## PART 1 GENERAL

* 1. SUMMARY
		1. This section includes condensing hot water boiler(s) for indoor space-heating application.
	2. REFERENCES
		1. Underwriters Laboratories:
			1. UL 795: Commercial-Industrial Gas Heating Equipment.
		2. American Society of Mechanical Engineers:
			1. ASME Section IV: Boiler and Pressure Vessel Code - Heating Boilers
			2. ASME CSD-1: Controls and Safety Devices for Automatically Fired Boilers
		3. American Society of Heating, Refrigeration and Air Conditioning Engineers:
			1. ASHRAE: Standard 90.1 Energy Standard for Buildings
		4. American National Standards Institute
			1. ANSI Z21.13: Gas Fired Low Pressure Steam and Hot Water Boilers
		5. Hydronics Institute, Division of Air Conditioning, Heating and Refrigeration Institute:
			1. BTS-2000: Testing Standard to Determine Efficiency of Commercial Space Heating Boilers
		6. National Fire Protection Association:
			1. NFPA 54: National Fuel Gas Code (ANSI Z223.1).
		7. Relevant local and/or project specific Codes and Standards
	3. SUBMITTALS
		1. In accordance with Contract Documents. Minimum product data to include:
			1. Capacities, accessories and options included with boiler.
			2. General layout, dimensions, size and location of all required connections.
			3. Electrical characteristics - provide wiring diagrams that are specific to this project.
			4. Weight and mounting loads.
			5. Manufacturer's installation and start-up instructions.
			6. Equipment Operation and Maintenance Manuals and control device cut-sheets.
	4. QUALITY ASSURANCE
		1. Use an adequate number of skilled workers, trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements, pertinent contract documents, and methods needed for proper performance of the work described therein.
		2. Provide the services of a manufacturer's factory-authorized representative to inspect and verify proper installation of this equipment, and to provide equipment start-up and operator training.
	5. DELIVERY, STORAGE, AND HANDLING
		1. In accordance with Contract Documents.
		2. Accept equipment and accessories in Factory shipping packaging. Inspect for damage. Keep boiler in a vertical position from time of delivery to final installation.
		3. While stored, all equipment must be protected from external elements such as inclement weather, job site construction activity, etc. Protect equipment from damage by leaving packaging in place until installation.
	6. WARRANTY
		1. The boiler shall come with the warranties stated below. Warranty period shall be one (1) year from date of start-up or eighteen (18) months from date of shipment, whichever comes first.
			1. Lifetime, shockproof warranty on seal of tube to header. Covers leaks in pressure vessel attributed to unequal expansion.
			2. All stainless steel heat exchanger shall carry a 10-year limited warranty.
			3. Pressure vessel and flue collector are covered against failure due to fireside flue gas corrosion: upper & lower pressure vessel headers shall carry a 10-year limited warranty and flexible boiler tubes & flue collector sides, top and bottom shall carry a 5-year limited warranty.
			4. Burner shall carry a 1-year limited warranty.
			5. All other parts shall carry a 1-year limited warranty.

