a MPPU.
2. General
 - a. The MCS controls all functions of the MPPU. Software shall be furnished and installed by the Contractor. The Contractor shall perform a functional test on the MPPU to ensure proper operation of all controls, failure modes, and equipment operation in accordance with the sequence of operation included in this specification document.
3. Requirements
 - a. A contractor operator, approved by the Government, under the supervision of a Government operator, shall enable the control system and cycle all components to demonstrate operation and complete all setup and pre-operations required for startup.
 - b. Verify functionality and performance of all safety interlocks.
 - c. Verify functionality and performance of Normal and Emergency Shutdown Functions.
 - d. Verify the functionality of the blower, blower inlet damper, dump valve, flow control valves, compressor units, condenser fans, heat rejection fans, heat rejection control valve, tempering fluid circulation pumps, tempering heaters, instrumentation and controls.
 - e. Measure and record maximum flow rates with supporting data such as humidity levels, temperatures and pressures for the following:
 - 1) Outlet 1 duct
 - 2) Outlet 2 duct
 - 3) Outlet 3 duct
 - f. During the testing period and prior to start of testing each day, the Contractor shall monitor measure, record and log outside air temperature (DB and WB) and atmospheric pressure.
 - g. Following startup, measure and record input voltage and current on all three phases where applicable.
4. Performance
 - a. Verify that the 480 volt contactor is engaged following reduced voltage starter power-up cycle.
 - b. Measure, record and log the following parameters:
 - 1) Blower inlet pressure
 - 2) Blower discharge pressure

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- 3) Blower discharge temperature
- 4) Concurrent flow conditions on discharge ducts.

Duct discharge pressure: 2.5 psig	
Requirement	Measurement
Outlet 1 duct: 85 lbm/min at 95F, 37 gr/lbm da	Flow rate, temperature, absolute humidity
Outlet 2: 100 lbm/min at 95F, 37 gr/lbm da	Flow rate, temperature, absolute humidity
Outlet 3 duct: 72 lbm/min at 95F, 37 gr/lbm da	Flow rate, temperature, absolute humidity

- c. Measure and record the following motor currents:
 - 1) Tempering fluid heater circulation pump.
 - 2) Each condenser fan.
 - 3) Each heat rejection fan.
 - 4) Heat rejection fluid circulation pump.
 - 5) Wrap around coil circulation pump.
 - 6) Each compressor motor.
- d. Measure and record the following temperatures and pressures:
 - 1) Inlet and discharge air temperature on heat rejection coil.
 - 2) Air temperature immediately downstream of evaporator coil.
 - 3) Pressure, dew point temperature and dry bulb temperature downstream of HEPA filters.
 - 4) Differential pressure across tempering fluid circulation pump.
 - 5) Purge Air quality measurements of particulate and NVR based on a sample taken from each discharge duct. The air quality requirements are:
 - (i) Cleanliness level shall meet ISO Class 8, per ISO-146441-1.
 - (ii) Hydrocarbon content shall not exceed 15 ppm maximum methane content.
- e. The contractor shall verify operation of compressor unit and measure and record motor current of each compressor motor at full load. Measure and record motor current during hot gas bypass operation.
- f. The contractor shall verify operation of the tempering fluid heaters including measurement and recording of heater current.
- g. Test Results
 - 1) Contractor shall prepare and submit a Factory Acceptance Test Report. The report shall include the following:
 - (i) Description of Test Setup
 - (ii) Discussion of Results
 - (iii) Discussion of Problems and Resolution including any repairs or rework required
 - (iv) Data including electronic files and manual data.

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3.5 DELIVERY, STORAGE, AND HANDLING

- A. The MPPU Upgrade Packages shall be properly crated and delivered to the job site. Materials and equipment, including surface finish, shall be protected against detrimental conditions within Contractor’s control, including: freezing, corrosion, penetration of dust and other particulate during shipping; on-site storage, installation and connection, or until acceptance at the storage location designated by the Government.
- B. If temporary storage of the equipment is required by the Contractor, the equipment shall be kept dry and, protected from weather and mechanical damage. The equipment shall be packaged or sealed to prevent incursion of detrimental particulate.
- C. Delivery of the systems shall be in accordance with the delivery schedule contained in the project’s Master Schedule.

