1. GENERAL
	1. RELATED DOCUMENTS
		1. General Contract Provisions
			1. Drawings and general provisions of the project contract apply to this specification.
	2. SUMMARY
		1. Summary of Work
			1. The work to be performed consists of providing all labor, equipment, materials, and documentation to furnish and install manufactured low-pressure hot water boilers in accordance with this specification.
	3. REFERENCES
		1. ASME – American Society for Mechanical Engineers
			1. BPVC – Boiler and Pressure Vessel Code
				1. Section IV – Heating Boilers
			2. B16 – Standardization of Valves, Flanges, Fittings, and Gaskets
		2. AHRI – Air-Conditioning, Heating, and Refrigeration Institute
		3. ANSI – American National Standards Institute
			1. B16 – Standards for Pipes and Fittings
			2. Z21.13 – Gas-Fired Low-Pressure Steam and Hot Water Boilers
		4. ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers
			1. 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
		5. CSA – Canadian Standards Association
			1. 4.9 – Gas-Fired Low-Pressure Steam and Hot Water Boilers
			2. B51 – Boiler, Pressure Vessel, and Pressure Piping Code
				1. CRN – Canadian Registration Number
			3. B149 – Natural Gas and Propane Installation Code
		6. ISO – International Organization for Standardization
			1. 9001 – International Standard for Quality Management Systems
		7. NEMA – National Electrical Manufacturers Association
			1. Panel enclosure types:
				1. Rating 1 – Indoor use, general purpose, and provide a degree of protection against the following:

Personnel access to hazardous parts.

Ingress of solid foreign objects (falling dirt) to enclosed equipment.

* + 1. NFPA – National Fire Protection Association
			1. 54 – National Fuel Gas Code
			2. 70 – National Electrical Code
		2. UL/cUL – Underwriters Laboratories / Underwriters Laboratories of Canada
			1. 795 – Standard for Commercial-Industrial Gas Heating Equipment
		3. XL-GAP – XL Catlin Global Asset Protection (Insurance)
	1. SUBMITTALS

**Note: Select multiple and strikeout others.**

* + 1. Calculations
			1. ASME calculations.
			2. Safety valve calculations.
		2. Drawings & Diagrams
			1. Dimensional diagrams (DD).
			2. Metric conversion drawings. **(Optional)**
			3. Piping and instrumentation diagrams (P&ID).
			4. Weld map drawings.
			5. Wiring diagrams.
				1. Control wiring.
				2. Power wiring.
				3. Signal wiring.
		3. Operation & Maintenance (O&M) Manuals
			1. Boiler.
			2. Burner.
			3. Controls.
			4. Operation.
			5. Maintenance.
			6. Parts.

**Note: Manuals may be combined documents.**

* + 1. Product Data
			1. Bill of materials (BOM).
			2. Instructions.
				1. Installation.
				2. Startup.
			3. Product performance.
				1. Efficiency.
				2. Emissions.
				3. Rated output capacity.
			4. Product cut sheets.
				1. Electrical.
				2. Motors.
				3. Pumps.
				4. Sensors.
				5. Valves.
			5. Product reports.
				1. ASME data reports.
				2. Fire test reports.
				3. Inspection reports.
			6. Product warranty.
		2. Quality Control Documents
			1. Quality control traveling document (QC).

Note: Additional submittals available upon request.

