DOMINION BRIDGE COMPANY, LIMITED - LACHINE, QUEBEC

OPERATION & MAINTENANCE INSTRUCTIONS
for
THREE (3) 15,000,000 BTU/HR FORCED CIRCULATION
HIGH TEMPERATHRE HOT WATER UNITS
at
WINNIPEG SEWAGE TREATMENT PLANT
WINNIPEG - MANITOBA

DOMINION BRIDGE COMPANY, LIMITED - Contract Y-2576

I N D E X

PART I

PROPOSAL & SPECIFICATIONS

File BB-2049

Proposal 1

Date June 3rd, 1963.

Proposal

and

Specifications

for

THREE (3) 15x10^6 BTU/HR

FORCED CIRCULATION HIGH TEMPERATURE HOT WATER UNITS

for

SEWAGE TREATMENT PLANT CORPORATION

WINNIPEG - MANITOBA

DOMINION BRIDGE COMPANY LIMITED

Boiler Division

PRINTED IN CANADA

DATE June 3rd, 1963.
PROPOSAL 1
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SPECIFICATION

GENERAL

The Company shall deliver to site for installation by others three (3) high temperature water units. The units shall be forced circulation, drumless type, shop assembled, arranged for natural gas or sludge gas firing equipment which shall be supplied by the Company and shall be arranged as indicated on the following Company's Drawing E1.

CODES & REGULATIONS

The units shall be designed for a maximum permissible working pressure of 200 psig. in accordance with laws, ordinances, and regulations of the Province of Manitoba and the Canadian Standard Association.

The pressure parts furnished under this proposal shall be designed and constructed in accordance with the latest edition of the A.S.M.E. Construction Code for Power Boilers, unless this Code conflicts with the Provincial Regulations.

SHOP TESTS

All equipment shall be completely assembled, wired and pressure tested prior to shipment. Each unit shall be tested at a hydrostatic pressure of 300 psig.

TUBES & HEADERS

The tubes shall be $1\frac{1}{4}$" O.D., .134 inch thick steel tubing to A.S.M.E. Specification SA-178 Grade "A" or SA-83 Grade "A".

The headers shall be seamless steel pipe to A.S.M.E. Specification SA-106 or equal.

The tubes shall be arranged as shown on drawing E1. The water shall be distributed to each tube according to the heat absorbing capacity, by means of Monel metering orifices. Each orifice shall be removable and shall be equipped with separate strainers. The tubes shall be welded into headers which are located outside the gas flow.

All tubes shall be drainable.

The roof, sides, rear and floor of the furnace shall be water cooled. The tubes in the furnace area shall be spaced on 1½" centres.

DOORS & OPENINGS

Each unit shall be furnished with:-

1 - 12" x 18" furnace access doors.
2 - 3" pressure tight construction, air cooled furnace observation doors.
2 - 12" x 15" access door in convection section.

CASING & SUSPENSION STEEL

The units shall be encased in a steel casing constructed of stiffened panels of No.10 gauge plates welded to the steel supports.

The steel casing shall be of welded construction to form a gas tight enclosure for pressurized firing. The casing shall be designed to be air tight under a pressure of 10" W.G.

PAINTING

All steel work shall be painted one coat before shipment from factory.

The finish painting, where required, shall be performed in field by the Purchaser.

TOOLS

One (1) set of special tools shall be supplied for the three (3) units, to include tools for handhole cover and orifices.

BRICKSETTING & INSULATION

The setting for each unit shall be designed with ample provision for expansion and contraction under varying load conditions.

The casing temperature in the furnace area shall not exceed the boiler room ambient temperature by more than 60°F.

Front Wall

To be lined with 5" Kast-O-Lite light weight insulating castable backed with 7" Castable Block Mix.

The refractory wall in front of breeching is to be constructed of 3" castable No.20.

Side Wall, Rear Wall, Floor and Roof

To be constructed of 1" of Acto shiplap tile backed with 3" of Castable Block mix.

Baffle

The horizontal portion of the baffle is to be 1" of Acto tile. The vertical baffle outside the tube bank shall be constructed of $4\frac{1}{2}$" Empire quality Fireclay brick. The baffle extending through the tubes is to be 3" KAST SET castable refractory.