## PART 2 PRODUCTS

* 1. ACCEPTABLE MANUFACTURERS
1. Thermal Solutions Boiler, Arctic Model ARC-[3500, 4000, 4500, 5000, 5500, 6000]. Refer to the Equipment Schedule in the Contract Drawings for the specific design and performance criteria.
2. It shall be the responsibility of the Contractor to insure that any substituted equipment is equivalent in fit, form and function to the specified equipment. The cost of any additional work caused by the substitution of equipment shall be borne by the Contractor.
3. Or approved equal.
	1. GENERAL REQUIREMENTS
4. Boiler
	1. The boiler shall be factory assembled & packaged as a complete unit and shipped on a heavy steel frame or knockdown configuration. Packaged unit shall be complete with jacket, gas manifold, burner and controls mounted and wired, as specified in this Section. The boiler shall be factory fire tested prior to shipment. Knockdown unit is fully assembled and fire tested as a package then dissembled & labeled for shipment. Boiler connections shall be limited to the water supply & return, relief valve and boiler drains, fuel input, electrical power, exhaust vent and air inlet (as specified/shown in contract documents).
	2. The boiler shall be constructed in conformance to ASME Section IV and UL 795. The boiler shall bear the ASME “H” stamp and be National Board Listed for 160 psi MAWP at 210°F. The gas train and safety controls shall conform to requirements of UL 795 and ASME CSD-1.
	3. Pressure vessel shall be constructed of 316L stainless steel non-welded flexible serpentine water tubes connected to 316L stainless steel headers. All tubes:
		1. Shall be easily removed and or replaced in field without welding or rolling and may be demonstrated upon request;
		2. Shall not require ASME “R” stamp for tube replacement; and
		3. Shall provide lifetime, shockproof seal on tube to header attributed to unequal expansion.
	4. Heat exchanger shall demonstrate accessibility to all components exposed to fireside products of combustion.
	5. Heat exchanger shall be capable of operating up to 100OF delta T at high fire.
	6. Boiler shall be capable of variable primary or primary/secondary piping arrangements.
	7. Boiler shall be equipped with a hinged front door for easy access to control devices, wiring connections and BMS interface cables/wires.
	8. The boiler shall be furnished with an adequate number of tappings and full size inspection openings to facilitate internal boiler inspection and cleaning.
	9. The ASME data plate shall be visible through open front door without removing boiler panels or screws.
	10. The boiler shall be complete with a 16 gauge metal jacket, steel casing, finished with a suitable heat resisting powdered coated finish. It shall be constructed on a structural steel frame and properly insulated with 1 inch thick insulation. The complete jacket shall be easily removable and reinstalled. The boiler shall incorporate individually removable jacket doors, with handles providing easy access to combustion chamber access panels. The entire tube area shall be easily accessible for fireside cleaning from both sides.
	11. The boiler furnace and convection chamber shall include access door opening to allow for inspection of the interior chamber and burner assembly. The interior walls of the furnace chamber shall be lined with high temperature ceramic fiber blanket insulation.
	12. Electrical input to the boiler shall be [3500 & 4000 – 208v or 240v or 460v/3ph/60hz]. Single-point electrical hook-up for the boiler shall be provided. Separate power wiring and control wiring is not acceptable. A dedicated electrical disconnect shall be provided by the installing contractor.
		1. Combustion System
			1. Burner operation shall provide infinite modulation with capacity for 20:1 turn down. Tru-O2 Turndown System shall exhibit no more than 1.0% difference in O2 settings between high fire and lowest setting. Tru-O2 Turndown System shall feature an independent ignition position independent of lowest firing rate and nine (9) point curve for adjustment and fine tuning.
			2. The burner shall be a metal fiber mesh burner with no moving parts capable of operating low NOx operation without additional components. The burner shall fire in a full 360-degree pattern providing uniform heat transfer. A viewing port shall be provided for visual observation of burner performance.
			3. The ignition system shall be supervised pilot with a UV scanner. It shall be independent from the burner turndown operation for reliability.
			4. The entire ignition and firing control sequence shall be monitored by a UL approved commercial-type microprocessor based integrated flame safeguard burner control. The burner control shall incorporate both pre-purge and post-purge timing functions
			5. The gas train shall be UL/CSD-1 compliant with a supply gas pressure range of 7”wc - 14” wc using Natural Gas. The gas train shall consist of high and low gas pressure switches (each with manual reset), a manual shut off valve upstream of burner and downstream of last gas valve. Two motorized gas valves shall perform the functions of safety shutoff and constant pressure regulation.
			6. The boiler electrical control circuit shall include a 120V limit string containing a low water cut off, water flow switch, high limit manual reset, blocked condensate switch, burner fuse, low gas pressure switch, high gas pressure switch, blocked vent switch, combustion air proving switch and proof of closure. CSD-1 compliant.

C. Multiple Boiler Control System

1. Scope of Supply
Boiler Control System shall coordinate the operation of up to eight (8) hot water boilers.
2. Hot Water Temperature Setpoint
The control system shall control boiler modulation and on/off outputs based on the remote system water supply temperature. The controller shall also be capable of adjusting the modulation rate setpoint automatically based on outdoor air temperature. The boiler controller shall also be able to allow setpoints based on Domestic Hot Water Priority (DHWP), Warm Weather Shut Down (WWSD) or Energy Management System (EMS) input of firing rate demand, remote setpoint or remote start/stop commands.
3. Multiple Boiler Sequence
The controller shall sequence each connected boiler and shall have adaptive technology to automatically match active boilers of various input sizes to the system load and water temperature requirements. The controller shall be connected by using standard RJ45 ethernet cables. The control system shall allow the connected boilers to exchange signals as required to provide coordinated fully modulating lead/lag functions. It shall not be required to wire individual control signals between boilers. Multiple boilers shall be modulated in “Unison” (all at the same firing rate) or “Sequential” (master boiler only to satisfy load with lag boilers operating at peak efficiency “Base Load” rate). To increase operational efficiency, the control system shall utilize both water temperature and firing rate based boiler sequencing algorithms to start and stop the boilers and shall minimize the total number of boilers in operation. The control system shall start and stop boilers when the water temperature is outside the adjustable temperature limit for longer than the adjustable time delay. In order to minimize temperature deviations, the control system shall start and stop the next boiler when the “lead” boiler is at an adjustable firing rate limit for longer than the adjustable time delay. The control system shall monitor both boiler lockout and limit circuits to automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. The boiler shall be run at low fire for warm-up for a preset low fire hold time. When enabled, warm weather shut down control logic shall prevent boiler operation. The controller shall also be capable of auto-rotation of the boilers based on user-selected run time hours.
4. Circulator Control
The controller shall include automatic alternating pump outputs. Either pump may be selected as the lead and the other as the backup. The system shall be designed to have one pump running at a time with the second pump available as a backup pump. If the lead pump fails to produce flow (sensed by a flow switch located in the individual pump piping), an alarm shall be generated and the backup pump is started. The backup pump shall run as long as the lead pump is called to run, and does not produce required flow. Lead pump shall be rotated manually or based on run time hours. If auto rotation is desired, the lead pump runs for a field adjustable overrun time until the backup pump is proven. The pump runs when the control is enabled, and there is no Warm Weather Shutdown.
	* + 1. Isolation Valves

