3rd Air Stream at B18 Complex
Wright-Patterson AFB, Dayton, OH

AF Project Number: ZHTV220801
P2#: 503968

SECTION 23 80 20.20 10

GAS-FIRED AIR HEATERS - 2ND AIRSTREAM
05/20

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel

AMERICAN PETROLEUM INSTITUTE (API)

API RP 530	(2015) Calculation of Heater-tube Thickness in Petroleum Refineries
API 560	(2016) Fired Heaters for General Refinery Service

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2021) National Fuel Gas Code
NFPA 70	(2023) National Electrical Code
NFPA 85	(2019) Boiler and Combustion Systems Hazards Code

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

1.2 SUBMITTALS

Government approval is required for submittals prior to construction.See section 1.3 for detailed submittal descriptions. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submittal Register

Quality Control Plan

SD-02 Shop Drawings

Certified Dimensional General Arrangement Drawings

Foundation Loading Diagrams Including Dimensions Of Mountings And Baseplates

Structural Steel Drawings

Burner Assembly Drawings

Coil Support Details

Instrumentation Installation Details

Electrical Schematics And Wiring Diagrams For Blower Motor

Instrumentation And Control Schematics, Wiring Diagrams, And Bill Of Materials

Instrumentation And Control Arrangement Drawings

SD-03 Product Data

Combustion Blower

Blower Motor

Air Dampers

Gas Control Valves

Gas Isolation Valves

Burner And Pilot Details

Flame Safeguard And Burner Management System

Tabulation Of Maximum Electrical And Instrument Air Utility Requirements

ISA Data Sheets For All Instruments And Controls

Product Manuals, Installation Instructions And Calibration Information For All Instruments And Controls

Air Heater Controller Code

Control Parameters, And Alert And Danger Alarm Settings Tabulation

SD-05 Design Data

Structural Steel Calculations

Tube Support Calculations

Refractory Thickness Calculations, Including Temperature Gradients Through All Refractory Sections And Sources Of Thermal Conductivities

Performance Curves And Data Sheets For Air Preheater, Fans, Drivers, Burners, And Other Auxiliary Equipment

SD-06 Test Reports

Welding, Welding Examination, And Welding Test Procedures And Results

Factory Test Performance Procedures

Certified Factory Test Performance Reports

Certified Hydrostatic Test Reports

Noise Data Sheets

SD-07 Certificates

Factory Testing Certification

Material Safety Data Sheets

Pressure Vessel Certification Data

Warranty

SD-08 Manufacturer's Instructions

Refractories And Insulation Installation, Dry-Out, And Test Procedures

Heater Installation And Assembly Manual

Spare Parts Recommendations And Price List

Preservation, Packaging, And Shipping Procedures

SD-10 Operation and Maintenance Data

Operating And Maintenance For The Heater And For Auxiliary Equipment Such As Air Preheater, Fans, Drivers, Dampers, And Burners

Motor Installation, Maintenance, And Operating Instructions

SD-11 Closeout Submittals

Final As-Built Of:
Certified Dimensional General Arrangement Drawings
Foundation Loading Diagrams Including Dimensions Of Mountings And Baseplates

Structural Steel Drawings
Burner Assembly Drawings
Coil Support Details
Instrumentation Installation Details
Electrical Schematics And Wiring Diagrams For Blower Motor
Instrumentation And Control Schematics, Wiring Diagrams, And Bill Of Materials
Instrumentation And Control Arrangement Drawings
Air Heater Controller Code
Control Parameters, And Alert And Danger Alarm Settings Tabulation

1.3 SUBMITTAL DESCRIPTIONS

1.3.1 Submittal Register

Submittal Register shall conform to Section 01 33 00.

1.3.2 Quality Control Plan

Quality Control Plan shall provide detailed descriptions of the processes, procedures, personnel responsibilities and reporting provided to assure that the air heater is constructed to high quality material, manufacturing and assembly standards.

1.3.3 Shop Drawings

Shop Drawings shall be provided in accordance with section 01 33 00. Preliminary and final shop drawings shall be provided. Proprietary drawings are not required.

1.3.3.1 General Arrangement Drawings

Certified Dimensional General Arrangement Drawings shall include:

a. The purchaser’s equipment number, the project name and location, the purchase order numbers,and the vendor’s reference number.
b. Coil terminal sizes, including flange ratings and facings; dimensional locations; direction of process flow; and allowable loads, moments, and forces on terminals.
c. Coil and crossover arrangements, tube spacings, tube diameters, tube-wall thicknesses, tube lengths, material specifications, including grades for pressure parts only, and all extended surface data.
d. Coil design pressures, hydrostatic test pressures, design fluid, and tube-wall temperatures and corrosion allowance.
e. A coil design code or recommended practice and fabrication code or specification.
f. Refractory and insulation types, thicknesses, and service temperature ratings.
g. Types and materials of anchors for refractory and insulation.
h. Locations and number of access doors, observation doors, burners, sootblowers, dampers, and instrument and auxiliary connections.
i. Locations and dimensions of platforms, ladders, and stairways.
j. Overall dimensions, including auxiliary equipment.