BREECHING

Each unit shall be complete with gas breeching from the boiler outlet. The gas breeching shall be of welded construction provided with suitable gas tight cleanouts and be fabricated of 3/16" low alloy, high tensile steel plates ASTMA-242 or equal.

FIRING EQUIPMENT

The Company shall supply and install the following firing equipment for each boiler:-

ONE (1) Raskin or equal dual burner, forced draft, fully automatic, modulating packaged gas burner units.

Each unit is also provided with the following additional equipment:-

1 - 4" Varec No.450 flame trap assembly.
4 - Main gas shut-off valves.
2 - Main gas vent valves.
4 - Pilot gas shut-off valves.
2 - Lubricated main gas cocks.

Fuels: Natural or sludge gases.

Gas Burner Capacities: 18,000 C.F.H. of natural gas or
29,000 C.F.H. of sludge gas.

Required gas pressures at unit inlet:

Natural Gas = 3.5 P.S.I.G.
Sludge Gas = 5.0 P.S.I.G.

Current: 220/3/60

Combustion Controls: Included with Bailey Instruments.

Fan: Centrifugal

Fan Motor: 5 HP

Elevation: 500 feet above sea level.

Weight: 2,200 lbs. each.

The gas pressure regulators shall be supplied by others. (Detailed as per the enclosed "Raskin" Specification Form DN-49-1a/2.)

MOUNTINGS

The units shall be equipped with the following trim which shall be supplied by the Company for installation in field by the Purchaser:-

1 - 2½" safety valve set at 200 psig. - Relieving capacity 15,100 lb/hr steam Consolidated 1902 JC

1 - 4" water inlet and outlet valve - Jenkins 203

1 - 8" temperature gauge, white dial with black markings - Pitanco

1 - ½" valve for pressure gauge - Vogt SW-853

1 - 8" temperature gauge, black dial with yellow markings bulb and stainless steel wall.

1 - 15" x 27" panel for above gauges, to be mounted at the front of the unit, colour to be specified by the Purchaser.

1 - 1" blow-down valve - Hopkinsons No.8803 & 2873

1 - ¾" vent valve - Vogt SW-854

2 - 4" thermometer wells for inlet and outlet water temperature.

BOILER DATA

15,000,000

Unit output BTU/hr - 15×10^6

Working pressure, psig. - 125

Design pressure, psig. - 200

Test pressure, psig. - 300

Heating surface:

Furnace (projected area)	sq.ft.	- 293
Boiler (circumferential)	"	- 1237
Total	"	- 1530

Furnace volume cu.ft. - 360

Furnace liberation BTU/cu.ft. - 51,000

Fuel: Natural gas of H.H.V. 1000 BTU/S.C.F.
Sludge gas of H.H.V. 600 BTU/S.C.F.

Ambient temperature °F. - 80

Max. casing temperature in furnace area °F. - 130

Water outlet temperature (constant) °F. - 240

Water inlet temperature °F. - 180

Water flow through unit (constant) lb/hr 250,000

Water pressure loss through unit psi. - 15 (preferably 18)

PERFORMANCE DATA (Natural Gas)

Load	%	100	75	50	25
Output	BTU/hr x 10^6	15	11.25	7.5	3.75
Water Flow	lb/hr		250,000		
Water outlet temp.	°F.	240	240	240	240
Excess Air	%	15	18	20	25
Water inlet temp.	°F.	180	195	210	225
Gas outlet temp.	°F.	450	380	310	270
Ambient temp.	°F.	80	80	80	80

Losses					
Load	%	100	75	50	25
Water vapour in air	%	.19	.16	.125	.11
Water from fuel	%	11.00	10.65	10.40	10.20
Dry products of Combustion	%	7.13	5.93	4.63	4.00
Radiation ¥	%	.50	.66	1.00	2.13
Unaccounted for	%	1.50	1.50	1.50	1.50
Total loss	%	20.32	18.90	17.66	17.94
Expected efficiency	%	81.18	81.60	82.84	82.56
Guaranteed	"	79.68	81.10	82.34	82.06

¥ Radiation loss in accordance to A.S.M.E. Power Test Code PTC-1946 Plate 2.

BOILING OUT

The boiling-out of the units should be carried out in conjunction with the boiling-out of the complete heating system making use of expansion tank, circulating pumps and circulating piping which are supplied by others and placed into operation by others.