The controller shall be capable to operate isolation valves. These valves are intended for use in variable flow systems. These systems are not primary piped and boiler water flow is provided by system pumps. The isolation valves close when a boiler is not running to ensure system water is not flowing through offline boilers. When a boiler is called to start, the isolation valve opens allowing flow through the boiler. If all boilers are off, the lead boiler’s isolation valve remains open. Isolation valves may be opened and closed manually or set to automatic control.

* + - 1. Load Monitoring

The controller shall monitor system load by measuring the system supply temperature, system return temperature, and system pump speed feedback or pump status. Maximum GPM can be entered for a constant-speed primary pump, or GPM can be measured for a variable-speed pump via a 0-10Vdc or 4-20mAdc feedback input.

* + - 1. EMS Communication

The controller shall collect monitoring points from the networked boilers and offer the Energy Management System (EMS) a single-point connection via included Modbus TCP/IP, Modbus RTU RS485, BACnet/IP and BACnet MSTP protocols. Additionally, the controller shall accept a 0-10vdc or 4-20mAdc setpoint input, an enable/disable contact input, and provide alarm and lockout contact outputs.

[OPTION: The boiler control system shall network with a separate communication gateway to connect with LonWorks [Johnson Controls Metasys N2] communication protocol.]

D. Water Trim

1. Water trim devices including an ASME rated pressure relief valve set at [30, 50, 60, 75, 100, 125, 150] psi, combination water pressure and temperature gauge and water flow switch & LWCO to prevent burner operation during low water flow conditions shall be provided.

E. Vent & Intake Air Connections

1. The boiler shall be designed to accommodate ducted combustion air or other positive pressure venting options. The flue duct shall be AL 29-4C, other stainless steel or polypropylene vent material approved for condensing flue gases for positive pressure venting. Single wall vent is acceptable where allowed by local code. Available pressure drop range to be provided for longer runs and upsizing. Common venting is allowed if sized properly to maintain a neutral to slightly negative draft. A mechanical draft system may be required
2. When used for ducted combustion, air intake piping can be PVC or galvanized smoke pipe that is sealed and pressure tight. Pipe must be at least the same size as the inlet air connection on the boiler.
3. The combined pressure drop through the vent and combustion air duct shall not exceed 100 equivalent feet.

2.3 PERFORMANCE

1. Boiler shall be AHRI certified at a minimum 95% thermal efficiency.
2. Provide services of a manufacturer's authorized representative to perform combustion test including boiler firing rate, gas flow rate, heat input, burner inlet gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, percent combustion efficiency, and heat output. Perform testing in accordance with contract documents.

## PART 3 EXECUTION

3.1 INSTALLATION

1. In accordance with Contract Documents and boiler manufacturer's printed instructions.
2. Flush and clean the boiler upon completion of installation in accordance with manufacturer's start-up instructions. The boiler must be isolated when any cleaning or testing of system piping is being performed.
3. Install skid plumb and level, to plus or minus 1/16 inch over base.
4. Maintain manufacturer's recommended clearances around and over equipment, and as required by local Code.
5. Arrange all electrical conduit, piping, exhaust vent, and air intake with clearances for burner removal and service of all equipment.
6. Connect exhaust vent to boiler vent connection.
7. If shown in Contract Drawings, connect full sized air inlet duct to flanged connector on boiler.
8. Connect fuel piping in accordance with NFPA 54. Pipe size to be the same, or greater, than the gas train inlet connection.
9. Use full size (minimum) pipe/tubing on all gas vent connections.
10. Connect water piping, full size, to supply and return connections.
11. Install all piping accessories per the details on the contract drawings.
12. Install discharge piping from relief valves (open termination for viewing) and all drains to nearest floor drain.
13. Provide necessary water treatment to satisfy manufacturer’s specified water quality limits.