3.6 FIELD QUALITY CONTROL

A. Refrigeration System Leak Test

- 1. An approved leak test procedure to start and operate pumps and accessories through complete cycles is required before beginning the test.
- 2. After completing the pressure test, the piping shall be evacuated to a pressure of 29.9-in Hg and filled with Refrigerant R410A.
- 3. The system shall be cleaned as part of the In-Service Leak Test described below.
- 4. An in-service leak test shall be performed on each refurbished refrigeration system.
 - a. Initial Service Leak Test: The system shall be fitted to its operating configuration. Perform an initial service leak test to verify that all connections are leak tight at the design operating conditions. The system shall run for two hours at the design operating conditions without observing or measuring any leaks.
 - b. Defective or damaged pumps, accessories, and controls shall be replaced with new materials.
 - c. Leaks and defects shall be replaced with new materials and the system retested until satisfactory results are obtained.
 - d. Take samples of refrigerant from test ports upstream and downstream of the strainers on each compressor.
 - e. Continue the test until the maximum number of particles per 0.1 square meters meets the following requirement:

Class 500	
Size, microns	No. per/0.1m ²
<100	unlimited
100 to 250	1073

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>250 to 500			27		
>500			0		

- f. The system shall be left fully charged with new elements installed in all strainer and filter housings.
- 5. A report for each test shall be prepared. These reports shall include the following:
 - a. Date of test.
 - b. Identification of piping assemblies tested.
 - c. Test medium used.
 - d. Test pressure and holding time.
 - e. Description of all leaks and repair details
 - f. Description of refrigerant replacement charge including total charge in the system
 - g. Description of filter and strainer element replacements
 - h. Signed set of flow diagrams marked to indicate sections of piping tested

B. Glycol Piping System Test

- 1. The following test shall apply to the glycol circuits of the following systems:
 - a. Heat absorption and rejection system
 - b. Wrap around coil system
 - c. Reheat water Circuit
- 2. The system and/or portions of piping systems to be insulated shall be tested prior to concealment. All lines shall be pressure tested prior to flushing and cleaning operations. Piping equipment and/or instruments which will not safely withstand the test pressures shall be isolated or removed. Spool pieces or isolation devices shall be provided for any piping equipment or instrumentation items removed for testing. All valves shall be turned to the OPEN position before applying test pressure. No tests shall be performed if any welded joints are concealed in any manner.
- 3. Test requirements are as follows:
 - a. An approved test procedure to start and operate pumps and accessories through complete cycles is required before beginning a test.
 - b. Each piping system shall be isolated and subjected to a static water pressure of 50 psig. A leak test shall be performed over a period of two hours, with connections and joints checked with leak detection fluid. Leaks and loss in test pressure due to leaks will constitute defects that must be repaired.
 - c. Medium: Water,
 - d. Each piping system shall be isolated and subjected to a static water pressure of 50 psi. The test source shall be isolated and allowed to stand for a period of four hours. Leaks and loss in test pressure will constitute defects that must be repaired.
 - e. Defective or damaged components, accessories, or controls shall be replaced with new materials.
 - f. Leaks shall be repaired and defective or damaged components replaced with new materials and the system retested until satisfactory results are obtained.
 - g. Portions of piping that vent the relief side of pressure safety relief valves to

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- atmosphere need not be hydrostatically tested.
4. A record of each hydrostatic test shall be made. These records shall include the following:
 - a. Date of test.
 - b. Identification of piping assemblies tested.
 - c. Test medium used.
 - d. Test pressure and holding time.
 - e. Signed set of flow diagrams marked to indicate sections of piping tested.
 5. After completing the pressure test, the system shall be cleaned using the system pressure for flushing the piping.
 - a. Supply line pressure during this flushing period shall be a minimum of 30 psi to promote purging of trapped gas and water.
 - b. Valves shall be cycled to permit all fluid conducting paths to be flushed.
 - c. The system shall be flushed until no particulate can be visually observed on the strainer screens after flushing for a period of 30 minutes. The strainers shall be removed and inspected at 15 minute intervals until they appear clean.
 - d. Pressurize system including heat exchanger to 50 psi and check for leaks.
 - e. Repair any leaks and repeat leak test until no leak is observed.