1.3.3.2 Foundation Loading Diagrams

Foundation Loading Diagrams Including Dimensions Of Mountings And Baseplates shall include:

a. Number and location of piers and supports.
b. Baseplate dimensions.
c. Anchor bolt locations, bolt diameters, and projection above foundations.
d. Dead loads, live loads, wind or earthquake loads, reaction to overturning moments, and lateral shear loads.

1.3.3.3 Additional Drawings and Diagrams

Provide the following drawings and diagrams:

a. Structural Steel Drawings; details of stacks, ducts, and dampers
b. Burner Assembly Drawings
c. Coil Support Details
d. Instrumentation Installation Details
e. Electrical Schematics And Wiring Diagrams For Blower Motor
f. Instrumentation And Control Schematics, Wiring Diagrams, And Bill Of Materials
g. Instrumentation And Control Arrangement Drawings

1.3.4 Product Data

Provide product data for the following:

a. Combustion Blower
b. Blower Motor
c. Air Dampers
d. Gas Control Valves
e. Gas Isolation Valves
f. Burner And Pilot Details
g. Flame Safeguard And Burner Management System
h. Tabulation Of Maximum Electrical And Instrument Air Utility Requirements
i. ISA Data Sheets For All Instruments And Controls
j. Product Manuals, Installation Instructions And Calibration Information For All Instruments And Controls
k. Air Heater Controller Code
l. Control Parameters, And Alert And Danger Alarm Settings Tabulation

1.3.5 Design Data

Provide the following design data:

a. Structural Steel Calculations
b. Tube Support Calculations
c. Refractory Thickness Calculations, Including Temperature Gradients Through All Refractory Sections And Sources Of Thermal Conductivities
d. Performance Curves And Data Sheets For Air Preheater, Fans, Drivers, Burners, And Other Auxiliary Equipment

1.3.6 Test Reports

Test Reports shall include logged data for factory running tests and shall include curves and envelope showing the as-built performance characteristics of pressure, flow and temperature at all operating conditions. Provide the following test reports:

a. Welding, Welding Examination, And Welding Test Procedures And Results

b. Certified Factory Test Performance Reports, or on-site commissioning report that can verify performance.
c. Certified Hydrostatic Test Reports
d. Noise Data Sheets

1.3.7 Certificates

Provide the following certificates:

a. Submit a Factory Testing Certification stating that the heater manufacturer has the equipment and capability to perform all required factory tests.
b. Material Safety Data Sheets
c. Pressure Vessel Certification Data
d. Provide manufacturer's Warranty covering all aspects of quality and workmanship for the air heater system for one year after finalization of commissioning. Warranties shall be available to cover delays in installation and extensions after commissioning.

1.3.8 Manufacturer's Instruction

Provide manufacturer's instructions for the following:

a. Refractories And Insulation Installation, Dry-Out, And Test Procedures
b. Heater Installation And Assembly Manual
c. Spare Parts Recommendations And Price List
d. Preservation, Packaging, And Shipping Procedures

1.3.9 Operation and Maintenance Data

Provide the following Operation and Maintenance Data:

a. Operating And Maintenance For The Heater And For Auxiliary Equipment Such As Air Preheater, Fans, Drivers, Dampers, And Burners
b. Motor Installation, Maintenance, And Operating Instructions

1.3.10 Closeout Submittals

Closeout Submittals shall include final as-built versions of all shop drawings.

1.4 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings, and not later than 2 months prior to the date of beneficial operation. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 General

Provide materials and equipment which are standard products of a manufacturer regularly engaged in manufacturing of the products and that essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening. All gas fired equipment must meet the

requirements of NFPA 54.

2.1.2 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.3 Equipment Guards

Completely enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto. Guard or cover high-temperature equipment and piping so located as to endanger personnel or create a fire hazard with insulation of type specified for service.

2.2 ELECTRICAL WORK

Provide electrical motor driven equipment complete with motors, motor starters, and controls. Electrical connections shall be 480VAC/3ph or 120VAC/1ph.Provide motors conforming to NEMA MG 1. Provide electrical characteristics as specified or indicated. Provide premium efficiency integral size motors in accordance with NEMA MG 1. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor through all temperature ranges in summer and winter. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring and controls power devices required for controls and devices specified, but not shown, must be provided. All electrical work shall meet the requirements of NFPA 70.

2.3 AIR HEATERS

Heater shall be provided as complete heater-burner package, including integral forced draft burner, coils, heater trim, refractory, insulation, controls, fuel train and accessory components. Heater-burner package shall be provided fully factory assembled and tested. If required for shipping, the air heater may be shipped in pieces and field assembled ready for ground mounting and connection to process air intake/discharge, plant compressed air, electrical, natural gas, vent and control lines. Equipment design and accessory installations shall permit accessibility for maintenance and service. Heater shall comply with NFPA 85/87. Heater shall be designed for working pressure of 750 psig and operating pressure of 825 psig. The air heater shall be capable of continuously producing heated compressed air at conditions listed below. Heater operation shall be stable at all points of operation within the ranges of temperatures, pressures and flows listed below. The air heater shall be provided capable of operating daily and also capable of operating after a period of inactivity of up to 30 days with no damage to the heat exchanger or any other components.

