

**SECTION 235216
CONDENSING BOILERS**

PART 1 GENERAL**1.01 SUMMARY**

- A. Section includes gas-fired, condensing boilers, trim, and accessories for generating hot water for space heating.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Performance Data including rated capacities, operating characteristics, efficiency and pressure drop curves.
 - 3. Trim options and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Installation & Dimensional drawings including clearances.
 - 2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Diagrams for power, signal, and control wiring.
- C. Written Statement of Warranty

1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
 - 1. Include controls operations manual specific to installed boilers with options as furnished.
- B. Written Statement/Certificate of Warranty including contact information.
- C. ASME Certification Certificate
- D. Field Test and Startup Reports including
 - 1. Initial startup and tuning report
 - 2. Design Heating Day Tuning/Startup report

1.04 COORDINATION

- A. Boilers shall be shipped, stored, and installed in accordance with manufacture's installation, operation and maintenance literature.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.
- C. ASME Compliance: Construction in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
- D. CSD-1: Controls and Safety Devices for Automatically Fired Boilers.
- E. ASHRAE/IESNA 90.1-2010 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- F. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- G. UL Compliance: Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to

authorities having jurisdiction.

- H. AHRI Certification: Combustion and Thermal Efficiencies
- I. Efficiency and Installation must meet Minnesota Energy Code 2015
- J. ETL Certification: Condensing Boilers

1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Entire boiler and all components: Repair or Replacement including Parts and Labor for 30 months from shipment or 24 months from Date of Substantial Completion, whichever provides the owner the longest period of full warranty coverage (whichever comes last).
 - 2. Pressure Vessel and Heat Exchanger: 10 years from date of Shipment.
 - a. Coverage shall include, but is not limited to, damage from thermal shock/stress and corrosion caused by flue gas condensation.

PART 2 PRODUCTS

2.01 FORCED-DRAFT, PACKAGED MODULAR ARRAY CONDENSING BOILERS

- A. Manufacturer: Riello
- B. Basis of Design Products: As Scheduled on the drawings
- C. Alternate Product and Manufacturers: Subject to compliance with Part 2 products in their entirety and evaluated via preapproved alternate procedure outlined in Sections 00 and 01. Alternate products must be approved by Engineer prior to bidding.
- D. Description: Factory-fabricated, -assembled, and -tested, direct fired, multiple array helical water-tube, packaged modular condensing boiler with heat exchangers sealed pressure tight, casing/frame mounted, with integral internal circulation pumps; flue-gas vent manifold; combustion-air intake manifold connections; water supply, return, and condensate drain connections; and controls. Intended for circulating heating water service.
 - 1. Redundant or Single Array Design: Multiple Heat Exchanger/Burner design, each module individually replicable and identical to the others in the array. Each module fully stand-alone in operation.
 - 2. Category: ASME Section IV
- E. Casing:
 - 1. Frame: Extruded Aluminum Alloy (AW-6060) finished with Baked Enamel Powder Coat (RAL 7016)
 - 2. Panels/Jacket: 18 and 22 ga carbon steel with baked enamel powder coat (RAL9006) with gasket seals.
 - 3. Front Door(s): Hinged for front service access with keyed lock
 - 4. Side Panels: Removable for full service access with keyed lock.
 - 5. Roller Tray: For each Module
- F. Array Boiler Module: Each designed and rated for ETL 500 MBH input capacity, all identical and interchangeable/replaceable individually. Fully "Stand-Alone" design.
 - 1. Heat Exchanger: Helical water-tube design. Manufactured by the boiler manufacturer. ASME stamped.
 - a. Helical Counter Flow, 2 pipe, Water Tube Coil with two Continuous Tube connected at the end sheets.
 - 1) 316L or 316Ti Stainless Steel
 - b. Tube Equivalent Minimum Diameter: 1" with flow design of 1.8 ft/sec
 - c. Water Backed Reservoirs: At each end
 - d. Fully Welded Construction (No Gaskets)
 - e. Fully Insulated Pressure Vessel
 - f. Heating Surface Area: 12.91 sqft
 - g. Internal Fired Surfaces Accessible for Inspection and Cleaning
 - h. Working Pressure: 80 psig