C. Ductwork Pneumatic Pressure Test

1. The following pressure test shall be applied to the length of the airline duct assembly.
2. The system and/or portions of piping systems to be insulated shall be tested prior to concealment. The ductline shall be pressure tested prior to purging and cleaning operations. Piping equipment and/or instruments which will not safely withstand the test pressures shall be isolated or removed. Spool pieces or isolation devices shall be provided for any piping equipment or instrumentation items removed for testing. All valves shall be turned to the OPEN position before applying test pressure. No tests shall be performed if any welded joints are concealed in any manner.
3. Test requirements are as follows:
 - a. An approved test procedure to start and operate pumps and accessories through complete cycles is required before beginning a test.
 - b. The duct system shall be isolated from the blower exit to the outlets of the MPPU and subjected to a pneumatic pressure of 6 psig. All condensate drain lines shall be sufficiently plugged. A leak test shall be performed over a period of two hours, with connections and joints checked with leak detection fluid. Leaks and loss in test pressure due to leaks will constitute defects that must be repaired.
 - c. Medium: Clean, filtered, industrial grade GN2.
 - d. The ductline shall withstand a pressure test to 6 psig. Leaks and loss in test pressure will constitute defects that must be repaired.
 - e. Defective or damaged components, accessories, or controls shall be replaced with new materials.
 - f. Leaks shall be repaired and defective or damaged components replaced with new materials and the system retested until satisfactory results are obtained.

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4. A record of each pneumatic test shall be made. These records shall include the following:
 - a. Date of test.
 - b. Identification of piping assemblies tested.
 - c. Test medium used.
 - d. Test pressure and holding time.
 - e. Signed set of flow diagrams marked to indicate sections of piping tested.
5. After completing the pressure test, the system shall be visually clean in accordance with KSC-C-123.
 - a. Valves shall be cycled to permit all paths to be flushed.
 - b. The system shall be purged for a period of 30 minutes. The airline filters shall be removed upon completion of purge and discarded.
 - c. New filters shall be installed after final pressure test and completing the cleaning purge.

D. Electrical Testing

1. On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and safe function.
 - a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1
 - b. Certify compliance with test parameters.
2. Correct malfunctioning conductors and cables at project site; retest to demonstrate compliance.

3.7 VALIDATION TESTING (ONSITE)

- A. Validation testing for this project shall include checkout, startup, shakedown, and final acceptance testing of the complete MPPU at the NASA location. Successful completion of each step in all four test plans shall be co-verified by the Government and/or representative. The four test plans in the final acceptance test process are defined as follows:

1. Checkout - Non-operating verification (visual and instrument testing) that the MPPU Refurbishment is properly installed in accordance with the approved design and manufacturer's installation instructions. Verification shall be made by visual inspection, instrument testing, calibration checks, and safety checks. Following a successful checkout, a component/systems readiness review shall be scheduled with the team partners before startup of each system.
2. Startup - Operating verification that the MPPU can be powered up and successfully reach design conditions.
3. Shakedown - Operation of the MPPU at the design load conditions in all operating modes including safety shutdown.
4. Final Acceptance Testing – Operation of the required valves at the design load conditions in all operating modes. This final test procedure shall prove the total functionality of the system and its ability to meet the performance requirements.