2.3.1 Performance

a. Process Air Inlet Pressure Range: 300 - 750 psig

b. Process Air Inlet Temperature: 100 degrees F

c. Process Air Inlet Flow Range: 2.5 - 34 lbm/s

d. Process Air Discharge Temperature Range: 250 - 1,250 degrees F

e. Heater Operation Period: up to 16 hours continuously

2.3.2 Construction

Provide heaters in accordance with ANSI Standards and the requirements of NFPA and API 560.

2.3.2.1 Outdoor Installation

a. Air heater shall be suitable for outdoor installation. Provide adequate weather and corrosion protection to ensure reliable service life over a 25-year period, with minimal degradation due to exposure to outdoor ambient conditions. The air heater will be installed near an active roadway which will expose all areas of the heater to possible salt spray. The exterior finish shall comply with ASTM B117.

b. Air heater shall be equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

2.3.2.2 Heater Casing and Insulation

Heater shall be completely encased in a double casing and filled with blanket insulation. Exterior casing shall be constructed of not lighter than 1/4 inch welded steel sheets primed and painted designed for installation outdoors. Internal casing shall be constructed of not lighter than 24 gauge welded 304 stainless steel or better sheets. Casing shall be gastight and shall be reinforced with structural steel to provide rigidity and prevent buckling. Insulation shall be of sufficient thickness to ensure a maximum casing temperature not to exceed 140 degrees F with a surface air velocity of 50 fpm and an ambient air temperature of 100 degrees F when operating at full capacity. Insulation material and installation shall be as recommended by the heater manufacturer. Insulation material shall not be negatively impacted by the operating frequency or duration of operation as listed in section 2.3.1 - Performance. Refractory and insulation shall be factory installed.

2.3.2.3 Supports

Air heater equipment shall be supported from the foundation with structural steel independent of the foundation. Heater supports shall permit free expansion and contraction of each portion of the heater without placing undue stress on any part of the heater or setting. For lifting and handling of the heater, lifting lugs shall be welded to the heater drum. Heater skid shall be reinforced and provided with space beneath the end of the beam for jacking the unit during installation. Holes shall be provided in the main beam for use by a rigger to drag or lift the unit by its base frame for final positioning, unless this method is not recommended by the heater manufacturer.

2.3.2.4 Piping, Terminals and Manifolds

a. The minimum corrosion allowance shall be in accordance with API

Standard 560 section 7.1.2.

b. All flanges shall be welding-neck flanges. Flanges on the inlet “cold” side to be Class 600# RTJ. Flanges on the outlet “hot” side to be Class 1500# flat faced.

c. Piping, terminals, and manifolds external to the heater enclosure shall be in accordance with ISO15649.

d. Threaded connections shall not be used for main process and fuel gas.

e. Provide low-point drains and high-point vents. The drains and vents shall be accessible from outside the heater casing.

f. Manifolds inside a header box shall be selected for the same design pressure as the connecting tubes and for a design temperature equal to the maximum fluid operating temperature at that location plus a minimum of 30°C (55°F).

g. External crossover piping shall be of the same metallurgy as the preceding heater tube; internal crossover piping shall be of the same metallurgy as the radiant tubes.

2.3.2.5 Ladder Access

a. Provide access ladders at locations required to access equipment more than 6ft above grade.

b. An intermediate landing shall be provided if the vertical rise exceeds 30ft for ladders.

c. Ladders shall be caged from a point 7.5ft above grade or any platform. A self-closing safety gate shall be provided for all ladders serving platforms and landings. Ladders shall be arranged for side step-off; step-through ladders shall not be used.

2.3.2.6 Heat Exchanger

Comply with the requirements of API 560 section 7. The process heat exchanger shall be of the helical coil type. Tubes shall be formed from 316 stainless steel or better. Tubes shall not be less than 4 inches in diameter and the thickness shall be determined in accordance with API RP 530. Coil welds shall receive 100 percent radiographic inspection. Tubes shall be bent to a true radius. Tubes that are distorted in bending, flattened or ridged are not acceptable. Design of the tubes shall permit tubes to drain by gravity. Coil supports shall be fabricated material(s) optimized to provide corrosion resistance at the heaters minimum and maximum operating temperature. The coil supports shall be designed to minimize expansion and creep due to frequent heater cycling (ON-OFF and modulation).

a. Calculations made to determine tube-wall thickness for coils shall include considerations for erosion and corrosion allowances for the various coil materials. The corrosion allowances shall be 0.040 in.

b. Maximum tube-metal temperature shall be determined in accordance with API 530. The tube-metal temperature allowance shall be at least 25 degrees F.

c. All tubes shall be axially seamless. Electric flash welding shall not be used for intermediate welds. Tubes furnished to an average wall thickness shall be in accordance with suitable tolerances so that the required minimum wall thickness is provided.