* 1. QUALITY ASSURANCE
		1. ASME BPVC-IV Data Report
			1. The vendor shall complete a ASME BPVC-IV Data Report.
			2. The vendor shall submit the completed ASME BPVC-IV to the owner and to the National Board of Boiler and Pressure Vessel Inspectors (NB) prior to shipping and installation.
		2. Factory Test Fire Report
			1. The manufacturer shall complete a test fire report verifying that all safety interlocks and critical functionality have been tested and correctly function at low-fire operating conditions.
		3. Factory Hydrostatic Pressure Test
			1. The completed packaged boiler system shall receive an ASME BPVC-IV hydrostatic pressure test with affixed valves, piping, and trim.
		4. Interchangeable Parts
			1. The packaged boiler system shall have identical parts, accessories, and assemblies to other packaged boiler systems of the same classification to facilitate timely and cost-effective maintenance.
		5. Manufacturer Documentation
			1. The manufacturer shall supply written factory test procedures for each test including criteria used to determine a successfully executed test and completed test results.
		6. Owner Inspections
			1. The owner or owner’s representatives reserve the right to inspect the packaged boiler system during fabrication and factory quality control testing phases.
			2. The owner shall be notified at least ten (10) business days in advance of factory quality control testing.
		7. Quality Management System (QMS)
			1. The manufacturer shall manufacture the packaged boiler system in an ISO 9001 certified facility.
		8. Shipping, Handling, & Storage
			1. The packaged boiler system shall be shipped, handled, and stored in accordance with the manufacturer’s written shipping, handling, and storage instructions.
			2. The responsibility of making freight claims shall be performed by owner-authorized representatives.
	2. MANUFACTURER-PROVIDED TRAINING
		1. Online Training **(Optional)**
			1. Scope: Steam boilers, boiler systems, steam system fittings, steam system accessories, feedwater systems, water treatment, combustion equipment, combustion controls, boiler controls, draft controls, instrumentation, control systems, steam boiler operation, and licensing.
			2. Duration: Online access for one full calendar year.
			3. Proof of completion: Manufacturer’s training certificate of completion.
		2. Custom On-Site Training **(Optional)**
			1. Scope: Custom to on-site components, assemblies, and systems.
			2. Duration: As required by owner or owner’s representatives.
			3. Required minimum trainees: 5.
			4. Proof of completion: Manufacturer’s training certificate of completion.
			5. Trainer lodging and transportation expenses shall be paid by owner or owner’s representative.
		3. Boiler Operation & Electrical Troubleshooting Seminar **(Optional)**
			1. Scope: Thermodynamics, heat transfer, boiler types, combustion, burners, efficiency, steam load demand, equipment, controls, low water cutoff, flame safeguards, wiring diagrams, maintenance, boiler circuits exercise, troubleshooting on simulation boards, and shop floor tour.
			2. Duration: Two eight-hour days.
		4. Boiler Operations Seminar **(Optional)**
			1. Scope: Thermodynamics, heat transfer, boiler types, combustion, burners, efficiency, steam load demand, controls, low water cutoff, flame safeguards, wiring diagrams, and maintenance.
			2. Duration: One eight-hour day.
		5. Boiler Systems PLUS 1 Seminar **(Optional)**
			1. Scope: Thermodynamics, heat transfer, boiler types, combustion, burners, efficiency, steam load demand, equipment, controls, low water cutoff, flame safeguards, steam traps, wiring diagrams, and maintenance.
			2. Duration: Two eight-hour days.
		6. Boiler Systems PLUS 2 Seminar **(Optional)**
			1. Scope: Thermodynamics, combustion analysis, burner technology, boiler technology, controls evolution, steam systems, water softeners, dealkalizers, feed systems, deaerators, pumps, water treatment, chemical injection, capturing losses, boiler shutdown, cutting boilers into cold and hot systems, and checking boiler safeties.
			2. Duration: Two eight-hour days.

**Note: Training excludes owner’s custom combustion settings and equipment service passwords.**

* 1. WARRANTY
		1. Packaged Boiler System Warranty
			1. The packaged boiler system shall be warranted for twelve (12) months from the date of initial operation of the equipment, but in no event shall the warranty extend more than eighteen (18) months from the date of shipment of the equipment.
		2. Pressure Vessel Warranty
			1. The pressure vessel shall be warranted against thermal shock for a period of twenty (20) years in accordance with the vendor’s warranty statement and provided the boiler is operated and maintained in accordance with the owner’s Operation and Maintenance Manual.
			2. The pressure vessel shall be warranted against fireside condensation corrosion for ten (10) years and provided the boiler is operated and maintained in accordance with the owner’s Operation and Maintenance Manual.
		3. Condensate Collection Chamber Warranty
			1. The condensate collection chamber shall be warranted against condensation corrosion for twenty (20) years and provided the boiler is operated and maintained in accordance with the owner’s Operation and Maintenance Manual.
		4. Burner Canister Warranty
			1. The burner canister shall be warranted for five (5) years and provided the boiler is operated and maintained in accordance with the owner’s Operation and Maintenance Manual.