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- B. Final acceptance of each system shall initiate the start of the warranty period.
- C. MPPU validation testing requirements are as follows:
 - 1. The following checks shall be performed before startup:
 - a. The pressure relief valve set pressure and operation shall be checked with static pressure source without the system running.
 - b. The manufacturer’s startup check list shall be performed, which should include: all motor rotation check; fluid checks; check valve orientation; controls check, and; set points check and adjustment as required. Damaged and malfunctioning controls and equipment shall be replaced.
 - c. The Contractor shall provide miscellaneous parts and materials to minimize startup delays. These parts and materials shall include but not be limited to strainer elements, fuses, gages, fasteners, gaskets, lubricants, and fittings.
 - 2. Approved procedures for startup and recording data shall be followed. The Contractor shall prepare and complete a test report showing in detail the results of the commissioning tests performed on the MPPU. Three copies of the completed test report shall be delivered to the Contracting Officer not more than 48 hours after completion of the tests. The report shall include the following test data:
 - a. Equipment models, numbers, and serial numbers shall be recorded.
 - b. The operating conditions of compressors, pumps, motors, heat exchangers, and controls shall be recorded.
 - c. MPPU’s shall be started and operated through complete duty cycles.
 - d. Cooling system performance over the design operating range.
 - e. Fluid cleanliness performance measurements including particulate and moisture levels.
 - f. Refrigerant compressor unit control shall be demonstrated including automatic starting and shutdown of compressors depending on load.
 - g. Motor Current measurements shall be taken with compressors running UNLOADED and LOADED at design flow and pressure.
 - h. Refrigerant high side and low side pressures and temperatures.
 - i. Excessive vibration, by component and resolution implemented
 - j. Temperature of motors
 - k. Pertinent observations regarding such events as unusual sounds, malfunctions or difficulties encountered, and resolutions implemented.

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3.8 TRAINING

- A. Training shall be provided as part of the Contract as described in the following paragraphs.
- B. The Government shall furnish classroom facilities and projection equipment. All training shall be conducted at NASA facility on the first shift, Monday through Friday. The course material shall be submitted 2 weeks prior to start-up of the system. The type and level of effort of the training and assistance required are as follows:

<u>Course Number</u>	<u>Course Title</u>	<u>Level of Effort, MH</u>
1	Overview of the MPPU Refurbishment, Operations, Preventative Maintenance, Troubleshooting, Repair, Startup, Shutdown, Instrumentation, and Calibration, including a review of spare parts, manuals and drawings.	40

3.9 RECORD DOCUMENTS

- A. All Project Record Documents (red-line dwgs) and any software licenses shall be delivered upon acceptance of each MPPU. One copy of the Operation and Maintenance Manuals shall be delivered two weeks prior to the scheduled start of acceptance test of each system. The manual shall include recommended spare parts for all mechanical and electrical equipment.

3.10 WARRANTY

- A. The warranty service period shall be one (1) year from the date of system acceptance in accordance with the requirements contained in the General Conditions of this Specification. Warranty service shall begin based upon the date of acceptance for each MPPU. The Certificate of Substantial Completion for each MPPU shall contain the warranty dates and end dates

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SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Supplementary and Special Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.
1. Piping materials and installation instructions
 2. Equipment nameplate data requirements
 3. Labeling and identifying mechanical systems and equipment is specified in Section 11820 "MPPU Refurbishment."
 4. Touch-up painting and finishing.
- B. Pipe and pipe fitting materials are specified in piping system Sections and on drawings.

1.3 SUBMITTALS

General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Section 01300.

- A. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article of this Section.

1.4 QUALITY ASSURANCE

- A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code - Steel."
- B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions of ASME B31.5.
 2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

1.5 DELIVERY, STORAGE, AND HANDLING

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- A. Order pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

- A. Refer to individual piping system specification Sections and Drawings for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B120.1 for factory threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual system specification Sections in Division 15 for special joining materials.
- B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.
 - 1. Pipe flange gasket materials shall conform to ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, except where thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.
- D. Brazing Filler Metals
 - a. Brazing filler materials shall be in accordance with individual piping systems specifications and in accordance with NASA SPEC-Z-0005.