2.3.2.7 Economizer

Provide economizer or process air pre-heater that is capable of pre-heating incoming process air using combustion flue gasses passing through a heat exchanger before being vented to atmosphere.

a. Heater shall be furnished with a packaged extended surface economizer. Economizer shall be shop assembled and shipped complete with structural steel frame, inner casing and shop applied insulation. Economizer shall be designed and fabricated in accordance with ASME BPVC SEC VIII. Flue gas flow through economizer shall be vertical.

b. Economizer shall be of continuous tube, loop tube design. Minimum design temperature of the economizer shall be 700 degrees F. Economizer shall be hydrostatically factory tested at 1.5 times the tube side design pressure. The unit shall be ASME code stamped and shall include nameplate and code documentation.

c. Headers and tubes shall be 316 stainless steel with minimum Schedule 40 wall thickness and equipped with minimum ANSI Class 600 raised face weld neck flanged connections. Header wall thickness and flange rating shall be dependent on tube side design pressure in accordance with ASME BPVC SEC VIII requirements. Tube arrangement shall be of the open lattice design. Drilled tube sheets are not acceptable.

d. The economizer shall be insulated with a minimum 2 inch thick blanket type insulation or approved equal.

e. Outer casing shall be weatherproof with a minimum 1/4 inch welded steel sheets factory primed and painted for outdoor exposure. Exposed surfaces not enclosed by outer casing shall be painted with high temperature paint.

f. Access door or flanged inspection plate (2" minimum), of galvanized steel construction, shall be provided in the economizer design. Access door shall be insulated.

g. Provide cold-end temperature control to maintain the temperature of all flue gas wetted surfaces above the flue gas acid dew point (FGADP) temperature. Maintain the exchanger’s cold-end surface temperatures above the FGADP temperature to avoid the harmful effects of acid dew point corrosion and minimize the unwanted deposition of acidic salts from condensation and particulate matter on wet surfaces that impede the performance of the exchanger.

2.3.2.8 Stacks

The design of stacks, ducts, and breechings shall be in accordance with API 560 section 13.

a. Stacks shall be self-supporting and shall be bolted to their supporting structure.

b. A corrosion-resistant metal cap should be provided at the top of the

stack lining refractory to protect its horizontal surface from the weather.

c. Stacks, ducts, and breeching shall be designed for all applicable load conditions expected during shipment, erection, and operation. Snow and ice shall be considered, particularly when the fired heater is not in operation. These load conditions shall include, but not be limited to, dead load, wind load, earthquake load, live load, and thermal load.

d. The minimum thickness of the stack shell plate shall be 1/4 in., including corrosion allowance. The minimum corrosion allowance shall be 1/16 in. for lined stacks and 1/8 in. for unlined stacks.

e. The material of the stack, breeching, and duct shall be adequate for all load conditions at the lowest ambient temperature at the install location when the fired heater is not in operation.

2.3.2.9 Access Doors

The heater shall be provided with access doors in sufficient number, size and location for cleaning, inspection and repair (see locations below). Access door shall be gastight and interior surfaces exposed to direct radiation and high temperature shall be lined with approved refractory material to prevent excessive heat loss. Access doors shall be protected from direct radiation by a refractory system of at least the same thermal rating and resistance as the adjacent wall lining. Access doors that are large or weigh more than 50 pounds shall be hinged.

a. One access door having a minimum clear opening of 18in. by 18in. shall be provided in the floor for vertical cylindrical heaters. A bolted and gasketed access door shall also be provided in any air plenum below the floor accessway. Where space is not available, access via a burner port is acceptable.

b. Observation doors and ports shall be provided for viewing all radiant tubes and all burner flames for proper operation and for light-off.

2.4 FUEL BURNING EQUIPMENT

Fuel burning equipment shall be provided complete with flame safeguard system, forced draft low NO_x burner, piping, fuel trains and instrumentation supplied as a factory assembled and mounted package on the heater front. Packaged burner shall be capable of firing the heater at a continuous rate, using natural gas at 30 psig as an integral unit. Emissions guarantees shall apply through specified turndown range. Burner shall have a stable flame over the turndown range. Submit an Environmental Permit Compliance certificate regarding the heater emissions.

2.4.1 Pilot

a. Pilot burner shall be natural gas-electric type with the capacity required to reliably light off the heater. A 6,000 volt secondary side ignition transformer shall be supplied and mounted backside of the windbox.

b. Provision shall be made in the burner housing for inspection of the pilot flame.

c. Pilot shall be provided with individual manual shut-off valve, pressure

gauge, pressure regulation separate from the main burner, self closing solenoid valve and vent valve in accordance with FM APP GUIDE and UL 795. Pilot and valving shall be in accordance with NFPA 85.

2.4.2 Combustion Air Blower

Combustion air fan shall be centrifugal type with backwardly inclined air foil bladed wheel. Combustion air-fan wheel shall be directly driven by a TEFC NEMA frame motor and shall be complete with inlet cone and screen and flange outlet. Combustion air fan shall be bottom flanged to be mounted on same structural member as windbox. Combustion air-fan shall be sized to provide sufficient static pressure to overcome system losses when providing 15 percent excess air at maximum firing rate, plus the amount of flue gas induced to comply with the NO_x emission requirements. The combustion air blower motor shall be provided with a TEFC enclosure and a rated power factor of greater than 0.85. The blower motor shall be provided with a solid-state reduced voltage starter or variable frequency drive.

2.4.3 Combustion Air Damper

Combustion air damper shall be flanged and located between combustion air fan and windbox. Combustion air damper shall be suitable for specified turndown and shall provide same turndown performance when up to 15 percent flue gas is induced and mixed in the airstream.