The Company shall supervise the boiling-out of the boilers only and supply the required chemicals in suitable quantities for boilers only.

The chemicals required for boiling-out of the remaining system shall be supplied by others.

The licensed personnel supplied by the Purchaser shall operate the units and allied equipment during the boiling-out procedure. The fuel, preferably wood, shall be supplied by the Purchaser.

START-UP & PRELIMINARY OPERATION

In connection with three (3) units, the Company shall supply for a period of 2 weeks (ten eight-hour days) a service engineer for start-up and instruction of the operating staff. This service shall be completed in one continuous operation immediately following boiling out, and Purchaser must provide adequate heating load so that all adjustments can be finalized. All operating personnel and necessary fuel water, etc., shall be supplied by the Purchaser.

ITEMS NOT INCLUDED

Unloading and hauling at the site.

Placing on foundations.

Stack

Boiler chemical feed equipment.

Tanks

Temporary Heat

Nitrogen compressors, nitrogen supply system.

All other equipment not specifically mentioned in this Specification.

SPECIFICATION APPROVED FOR SUBMISSION

DOMINION BRIDGE COMPANY, LIMITED

J.M. Dyke - Chief Engineer
Boiler Products Division

Made by: R.D.
Checked by: A.P.
Typed by: M.B.

F. J. RASKIN

COMBUSTION

4220 Iberville St.
MONTREAL, QUE.

LAfontaine 4-3704

Form DN-49-1a/2

SPECIFICATION

OF "RASKIN" COMPACT IX GAS BURNER

CSA APPROVAL NO. 49.3

These fully-automatic and modulating units are factory assembled and tested, and basically include the following components:

1 - Raskin Series R-1 gas ring with manifold and air vanes for natural gas operation.
1 - Raskin Series R-2 gas ring with manifold and air vanes for sludge gas operation.
2 - Lubricated gas cocks with wrenches.
1 - Raskin type D-6 air register with refractory throat.
1 - Buffalo HVA-151 forced draft fan with louver damper.
1 - 5 H.P. Standard drip-proof protected motor with sheaves and V-belts.
2 - Gas shut-off valves with 3/4" vent valve for natural gas.
2 - Gas shut-off valves with 3/4" vent valve for sludge gas.
2 - 3-1/2" dial Marshalltown No. 83 gas pressure gauges.
1 - Raskin type F-7 gas-electric flame igniter complete with 5000 V transformer, dual gas shut-off valves K-3A, cock and 1/2" Maxitrol RV-42 gas pressure regulator.
1 - Control cabinet containing fireye FP-2 Model 6012 programming relay, magnetic motor starter, pilot lights, push-button station, fuses, circuit transformer and air safety switch.
1 - Change-over switch.
2 - Low and high gas pressure interlocking switches C437.
1 - Entrance transformer, Hammond 575/115-230 V.
1 - Main disconnect switch, Square D.

The auxiliary equipment, such as draft regulators, alarm bells, etc. may be supplied at an additional price as specifically mentioned in our proposal accompaning this specification sheet. The two form the basic bid.

SR:yt

May 28, 1963

AILEY METER COMPANY LIMITED

EQUIPMENT SPECIFICATION

May 29th, 1963

METROPOLITAN CORPORATION OF GREATER WINNIPEG
NORTH END SEWAGE TREATMENT PLANT
HEATING, VENTILATION AND DEHUMIDIFICATION
CLAUSE 39.05 - HOT WATER BOILER SYSTEM INSTRUMENTATION

SPECIFICATIONS

Set of metering and control equipment for three medium temperature hot water boilers and to be supplied in strict accordance with the detailed specifications. Each boiler to be equipped with a single burner and designed to fire either natural gas or sewage sludge gas with the fuel input regulated to maintain a constant temperature of 240°F for the water leaving the storage tank with the individual boiler outlet temperatures controlled between 240°F and 285°F depending upon the system demand.

Service

The necessary service to provide a minimum of 15 days supervision at the site covered over the period of installation plus the time of our service engineer to verify the calibration of all components, place the equipment into operation, run combustion tests on both natural gas and sludge gas firing and to place the equipment into satisfactory operation.

Connecting Piping

To include all necessary copper tubing, small valves and fittings, required to connect the metering and control equipment to the boiler control panel including all draft lines and instrument air supply between the components and the boiler room pressure reducing and air filtering stations.