**Note: Prorated warranties are not acceptable.**

1. PRODUCTS
	1. ACCEPTABLE MANUFACTURERS
		1. Cleaver-Brooks
	2. INSURANCE REQUIREMENTS
		1. XL-GAP (CSD-1)
	3. GENERAL
		1. Codes & Standards

**Note: Strikeout inapplicable selections.**

* + - 1. Packaged boiler system UL Listed and bears the UL/cUL Listing Mark.
			2. Packaged boiler system certified by the AHRI.
			3. Packaged boiler system constructed in accordance with ASME BPVC-IV and bears the ASME “H” Mark.
			4. Packaged boiler system constructed in accordance with CSA B51 and bears a CRN. **(Canada Only)**
			5. Packaged boiler system constructed in accordance with NFPA 70.
			6. Packaged boiler system constructed in accordance with UL 795.
			7. Packaged boiler system installed in accordance with ASHRAE 90.1.
			8. Packaged boiler system installed in accordance with CSA B149. **(Canada Only)**
			9. Packaged boiler system installed in accordance with NFPA 54.
		1. Boiler Room Environmental Conditions
			1. Indoor – Typical boiler room environment.
		2. Electrical Panel Enclosure Types:
			1. NEMA Rating 1.

**Note: All electrical components in panel enclosures are NEMA Rating 1 or a higher rating.**

* + 1. Factory Assembled
			1. Factory-assembled packaged boiler system.
	1. BOILER
		1. Boiler Design
			1. Cleaver-Brooks ClearFire® Large Condensing Firetube Boiler (CFLC) or equivalent.
			2. A large-mass, low pressure drop, two-pass, horizontal-fired firetube-type boiler with duplex stainless steel tubes, tube sheets, and combustion chamber mounted on a structural steel stand.
			3. A counter-flow heat exchanger design with a non-condensing zone and a condensing zone.
			4. Maximum allowable working pressure (MAWP): 160 psig.
			5. Maximum operating pressure (MOP): 144 psig.
			6. Maximum allowable operating temperature: 194°F (90°C).
			7. Maximum supply and return water temperature differential: 100°F (38°C).
			8. Maximum noise level at maximum firing: 85 dB(A).
			9. Boiler casing:
				1. Material: Metal with powder coat finish.
				2. Thickness: 18 gauge.
			10. Boiler insulation.
				1. Material: Fiberglass.
				2. Thickness: 2 in.
			11. The boiler, base frame, and other components shall be factory painted using a hard enamel paint finish to withstand heat and prevent rusting of the boiler.
		2. Furnace
			1. Access from a front-hinged burner door.
			2. Water cooled on furnace rear (wetback).
		3. Boiler Tube Design
			1. Cleaver-Brooks EX carbon steel extended heating surface firetube heat exchanger or equivalent.
				1. Firetube material: SA178A carbon steel.
				2. Located in the non-condensing zone of the boiler.
			2. Cleaver-Brooks AluFer® duplex stainless steel condensing firetube heat exchanger or equivalent.
				1. Firetube material: UNS S32101 duplex stainless steel.
				2. Duplex stainless steel tubes fitted with aluminum alloy internal heat transfer fins.
				3. Minimum fireside heating surface per boiler horsepower (BHP): 10 ft2.
				4. Located in the condensing zone of the boiler.
	2. BURNER
		1. Burner Design
			1. Included as a package from the boiler manufacturer.
			2. Pre-assembled venturi gas valve with forced draft blower for simultaneous fuel-to-air ratio modulation.
				1. Minimum fuel-to-air turndown ratio: 5:1.
				2. Direct driven by an electronically commutated motor (ECM).
				3. Linear modulation characteristic for precise set control and minimum cycling.
				4. Normalizes excess air by compensating for barometric pressure, temperature, and humidity.
				5. External linkages, damper motor drives, or single-speed motors are not acceptable.