2.4.4 Natural Gas Burner

Natural gas burner shall be a multi-spud burner with gas feed pipe in center of air register for easy removal. Natural gas burner shall be forced draft type and shall be suitable for efficiently burning natural gas having a calorific value of 1,050 Btu per cubic foot when supplied at a pressure of approximately 30 psig. Natural gas shall be discharged in burner throat area. Natural gas-air premix or natural gas discharged outside of burner throat are not acceptable. Main natural gas burner shall be capable of firing the heater to maximum capacity with turndown as required to provide stable operation over the range of temperatures, pressures and flows as listed in 2.3.1 - Performance. Natural gas burners shall be of type, size and so located and arranged that in no case shall the flame impinge on any surface in the heater nor shall the flame extend beyond the limits of the burner.

2.4.5 Heater Piping Trains

Piping train shall be completely prepiped, wired and mounted on heater. Natural gas train shall be in accordance with NFPA and FM standards and requirements and shall include but not be limited to following items:

2.4.5.1 Natural Gas Train

a. Comply with NFPA 54.

b. Natural gas flow control valve with characterizing adjustments to match airflow.

c. Manual shut-off valve (NO) at supply and discharge of vent and drain valves.

d. Manual shut-off valve (NO) at pilot natural gas supply and discharge

of vent and drain valve.

e. Manual shut-off valve (NO) at main natural gas valve supply and discharge.

f. Y-type strainer supplied in pilot natural gas and main natural gas lines.

g. Two (NC) solenoid safety shut-off valves, in series, in pilot line with one (NO) solenoid vent valve located between safety shut-off valves, piped to atmosphere.

h. Two shut-off valves with proof of closure, piped in series in main gas line with one (NO) solenoid vent valve located between safety shut-off valves, piped to atmosphere.

i. One pressure regulating valve in pilot natural gas line to regulate natural gas pressure to igniter.

j. One pressure regulating valve to regulate main natural gas pressure at natural gas train inlet.

k. Natural gas meter. Totalizing with pulse output for remote monitoring.

l. Natural gas flow transmitter for main natural gas to burner.

m. Pressure gauge, with shut-off valve for main natural gas supply.

n. Pressure gauge, with shut-off valve for main natural gas at burner.

o. Pressure gauge, with shut-off valve for natural gas supply to pilot.

p. Pressure gauge, with shut-off valve for natural gas pilot.

q. Low natural gas pressure switch.

r. High natural gas pressure switch.

2.5 CONTROLS

Provide a complete electronic instrumentation and control system. The control system shall utilize one master programmable logic controller (PLC) for monitoring all system functions and I/O interfaces. All system instrumentation shall be connected to & monitored by this master PLC. Any/all subsystem devices that are part of the air heater system as a whole (e.g. BMFS, Burner Management Flame Safeguard system) shall be interfaced with and be monitored by this master PLC. Any gas train devices that are directly monitored/controlled by the BMFS shall be connected directly to the BMFS. All data points from this master PLC and all connected subsystems shall be made available on all HMIs and via a single Ethernet interface on this master PLC (for Customer Supervisory System Interface).

2.5.1 Control Functions

The PLC shall control the air heater system to meet output process air temperature, and coil tube overtemperature, requirements. The controller shall permit user input to modify these setpoints within the operational envelope of the air heater system. The controller shall allow the heater

to perform within the entire performance criteria stated earlier.

a. The output process air temperature PID control shall use the main output process air temperature as its process input.

b. The coil tube overtemperature PID control shall override the air temperature control to maintain the coil tubes under their high temperature limit.

c. The fuel-to-air ratio control shall be mechanical or electronic and shall keep the ratio at an optimal point for the entire operational envelope of the heater.

d. Operator override control of the fire rate of the external fire rate signal shall be available.

2.5.2 Control Enclosure and Terminations

2.5.2.1 Terminal Enclosure

All instrumentation shall be wired to a terminal enclosure before routing to the air heater master PLC controller (facilitating a future replacement of the PLC when obsolete). The termination may be within the primary control enclosure.

2.5.2.2 Control Enclosure

A control unit enclosure conforming to NEMA ICS 6, factory designed, assembled, and mounted shall be provided complete with connections made to sensing and control points. The enclosure shall be fabricated of formed stretcher leveled sheet steel, reinforced, and assembled into a rigid unit. Gasketed access doors shall be provided as required. Provide enclosure handle set with an integral loop/provision to accept a customer-provided, full-size padlock. This outdoor enclosure shall meet NEMA 4x requirements and provide protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water), provide additional level of protection against corrosion and will be undamaged by ice formation. Provide an enclosure heater for the local control enclosure to maintain a minimum temperature.

2.5.2.3 Control Power

Control power shall derive from a control power transformer and subsequent power supplies connected to the primary 480VAC feed to the heater.

2.5.3 Control Interface Panels

Two control interfance panels shall be provided where one is local at the air heater and one is located remotely in an adjacent building.