Boiler Recorders

Bailey Type KM55A Model E101 Class 888Y Recorders designed to:

(a) Record BTU production.
(b) Totalize BTU production.
(c) Record boiler water outlet temperature.
(d) Record flue gas temperature.

...2

Each record to be provided on a uniformly graduated direct reading 12" - 24 hour chart, capillary type inking system with the recorders to have internal illumination.

Each boiler recorder to include the following components:

1 - Type CC1351 water flow transmitter complete with 6" orifice plate, orifice flanges, radiator reservoirs and connecting piping.
1 - Type KT1310A boiler outlet water temperature transmitter complete with stainless steel protecting well.
1 - Type KT1310A (common) boiler inlet temperature transmitter.
1 - Type KT1340A flue gas temperature transmitter.
1 - Set of pneumatic computing relays to calculate boiler BTU.

Boiler Indicating Gauges

(3) Bailey Type PG200SA 6-unit Vertical Indicators with 7" scale and internal illumination, designed to indicate:

(a) Burner gas pressure.
(b) Windbox pressure.
(c) Furnace pressure.
(d) Boiler water flow.
(e) Natural gas flow.
(f) Sludge gas flow.

Gas Flow Meters

(6) Orifice type Gas Flow Meters to transmit, indicate and totalize natural gas and sludge gas flow to each boiler and including:

1 - Set of indicators included under Item 2 above.
6 - Bailey Type BJ232 differential transmitters.
3 - 4" stainless steel natural gas orifice plates designed for 4" H_2O differential at maximum flow.
3 - 4" stainless steel orifice plates for sludge gas flow designed for 6" H_2O differential at maximum flow.
6 - Sets of 4", 300 pound slip-on orifice tap flanges.
6 - Sets of connecting piping.
6 - 6-digit gas flow totalizers for panel mounting to provide total flow of natural and sludge gas to each boiler.

Plant Recorder

Bailey Type KM55A Model E101 Class 8880 Recorder designed to:

(a) Record expansion tank level.
(b) Hot water return temperature.
(c) Hot water supply temperature to the system.

And to include:

1 - Type LJ2330B pneumatic level transmitter for expansion tank complete with connecting manifold piping and radiator reservoir.
1 - Type KT1310A system temperature transmitter complete with protecting well.

Alarm Annunciator

4 x 5 Scam Twin Point Type AF annunciator complete with 16 alarm points as specified, alarm horn, disconnect pushbutton with all necessary pressure switch contacts to actuate the alarm point.

Boiler Combustion Controls

(3) Complete sets of Pneumatic Combustion Control Systems designed to:

(a) Maintain the temperature of the water leaving the storage tank at 240°F within ± 4°F.
(b) To reset the set point of the individual boiler outlet water temperature controllers over a range of 240° to 285°F with maximum and minimum limits.
(c) To regulate fuel and air in parallel.
(d) To include adjustable minimum firing rates for burner stability.
(e) To include low fire start to be actuated from the flame failure system with slow rate of build-up with fast acting control after a preset time limit.

System to include:

3 - KT1310A water outlet temperature transmitters (included under Item 1).
3 - Computing relays with proportional plus reset action.
3 - Type AM2100 boiler master and fuel selector stations.
3 - Type AM3100 forced draft fan selector stations with bias features for fuel air ratio adjustment.
3 - Type AC0404P forced draft fan control drives complete with linkage.
3 - 4" Pneumatic sludge gas pressure control valves to maintain 7 psig. upstream of boiler control valve.
3 - 4" sludge gas control valves, complete with cam characterizing positioning relay, adjustable minimum stops, low fire start switches.

EQUIPMENT SPECIFICATION

3 - 3" natural gas control valves complete with cam operated positioning relay, adjustable minimum stop, low fire start switches.
3 - Manual transfer valves to select either fuel.
3 - Sets of components to provide individual boiler shut-down from limits and to provide slow rate of build-up of firing for a predetermined time interval.
3 - Pneumatic pressure switches, solenoid operated 3-way valves, adjustable bleed valves.
3 - 3-way solenoid valves to stroke the F.D. fan drives to the wide open position during the pre-purge period.