2.3 PIPING SPECIALTIES

- A. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
 - 1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld

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- neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
 3. Dielectric Unions: Factory fabricated, union assembly, for 250 psig minimum working pressure at 180 deg F temperature.
 4. Dielectric Flanges: Factory fabricated, companion flange assembly, for 150 or 300 psig minimum pressure to suit system pressures.
 5. Dielectric Flange Insulation Kits: Field assembled, companion flange assembly, full face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.
 6. Dielectric Couplings: Galvanized steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 300 psig minimum working pressure at 225 deg F temperature.
 7. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive, thermoplastic lining, with combination of plain, threaded, or grooved end types and 300 psig working pressure at 225°F temperature.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 15 specify piping installation requirements unique to the piping system. Clean and flush piping per the requirements of the individual piping system specifications.
- B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
- C. Install piping at indicated slope.
- D. Install components having pressure rating equal to or greater than system operating pressure.
- E. Install piping free of sags.
- F. Install piping to allow application of insulation plus 2-inch minimum clearance around insulation.
- G. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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- H. Install fittings for changes in direction and branch connections.
- I. Install couplings according to manufacturer's printed instructions.
- J. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system specification Sections.
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - 3. Soldered Joints: Construct joints according to AWS "Soldering Manual," Chapter 22 "The Soldering of Pipe and Tube."
 - 4. Brazed Joints: Construct joints according to NASA KSC-SPEC-Z-0005.
 - 5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B120.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
 - a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
 - c. Thread compound must not protrude past joint and shall not contact process fluid. Align threads at point of assembly.
 - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 - 6. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to "Quality Assurance" Article.
 - 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- K. Piping Connections: Except as otherwise indicated make piping connections as specified below.
 - 1. Install unions, in piping 2-inches and smaller, adjacent to each valve and at final connection to each piece of equipment having 2-inches or smaller threaded pipe connection.
 - 2. Install flanges, in piping 2-1/2-inches and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - 3. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to

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connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Engineer.
- B. Install equipment level and plumb, parallel and perpendicular to other systems.
- C. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

3.3 PAINTING AND FINISHING

- A. Damage and Touch up: Repair marred and damaged factory painted finishes with materials and procedures to match original factory finish.

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SECTION 16195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes identification of electrical materials, equipment, and installations.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with ANSI C2.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 1. Brady USA, Inc.; Industrial Products Div.
 2. Carlton Industries, Inc.

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- 3. Cole-Flex Corp.
- 4. Ideal Industries, Inc.
- 5. Panduit Corp.
- 6. Seton Name Plate Co.
- 7. Standard Signs, Inc.

2.2 WIRE MARKERS

- A. Wire markers shall be oil-resistant, adhesive-backed vinyl film with legends etched into the surface. Markers shall be Brady B-700 or equal.

2.3 IDENTIFICATION LABELS

- A. Identification labels for receptacles and switches shall be black lettering on a white vinyl adhesive background. Identification labels shall conform to the standards in KSC-STD-E-0015.

2.4 ENGRAVED NAMEPLATES AND SIGNS

- A. Engraved labels, nameplates, and signs shall be constructed and mounted in accordance with KSC-STD-0015.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Electrical cable assemblies shall be identified at each end of the cable and labeled in accordance with NASA-STD-8739.4.
- B. Each branch circuit conductor shall be labeled with wire markers to identify circuit number. Identify wires at each connection and junction box.
- C. All receptacles and switches shall be identified by circuit number. Devices shall have identification on the inside of receptacle and switch wall plates.
- D. Install identification devices according to manufacturer's written instructions.
- E. Install labels at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- F. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract

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Documents or required by codes and standards. Use consistent designations throughout the Project.

- G. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- H. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
- L. Apply warning, caution, and instruction signs and stencils as follows:
 - 1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.
 - 2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- M. Install identification as follows:
 - 1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use lettering 2 inches (51 mm) high. Use black lettering on white field. Apply labels for each unit of the following categories of equipment.
 - a. Panelboards, electrical cabinets, and enclosures
 - b. Motor control centers.
 - c. Motor starters.
 - d. Push-button stations.
 - e. Contactors.
 - f. Control devices.
 - g. Transformers.
 - h. Receptacles.
 - i. Switches.
 - j. Safety Switches.
 - 2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

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