2. Gas & Water Connections: O-Ring compression seals for module replacement.
3. Combustion Chamber: Sealed designed for stable operation at all firing rates.
 - a. 316L or 316Ti Stainless Steel Construction Integral to Heat Exchanger
 - b. Window Port: To view firing and flame quality
4. Automatic Air Fuel Ratio Gas Valve: Pressure sensing venturi to automatically optimize A/F ratio for all firing rates. Self-Compensating. Full safety shut-off
5. Zero Governing Gas Valve with Dual Safety Shut-offs.
6. Burner: Premix with stainless steel knitted metal fiber construction
 - a. Fully Modulating: 5:1 turndown on each module
 - b. Direct Ignition: Self Grounding Electrode designed for both ignition and flame monitoring.
 - c. Flame Monitor: Flame Rod (rectification) type.
 - d. Not more than 5.1% Excess Oxygen at all firing rates
7. Blower: Fully Modulating Variable Speed matching burner turndown
8. Burner Control: Individual to each module heat exchanger
 - a. Direct Spark Ignitor: 3 ignition trials before lockout
 - b. Individual Flue Gas Temp Monitoring
 - c. Individual Water Temp Monitoring and Control
 - d. Automatic Individual Module Shutdown
 - e. Each Burner/Module can be shut-off and power isolated for servicing.
9. Water Flow Switch/Proof: Individual for each Heat Exchanger, Vortex flow meter with continuous analog signal monitored for each individual module.
10. Electrical Connections: Plug type for ease of replacement/servicing. Screw terminal connections.
11. Safety Relief Valve: ASME rated 75 psi
12. Heat Exchanger Water Pumps: One for each module with check valves for each pump.
- G. Variable Flow Building Loop Arrangement: Boiler(s) shall be operated in a primary secondary piping arrangement with a variable flow secondary (building) loop environment and must be optimized/designed for this application strategy.
- H. Gas Train: Factory Assembled, piped and wired.
- I. Field Gas Connection: Manual shutoff, dirt leg, and pressure regulator.

2.02 TRIM

- A. Safety Relief Valves (one for each Heat Exchanger): ASME rated 75 psi, manifolded internally (inside the package cabinet) single outlet.
- B. Pressure and Temperature Gage(s): Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- C. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- D. Factory or factory recommended condensate neutralization kit: Factory/Representative/Vendor furnished in size and configuration as recommended by manufacturer. Field Installed per manufacturer recommendations.
- E. Outside air temperature station, wired to boilers by contractor.
- F. Independent Common header heating water supply temp sensor, field installed and wired to boilers.
- G. Factory Exhaust Adapter: As required for Flue System Furnished on Project
- H. Cold Climate Air Inlet Damper: Automatic Operation

2.03 BOILER CONTROLS

- A. Boiler Control Panel:
 1. Operator Display: 7" Touchscreen Outside Front Panel
 - a. Full Diagnostics

- b. Real Time Data Logging
 - c. Error History
 - d. Current Operating Status/Data: Module/Package Temp, Module Firing Rates,
 - e. Not integral to boiler operation (boiler to continue operating upon touchscreen failure)
 - f. Water Flow Rate: Each Module
 - g. Service Reminders
2. Service Screen Display: Inside front door Panel
3. Firmware Update: Via USB
- B. Integrated Module Sequencing Controller: Capable of automatic cascade internal array sequencing for lead-lag and parallel operation. The system will incorporate the following capabilities at a minimum:
 1. Efficiently sequence all modules units on the same system to meet load requirement and optimize efficiency.
 2. Automatically rotate lead/lag amongst the modules and monitor run hours per module and balance load in an effort to equalize unit run hours.
 3. Automatic bump-less transfer of master function to next unit on the chain in case of designated master unit failure; master/slave status should be shown on the individual unit displays.
 4. Designated master control, used to display and adjust key system parameters.
- C. Master/Satellite Cascade Sequencing Control: Boiler Unitary Sequencing of up to 8 Array Packaged Boilers to optimize operation stability and sequencing. Automatic transfer of master control to another boiler unit upon failure.
- D. Burner Safety Controls: To maintain safe operating conditions, burner safety controls limit burner operation for each module.
 1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
 3. Air Safety Switch: To prevent operation until sufficient prepurge air is assured.
 4. Flame failure monitoring: Rectification-type electronic sensor.
 5. High/Low Gas Pressure
- E. The control system shall be capable of resetting the set point based on outdoor air temperature with the optional outside air temperature sensor (included for field installation). Graphic display of the reset curve shall be available through the operator touchscreen.
- F. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:
 1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
 2. Setpoint Low Limit: Allow for a selectable minimum operating temperature.
 3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired. Initial failsafe header supply temp setpoint shall be 150°F
- G. The control panel hardware shall support MODBUS RS-485 remote communications.
- H. Each boiler or module as applicable for CSD-1 Compliance, shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler/module shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD 1.
- I. Building Automation System (BAS) Interface: MODBUS RS485

1. Furnish with Factory Optional BACnet IP Protocol Converter
2. Map all available system parameters and boiler parameters as applicable through BAS interface.