Flame Failure Equipment

Sets of Flame Failure Equipment, Bailey Automatic Type Purge A, for combination firing, designed to provide:

(a) Automatic boiler light-off and shut-down.
(b) Automatic purging prior to light-off.
(c) Proof of pilot flame.
(d) Proof of main flame.
(e) Fuel selector switch for natural or sludge gas.

Systems to include:

3 - Fireye Type FP2 Model 6012 programming safeguard controller, flush mounting, with three pilot scanners and three main fuel scanners.
3 - Control cabinets to include alarm horn, signal lights, circuit breakers, auxiliary relays, pushbuttons and ignition transformer.
3 - 3/8" pilot gas shut-off valves, auto. reset.
3 - 3" natural gas shut-off valves, auto. reset.
3 - 3" sludge gas shut-off valves, auto. reset.

Each system to include the following limits:

(a) Low water flow circulation - pressure switch.
(b) Forced draft fan failure - tail contacts on motor starter.
(c) High boiler outlet temperature - pressure switch.
(d) High natural gas pressure - pressure switch.
(e) High sludge gas pressure - pressure switch.

Expansion Tank Control System

Control System for the expansion tank, low pressure nitrogen tank and high pressure nitrogen tank as specified including pressure reducing valves, pressure switches, gauges, nitrogen bottle manifold piping and relief valves.

Control Panel - No. BHV1

Bailey free standing, walk-in type, side access Control Panel with lighting canopy as detailed in specification drawing No. 152. Panel to be fabricated from smooth rolled steel sheet with approximate dimensions of 12'-4" wide, 7'-6" high and 4' deep, with the exterior to be finished in a color to be specified and the interior finished in flat white. Panel to include dust proof hinged doors on either end and located to provide access at the rear of the motor control panels 1-A and 1-B.

Panel to have all instruments and control components listed in this quotation factory mounted with all connecting piping and wiring completed to tagged terminal strips. Each surface mounted item to be identified by means of an engraved lamicoid nameplate.

To include:

1 - Graphic section to be fabricated from a lucite plastic sheet with all boiler, pumps, and piping symbols back engraved, and color coded for the process.

Graphic section to include:

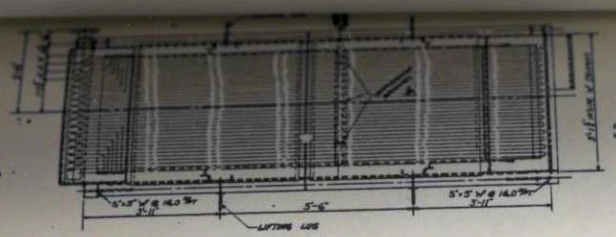
22 - Illuminated motor start buttons - C.G.E. miniature, with engraved nameplates.
22 - Illuminated stop buttons - C.G.E. miniature, with engraved nameplates.
7 - 2 position selector switches - C.G.E. miniature, with engraved nameplates.

Factory wiring of all pushbutton stations and lights.

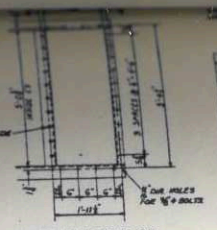
Panel to include detailed manufacturing drawings for approval, detailed tubing drawings and complete schematic and detailed wiring drawings for all electrical components.

Boiler Room Instrument Air Supply

Bailey 12 cfm. instrument air filter and pressure reducing set to provide 40 psig. air for valves and drives, and 17 psig. air to the panel board as required. Station to be factory assembled complete with by-pass and shut-off valves, pressure gauges, to enable a change in filter under continuous operation.