2.5.3.1 Local Control Interface Panel

The local control interface panel shall be located at the local Control Enclosure. Any exterior facing controls/HMIs shall have adequate NEMA 4 protection from harmful environmental conditions. The local control interface panel shall include all user control, monitoring and alarming functions needed to fully operate the air heater. This shall include at a minimum:

a. Discrete devices for burner control, burner reset, combustion blower start/stop with indication, and an emergency stop button.

b. An industrial HMI color touchscreen display that shows all instrumentation and control parameters of the air heater system. The display shall be 12-inch diagonal minimum to accommodate all heater sensor displays and graphics.

(1) The HMI shall also include active alarm indication and historical alarm logging. Logging shall be of FIFO configuration with a 30 day minimum buffer.
(2) Active alarm status shall include sensor tag, sensing level and alarm date/time.
(3) Historical alarm status shall include sensor tag, sensing level and alarm date/time.
(4) A tabulation of the startup and running permissives shall be provided
(5) A status display of the burner management flame safeguard system shall be provided.

c. On/off Disconnect switch for control panel power (located behind the face of the panel).

2.5.3.2 Remote Control Interface Panel

The remote control interface panel shall mount into a standard 19-inch wide rack blanking panel and be no taller than 14 inches (8 rack units). The remote panel shall have as a minimum:

a. An Ethernet-based industrial HMI color touchscreen display that shows all instrumentation and control parameters of the air heater system. The HMI display shall be 12-inch diagonal minimum to accommodate all heater sensor displays and graphics.

(1) The HMI shall also include active alarm indication and historical alarm logging. Logging shall be of FIFO configuration with a 30 day minimum buffer.
(2) Active alarm status shall include sensor tag, sensing level and alarm date/time.
(3) Historical alarm status shall include sensor tag, sensing level and alarm date/time.
(4) A tabulation of the startup and running permissives shall be provided.
(5) A status display of the burner management flame safeguard system shall be provided.

b. On/off Disconnect switch for control panel power (located behind the face of the panel).

2.5.4 Alarm Types for Active and Historical

a. Alert alarms shall indicate a non-standard condition on the air heater system. These alarms shall be logged.

b. Danger alarms shall indicate a hazardous condition that the heater may be damaged if it continues. Danger alarms shut the heater down. These alarms shall be logged.

c. Both types of alarms (alert & danger) shall have visual and audible annunciators at the local Control Interface Panel only (not at the remote Control Interface Panel). Audible annunciators are to be of the 30mm, 2900HZ, 95dB type.

2.5.5 Permissives

a. Startup permissives shall all be satisfied before the air heater burner is available to start. These control system inputs shall be from the internal air heater system or from external indication. External indication may include process air flow and other indicators. Indication shall be made to show all permissives have been satisfied and the air heater burner is ready to start. Starting shall only occur by the operator pressing the burner ON selector locally and remotely. The combustion blower may have separate startup permissives required before start up.

b. Running permissives shall all be satisfied to keep the air heater running. The loss of any of these permissives shall cause a danger alarm and shall disable the run permissive shutting off the burner. The stop button, any sensor or switch indicating danger and any applicable external indicators shall cause a loss of run permissive. The combustion blower shall have its own run permissives and shall shut down if the blower stop button is pressed or the emergency stop button is pressed.

2.5.6 Burner Management Flame Safeguard System

a. A burner management flame safeguard (BMFS) control system shall be microprocessor-based and provide:

(1) Automatic sequencing of the burner system through prepurge, pilot trial for ignition (PTFI), main trial for ignition (MTFI), run (AUTO), and post purge.
(2) Flame proving and lockout on flame failure during PTFI, MTFI, and AUTO.

b. The BMFS control shall be mounted in the heater control cabinet. Flame safeguard system components shall be UL listed. Complete and automatic flame safeguard system shall be provided in accordance with NFPA requirements safe start-up, on-line operation and shut-down of package burner.

c. Flame safeguard system shall be micro-processor based system including, but not limited to, automatic burner sequencing, flame supervision, status indication, fire-out annunciation and self diagnostics.

d. Provide a monitoring and control connection between the BMFS system and the air heater master PLC using Modbus/TCP to allow monitoring of all BMFS system data points by the master PLC.

e. A self-check ultraviolet flame scanning detection system.

f. Flame proving and lockout on flame failure during PTFI, MTFI and AUTO. Flame failure signal shall be displayed on flame safeguard display or burner control panel.

g. Logic provided with flame safeguard system shall:

(1) Prevent introduction of igniter flame (pilot) or main fuel flame to burner until burner, heater passes and stack have been purged of combustible gases.

(2) Prevent opening of automatic fuel shut-off valves in main fuel line until igniter flame is proven.

(3) Limit trial for main fuel ignition to ten (10) seconds from time igniter flame is proven.

(4) In event of burner failure, operator intervention shall be required to manually reset flame safeguard controller prior to restart.

h. The BMFS system shall provide a check-run switch to allow a qualified service technician to halt the burner sequence in any of five different positions:

(1) High fire purge
(2) Low fire purge
(3) Pilot trial for ignition
(4) Main trial for ignition
(5) Low fire (burner on)

i. A display module shall consist of a two (2) line with sixteen (16) characters per line liquid crystal (LCD) or vacuum fluorescent (VFD) display and multi-functional 4-key, positive action keypad.

j. A pre-wired or terminal block wiring base shall be provided which will allow for all system terminations to be completely wired prior to the installation of the control. The control shall be removable or replaceable without removing any wiring terminations.

k. The control will continually test the status of all safety critical loads (ignition transformer, pilot fuel valve, main fuel valve) to insure they are operating properly.