2.04 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Related electrical devices and connections are specified in Division 26 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 1. House in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color-coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a metal raceway.
 4. Field power interface shall be to wire lugs.
 5. Provide branch power circuit to each motor and to controls.
 6. Provide each motor with overcurrent protection.
 7. Volts/Ph/Hz: 230/1/60.
 8. Full-Load: 30.2A

2.05 CAPACITIES AND CHARACTERISTICS:

- A. Capacities and Characteristics are Scheduled on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, coordinate anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 1. Boilers will be installed on existing concrete pad (with extensions)
 2. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections. Observe all manufacturer's service, maintenance, and operational clearance requirements.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION

- A. Install Boilers adhering to all Manufacturer's Published installation instructions. Download from manufacturer's website.
- B. Install boilers level on concrete pad. Coordinate Pad dimensions and provide min 3.5" concrete housekeeping pad, for all adjacent boilers or one for each.
- C. Vibration Isolation: Elastomeric isolation pads as specified elsewhere with a minimum static deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
- D. Install gas-fired boilers according to NFPA 54.
- E. Assemble and install boiler trim.
- F. Install electrical devices furnished with boiler but not specified to be factory mounted.
- G. Install control wiring to field-mounted electrical devices.
- H. Installation Responsibilities:
 1. Hardwired (independent of BAS) Emergency boiler shutoff switch at each entrance to boiler room by Electrical Contractor.
 2. Boiler to BAS Interface: By Temperature Controls Contractor (TCC).
 3. AC Power Wiring to Individual Boilers: By Electrical Contractor.
 4. Boiler Cascade Wiring (if applicable): Per factory wiring manual for master-slave boiler controller arrangement, wired by TCC, in full.

5. Common Hot Water Supply Sensor: Immersion type sensor and well tap furnished by boiler manufacturer. Piping contractor shall install well. TCC shall install and wire to master unit.
6. Boiler Outdoor Air Sensor: Furnished with Boiler by the factory, Installed and Wired by TCC.
7. BAS Common Supply Sensor: Furnished and installed by Controls Contractor (for monitoring). Into immersion well furnished by controls contractor and installed by piping contractor.

3.03 CONNECTIONS

- A. Provide installation for fully sealed combustion, Pipe PVC intake piping to roof and provide gooseneck and birdscreen min 30" from roof.
- B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to boiler to allow service and maintenance.
- D. Install Condensate Drain Piping and Acid Neutralization Equipment in accordance with manufacturers installation instructions. Utilize non-kinking flex polypropylene tubing.
- E. Install condensate and pressure relief piping per code from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection.
- F. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- G. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- H. Install full size piping from safety relief valves to within code required height AFF.
- I. Boiler Venting:
 1. Install flue venting and sealed combustion-air intake per manufacturers requirements.
 2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."
 3. Common or individual vents shall terminate a minimum of 60" Above the roof and a minimum of 36" above any adjacent combustion air intake. Provide velocity cone vent termination.
 4. Provide condensate and rain drip drain tube from bottom of any common vent riser or continuously slope back to individual manifold drains.
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

- A. Engage a factory service representative to perform startup service: In accordance with all manufacturers IOM startup requirements.
 1. Prime Flue Condensate Drain Traps per manufacturer instructions.
 2. Complete installation and startup checks according to manufacturer's written startup forms and instructions.
 3. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 4. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
 6. Verify Cascade controls are fully functional per manufacturer specifications.

7. Verify functionality and all point mapping for BACnet or Modbus BAS Interface. TCC and Factory Representative shall fully commission BAS interface and ensure all points specified are brought to the BAS graphics
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Manufacturer's Field Service: Coordinate the engagement of a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Manufacturer's representative shall fully inspect all aspects of installation for conformance with available factory installation requirements including wiring.
- D. Performance & Tuning Tests:
 1. Engage a factory service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at [low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20] percent of full capacity. Determine efficiency at each test point.
 4. Repeat tests until results comply with requirements indicated.
 5. Provide analysis equipment required to determine performance.
 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 7. Notify Engineer in advance of test date times.
 8. Document test results in a report and submit to Engineer.
 9. Complete any manufacturer recommended tuning and optimization per manufacturer specified startup checklist.
 10. The same factory service representative shall be engaged during winter months within 6-months of substantial completion on a near design heating day to perform a second performance and tuning test including all aspects/activities of the original startup.

3.05 OWNER TRAINING

- A. Engage Factory Authorized Service Representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 1. Prolonged Shutdown and Restart: Provide written instructions and training for prolonged shutdown and associated startup.

END OF SECTION 235216

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