			3. Mounted to a hinged door to provide access to the burner head, furnace, tube sheet, and tubes.
			4. Burner ignition type: Interrupted gas pilot ignition.
			5. Woven Fecralloy fiber burner head to facilitate 360° low-temperature radiant flame.
		2. Burner Fuel
			1. Burner designed to operate on natural gas or propane (fuel series 700).
		3. Emissions
			1. Guaranteed to limit emissions from full operating conditions to designed burner turndown:
				1. Maximum NOx emissions: 20 PPM.
				2. Maximum CO2 emissions: 130 PPM.
			2. Emission certification available to engineer and purchaser.
			3. Emission levels demonstrated at the time of startup.
			4. External flue gas recirculation as a means of emission control is not acceptable.
	3. PRESSURE VESSEL & CONNECTIONS
		1. Supply Connection
			1. Connection type: Raised face (RF) flange.
			2. ASME B16 pressure class: 150 lb.
		2. High Temperature Return Connection
			1. Connection type: Raised face (RF) flange.
			2. ASME B16 pressure class: 150 lb.
		3. Low Temperature Return Connection
			1. Connection type: Raised face (RF) flange.
			2. ASME B16 pressure class: 150 lb.
		4. Air Vent Connection
			1. Connection type: FNPT.
		5. Condensate Drain Connection
			1. Connection type: FNPT.
		6. Stack Connection
			1. Connection type: FNPT.
	4. VALVES & VALVE PIPING
		1. Safety Relief Valves
			1. Sized in accordance with ASME BPVC-IV requirements.
			2. Valve set point: As scheduled.
			3. Valve relieving requirement: Full capacity.
			4. Fully-enclosed steel spring.
			5. Factory set and sealed.
			6. Shipping method: Shipped loose.
	5. BOILER TRIM
		1. Main Low Water Cutoff (LWCO) Device
			1. Manufacturer: Warrick.
			2. Design style: Solid state probe device.
			3. Reset switch type: Manual reset with test switch.
		2. High Water Temperature Cutoff Device
			1. Reset switch type: Manual reset.
		3. Hot Water Supply Negative Temperature Coefficient (NTC) Thermistor
		4. Hot Water Return Negative Temperature Coefficient (NTC) Thermistor
		5. Hot Water Supply Limit Probe
		6. Hot Water Return Limit Probe
		7. Combination Temperature/Pressure Gauge
			1. Shipping method: Shipped loose.
		8. Condensate Treatment Assembly
			1. Assembly type: Tube.
			2. Neutralizing box.
			3. Neutralizing media.
			4. Shipping method: Shipped loose.
	6. GAS TRAIN
		1. Primary Gas Train
			1. Gas regulating method: Pre-assembled venturi gas valve.
			2. Piping material: Carbon steel.
		2. Combustion Air Inlet Filter
		3. Combustion Air Proving Switch
		4. High Air Pressure Switch
		5. Low Gas Pressure Interlock
			1. Reset type: Manual reset.
		6. High Gas Pressure Interlock
			1. Reset type: Manual reset.
		7. Upstream Manual Test Cock
		8. Downstream Manual Test Cock
		9. Manual Shutoff Valve
			1. Valve type: Ball valve.
		10. Unibody Double Safety Gas Valve Assembly
		11. Gas Pressure Regulator **(Optional)**
			1. Shipping method: Shipped loose.
		12. Burner Servicing Union Connection
	7. BURNER CONTROLS
		1. Flame Condition Scanner
			1. Scanner type: Ultraviolet spectrum (UV) scanner.
		2. Remote Emergency Shutoff Switch
			1. Contact type: Terminals only.
		3. Integrated Burner Management System (BMS) & Boiler Combustion Control System (CCS)
			1. Cleaver-Brooks Falcon Boiler Controller or equivalent.
			2. Microprocessor-based controller.
			3. Automatic boiler/burner operation sequencing (standby, pre-purge, safe start check, direct spark ignition, spark proving, run, post-purge).
			4. Monitors boiler/burner conditions:
				1. Low gas pressure.
				2. High gas pressure.
				3. Air proving.
				4. Stack back pressure.
				5. High water limit.
				6. Low water limit.