2.5.7 Customer Supervisory System Interface

The air heater system master control PLC will provide an Ethernet-based interface for customer connection to the customer's existing facility SCADA system. All analog and discrete instrumentation data points, all control output, all alarm, and all control functional parameters data shall be accessible through this interface. All available data points shall be fully described in a written or digital data definition provided by the manufacturer. All data points shall be accessible via the OPC-UA protocol (with secure connection options available). Modbus/TCP protocol may be substituted upon customer's approval.

2.5.8 Update / Refresh Rates of Data

Sufficient I/O, processing and communication hardware shall be provided to meet or exceed the following data update rates:

a. All Instrumentation for logging and alarming = 1 sample per second.

b. All Instrumentation and controls for closed loop feedback control = 10 samples per second.

2.5.9 Pressure Sensors

Pressure sensors shall be equivalent to Viatran model 34A for pressure and 374 for differential pressure. An isolation valve and calibration port shall be provided at each pressure sensor location. Pressure sensors are required in the following location at a minimum:

a. Process air inlet and outlet.

b. Natural Gas supply.

c. Combustion air blower discharge.

d. Differential pressure across combustion chamber.

e. Instrument air pressure (60 - 125 psig). Select pressure gauge dial range to be 125% of maximum operating pressure.

2.5.10 Temperature Sensors

All temperature measurements shall use K-type thermocouples. Temperature sensors are required in the following location at a minimum:

a. Process air inlet and outlet.

b. Combustion chamber.

c. Four tube wall temperatures at heat exchanger's hottest locations. Lead wire, insulators, and protective sheaths shall be designed to accommodate all anticipated tube movement. Protective sheaths shall be made gas-tight and constructed of type310 stainless steel or other alloy suitable for the operating conditions. Such sheaths shall be attached to the heater tubes by welded clips or bands. All thermocouple assemblies shall terminate on the exterior shell of the fired heater with a thermocouple head.

d. Economizer outlet.

e. Flue gas stack.

2.5.11 Flow Instruments

a. Natural Gas Flow: Flow meter with 1.50 percent accuracy throughout the operating range. Flow meter shall be designed for outdoor installation.

2.5.12 Monitoring Instruments

Provide the following monitoring instruments in addition to the monitor and safety controls. Pressure gauges shall conform to ASME B40.100, 4 1/2 inch, black marking pointer, single bourdon tube, stainless steel case. Provide pressure gauges with a pressure snubber and a stainless steel barstock needle isolation valve. Thermometers shall be extended stainless steel sheathed bimetallic stem, 3 1/2 inch dial, and separable 4 inch stainless steel wells. Temperature measurements at inaccessible locations shall be made with remote reading thermometers conforming to MIL-T-19646, Class C separable well of Type 304 stainless steel. Select pressure and temperature gauge ranges to give a normal operating reading near the midpoint of the scale range.

a. Flue gas sensors (O2). Connections shall be provided in the flue gas exit from each radiant section, at the convection-section outlet, in each stack and each take-off to a stack. Sampling-point locations shall be determined according to environmental requirements regarding upstream and downstream flow disturbances. The connections shall be DN100 (4NPS) schedule 80 pipe with a class PN20 (ASME Class 150) raised-face flange. The pipe shall be welded to the outside casing plate and project 8in to the face of the flange. The heater manufacturer shall furnish for each connection a class PN20 (ASME Class 150) blind flange with appropriate gaskets for the temperature and corrosive conditions of the flue gas. The pipe shall extend 1.5in. into the heater from the hot-face of the refractory lining.

2.6 VENT PIPING

Provide vent piping conforming to the requirements of NFPA 54. Plastic material polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. Provide vent stack with rain cap and birdscreen.

2.7 SHOP FABRICATION AND FIELD ERECTION

a. The heater, all auxiliary equipment, ladders, stairs, and platforms shall be shop assembled to the maximum extent possible consistent with the available shipping, receiving, and handling facilities specified by the purchaser. Individual sections shall be properly braced and supported to prevent damage during shipment. All blocking and bracing used for shipping purposes shall be clearly identified for field removal. Coil-flange faces and other machined faces shall be coated with an easily removable rust preventive. Openings in pressure parts shall be covered to prevent entrance of foreign materials.

b. The vendor shall state the type of protection provided for refractory and insulation to avoid damage from handling or weather during shipment, storage, and erection.

c. All surfaces to be welded shall be free from scale, oil, grease, dirt, and other harmful agents. Welding operations shall be protected from wind, rain and other weather conditions that can affect weld quality.

d. The heater steel structures shall be fabricated in accordance with the structural design code.

e. Coils shall be fabricated in accordance with the applicable provisions of the pressure design code.

f. Conform to the requirements of API 560 section 16.2 for structural steel and heater stack fabrication requirements.

g. Conform to the requirements of API 560 section 16.3 for coil fabrication requirements.

h. Conform to the requirements of API 560 section 16.4 for painting and galvanizing requirements.

i. Conform to the requirements of API 560 section 16.5 for Shipping Preparation requirements.