				7. Hot water supply temperature.
				8. Return water supply temperature.
			5. Touchscreen graphical human-machine interface (HMI).
				1. System digital display.
				2. Boiler/burner sequencing indication.
				3. Parameter set points.
				4. Mode selection.
				5. Fault test.
				6. Alarm/lockout with message history (last 15 messages).
			6. Compatible with building energy management systems (EMS).
		4. Multiple-Boiler Combustion Control System (CCS) **(Optional Lead-Lag Kit with Falcon Boiler Controller)**
			1. Eight (8) boiler limit in lead-lag control network.
			2. Inter-boiler communication via Modbus RS-485 wiring.
			3. Automatic selection of boilers based on load demand.
			4. Multiple-loop PID set point load control (central heat, hot water, and lead-lag).
			5. Remote reset/modulation/set point control.
			6. Adjustable outdoor reset schedule.
			7. Warm weather shutdown.
			8. Frost protection.
			9. Three (3) configurable pump control relays for each boiler.
			10. Time-of-day dual-set point control (night setback).
			11. Central heating and domestic hot water loop control.
			12. Heating modulation control.
			13. Hot water system pump control.
			14. High limit temperature control.
			15. High stack temperature limit.
			16. Thermowell NTC temperature sensors to provide measured process variable signals to the controller.
			17. Alarm annunciation.
			18. Three levels of access to control configuration:
				1. End-user.
				2. Installer/service engineer (password protected).
				3. OEM manufacturer (password protected).
			19. Flame supervision CPU functions:
				1. Controls pre-purge and post-purge operations.
				2. Operating history.
				3. Boiler cycle history.
				4. History of the last six boiler faults.
				5. Dedicated power supply.
				6. Safety shutdown with error display.
				7. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
				8. High and low gas pressure supervision.
				9. Combustion air proving supervision.
				10. High air pressure (high back draft) supervision.
				11. Supply temperature and set point temperature displayed at all times on touchscreen display.
				12. Controller equipped with touchscreen display for setup, troubleshooting, and operational display, including Modbus communication capability.
				13. Include system circulating pump programming and two heating loop programming.
				14. Parameter input control set points pre-downloaded before shipping.
				15. Field operating conditions programmed upon initial field operation.
				16. Panel-mounted controls and located at the front panel of the boiler to prevent water damage.
		5. Multiple-Boiler System Control **(Optional)**
			1. Cleaver-Brooks Hydronic System Control (HSC) or equivalent.
				1. Designed to deliver heating water from a hydronic boiler system at a desired set point temperature to a building heating system or process heating application.
			2. Sequence and modulate a maximum of ten (10) condensing boilers and ten (10) non-condensing boilers sharing a common supply water and return water.
			3. Multiple-loop PID set point control to maintain the system supply water temperature.
			4. Module manager (System Administrator).
				1. Manages and communicates with the BIM, PIM, and DIM via control area network (CANbus).
				2. Analog (4-20 mA) input from the supply water temperature sensor, return water temperature sensor, and outside air temperature sensor.
				3. Digital input from the domestic hot water (DHW) demand priority, cold building set point override, and local system pump proving switches.
				4. Graphical human-machine interface (HMI).