2.8 SOURCE QUALITY CONTROL

2.8.1 Factory Performance Test Procedures

The completely assembled air heater package, including the actual contract blower motor, burner, economizer and control panel shall be subjected to performance tests. Unit shall comply with guarantee requirements applying engineering adjustments to guarantee conditions. Test shall be certified by the manufacturer. Test shall be run on the manufacturer's test stand using driver for this contract. Full-range performance tests shall indicate performance at maximum rated flow and rating point. All accessory performance conditions shall be reported, including economizer, burner, and control systems.

2.8.1.1 Weld Examination

1. Radiographic, ultrasonic, visual, magnetic-particle, or liquid-penetrant examination of welds in coils shall be in accordance with the pressure design code. The extent of examination of welds in coils, including return bends, fittings, manifolds, and crossover piping,shall be as follows:

a. All welds in Cr-Mo steels and austenitic stainless steels shall be 100 percent radiographed.

b. Ten percent (10 percent) of all carbon-steel welds by each welder shall be 100 percent radiographed. If the required examination identifies a defect, progressive examination shall be performed in accordance with ISO 15649.

c. Acceptance criteria of welds shall be in accordance with the pressure design code.

d. All longitudinal seam welds on manifolds shall be 100 percent radiographed. In addition, these welds shall be examined by the liquid-penetrant method (for austenitic materials) or the magnetic-particle method (for ferritic materials).

e. In cases where weld or material configuration makes radiographic examination difficult to interpret or impossible to perform, such as nozzle (fillet) welds, ultrasonic examination may be substituted. If ultrasonic examination is impractical, liquid-penetrant examination shall be performed (for austenitic materials) or magnetic-particle examination shall be performed (for ferritic materials).

2. Postweld heat treatment shall be performed in accordance with the pressure design code. Any required radiographic examination shall be performed after completion of heat treatment.

3. Proposed welding procedures, procedure qualification records, and welding-consumable specifications for all pressure-retaining welds shall be in accordance with the pressure design code and shall be submitted by the equipment manufacturer for review, comment, or approval by the Owner/COR.

4. Welder qualifications and applicable manufacturer’s report forms shall be maintained. Examples include certified material mill test reports, AWS or other classification and manufacturer of electrode or filler material, welding specifications and procedures, positive materials identification

documentation of alloy materials, and nondestructive examination procedures and results. Unless otherwise specified by the purchaser, records of examination procedures and examination-personnel qualifications shall be retained for at least five years after the record is generated for the project.

2.8.1.2 Fiber Lining Inspection Requirements

a. Prior to installation, verify compliance data sheets claims of density and chemical composition.

2.8.1.3 Fiber Lining Workmanship

a. In a layered blanket system, joints shall be tight or overlapped, as specified.

b. Blankets shall not be stretched.

c. Hot face blanket layers shall be installed in lengths no less than 4ft, and no greater than 25ft.

2.8.1.4 Pressure Testing

a. Assembled pressure parts shall be hydrostatically tested to a minimum pressure equal to 1.5 times the coil design pressure, multiplied by the ratio of the allowable stress at 100 degrees F to the allowable stress at the design tube metal temperature. The maximum test pressure shall be limited to the extent that the weakest component shall not be stressed beyond 90 percent of the material’s yield strength at ambient temperature. Hydrostatic test pressures shall be maintained for a minimum period of 1 hour to test for leaks.

b. If hydrostatic testing or pneumatic pressure-testing of pressure parts is not considered practical, by agreement between the Owner/COR and the manufacturer, 100 percent radiography shall be performed on all circumferential welds and pneumatic leak-testing shall be performed using air or a nontoxic, nonflammable gas. The pneumatic leak test pressure shall be 60 psi gauge or 15 percent of the maximum allowable design pressure, whichever is less. The pneumatic test pressure shall be maintained for a length of time sufficient to examine for leaks, but in no case for less than 15 min. A bubble surfactant shall be applied to weld seams to aid visual leak detection.

c. Water used for hydrostatic testing shall be potable. For austenitic materials, the chloride content of the test water shall not exceed 50ppm, by mass.

d. Unless the test fluid is the process fluid, the test fluid shall be removed from heater components upon completion of hydrostatic testing. Heating shall not be used to evaporate water from austenitic stainless steel tubes.

2.8.2 Supervision of Testing

System and components testing shall be conducted or supervised by either a designated authorized and factory trained representative of the air heater manufacturer supplying the unit or a registered Mechanical Engineer experienced in such work.

2.8.3 System Test

Testing of system shall conform to requirements outlined and shall be witnessed by the Contracting Officer or Contracting Officers Representative (COR).

2.8.4 Approval of Testing Procedure

Proposed testing procedure shall be approved by the Contracting Officer and the individual in charge of testing prior to conducting tests.

2.8.5 Certification of Performance Tests

The test supervisor shall certify performance by test to be in compliance with specifications.

PART 3 EXECUTION

3.1 NOT USED

-- End of Section --