System setup and commissioning: boiler assignments, staging methods, outdoor reset schedule, night setback schedule, and PID tuning.

Individual boiler status, sequence, and trend analysis.

Sensor and calculated set point temperatures.

Alarm status and history.

* + - * 1. Graphic terminal touch screen: 6 in. color touch screen.
			1. Boiler interface module (BIM).
				1. Controls boiler combustion modulation, boiler outlet temperature limit, and boiler pump modulation.
				2. Two resistance temperature detectors (RTD).
				3. Graphical human-machine interface (HMI).

Individual boiler parameterization: low-fire hold time, outlet temperature limit, boiler pump/valve configuration, and damper interlock assignment.

* + - * 1. Graphic terminal touch screen: 3.5 in. monochrome touch screen.
				2. Installed at each boiler in the hydronic boiler system.
			1. Pump interface module (PIM).
				1. Enable, sequence, and modulate a maximum of four (4) system pumps.
				2. Graphical human-machine interface (HMI).

Individual pump parameterization: pump sequencing, analog input scaling, pump modulation set point, and PID tuning.

* + - * 1. Graphic terminal touch screen: 3.5 in. monochrome touch screen.
			1. Damper interface module (DIM).
				1. Enable and prove connected device functionality. (Dampers, draft controls, gas boosters, etc.)
				2. Controls boiler start permissive interlock functions.
				3. Maximum of twenty-four (24) damper devices enabled per DIM.
				4. Maximum of six (6) enable outputs and six (6) prove inputs per DIM.
				5. Maximum of four (4) DIMs per HSC network.
				6. Graphical human-machine interface (HMI).

Individual damper parameterization: manual-off-auto configuration (MOA) and off-delay timer.

* + - * 1. Graphic terminal screen: 3.5 in. monochrome LCD with keypad interface.
	1. ELECTRICAL
		1. Main Power Distribution Panel
		2. Audible Alarm
			1. Alarm type:

**Note: Select one and strikeout other.**

* + - * 1. Electric sounder.
				2. Alarm lights. **(Optional)**
1. EXECUTION
	1. INSTALLATION
		1. Packaged Boiler System Installation
			1. The installation shall be performed in accordance with national, state/provincial, and local regulations.
				1. The installation shall be performed in accordance with NFPA 54.
				2. The installation shall be performed in accordance with NFPA 70.
			2. The installation shall be performed in accordance with the manufacturer’s written instructions.
			3. The installation shall include factory piped or shipped loose components and assemblies.
			4. The installation shall include interconnecting electrical wiring for control and power components.
	2. SERVICES PROVIDED BY MANUFACTURER OR MANUFACTURER’S AUTHORIZED REPRESENTATIVE
		1. Pre-Installation Inspection
			1. Examine boiler room conditions affecting the safety of boiler room personnel and packaged boiler system installation, operation, performance, and maintenance.
			2. Verify boiler room clearances are in accordance with manufacturer’s recommended clearances.
			3. Verify boiler room air supply connections or louvers.
			4. Verify boiler room drain outlet connections.
			5. Verify boiler room electrical supply connections.
			6. Verify boiler room flue gas outlet (stack) connections.
			7. Verify boiler room fuel supply connections.
			8. Verify boiler room relief valve outlet connections.
			9. Verify boiler room hot water outlet connections.
		2. Site Training
			1. Train boiler room personnel packaged boiler system safety, operation, and maintenance procedures.
			2. Minimum duration: 8 hours divided among boiler room personnel shifts as specified by owner and/or owner’s representative.
		3. Pre-Startup Inspection
			1. Inspect installed packaged boiler system for damaged, incorrect, incorrectly installed, and missing components, assemblies, and connections.
			2. Replace any damaged or nonfunctional components.
			3. The pre-startup inspection results shall be submitted to the owner and/or owner’s representative.
		4. Site Hydrostatic Pressure Test **(Optional)**
			1. The completed packaged boiler system shall receive an ASME BPVC-IV hydrostatic pressure test with affixed valves, piping, and trim.
			2. The site hydrostatic pressure test results shall be submitted to the owner and/or owner’s representative.

**Note: The site hydrostatic pressure test may be required by national, state/provincial, or local codes.**

* + 1. Boiler Startup
			1. Test and document the following packaged boiler system components, assemblies, and connections:
				1. Safety valves.
				2. Low water cutoff.
				3. Auxiliary low water cutoff.
				4. High limit control.
				5. Operating control.
				6. Modulating control.
				7. Low gas pressure switch.
				8. High gas pressure switch.
				9. Combustion air proving switch.
				10. Low fire switch.
				11. High fire switch.
				12. Blower motor overloads.
				13. Gas valve auxiliary switch.
				14. Pilot valve leak test.
				15. Main gas valve leak test.
				16. Main gas vent leak test.
			2. Test, measure, and document the following packaged boiler system operation and performance metrics at a minimum of eight (8) firing rate data points at no more than 6% excess air:
				1. CO.
				2. NOx.
				3. O2.
				4. Stack temperature.
				5. Efficiency.
				6. Stack pressure.
				7. Gas pressure before gas pressure regulator.
				8. Gas housing manifold pressure.
				9. Water pressure.
				10. Variable frequency drive (VFD) frequency.
			3. The boiler startup results shall be submitted to the owner and/or owner’s representative.
			4. The owner and owner’s representatives reserve the right to witness the boiler startup.