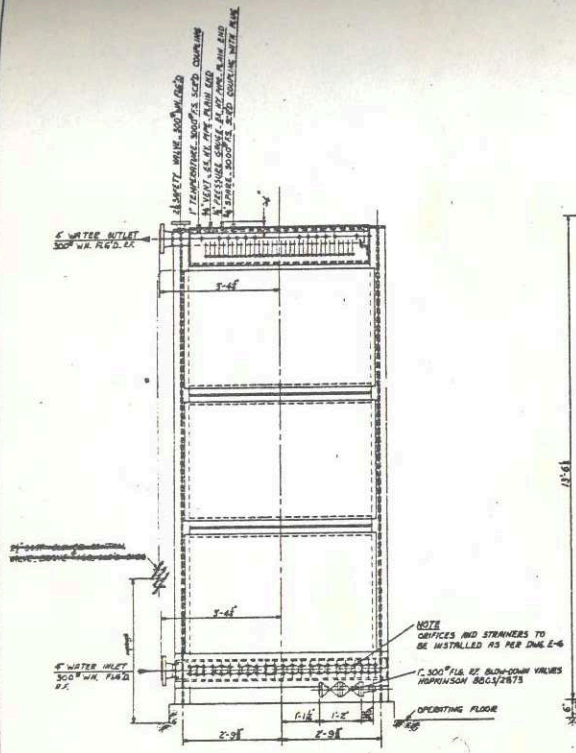


TOP VIEW

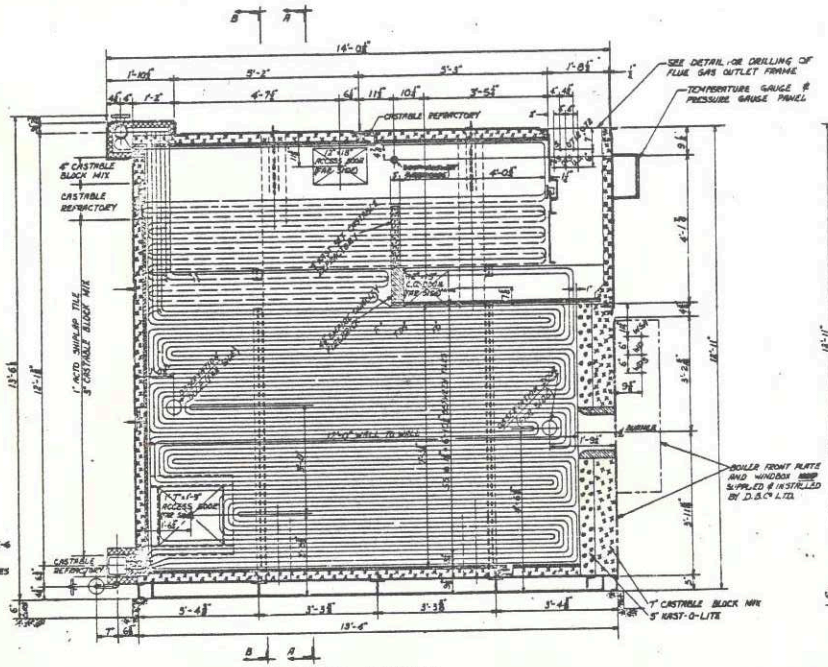


DRILLING OF FLUE GAS OUTLET FRAME

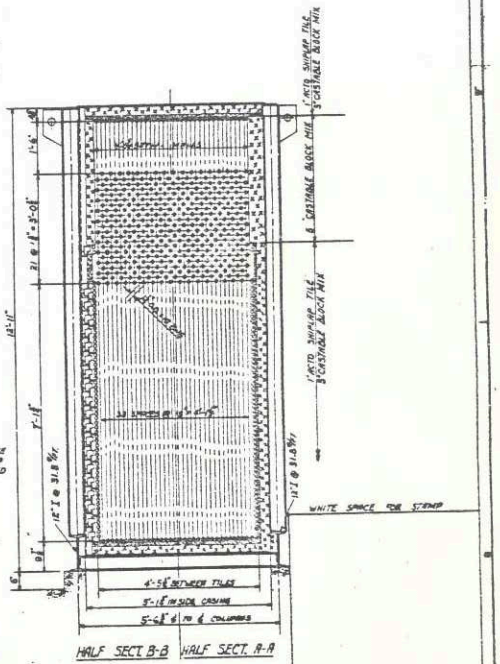
LIST OF INSTRUMENTS CONNECTIONS			
PG	1"	SCPD	PRESSURE GAUGE
LWG	1"	SCPD	WATER GAUGE
LWG2	1"	SCPD	WATER GAUGE SPARE
LWG3	1"	SCPD	WATER GAUGE SPARE
WGA	¼"	SCPD	WATER GAUGE AIR
P	2"	W.N.P.D.	BOILER METER
S	2"	W.N.P.D.	BOILER METER
UD	2"	W.E.D.	UPTAKE DAMPER
OT1	1½"	FLGD	FLUE GAS OUTLET TEMP. SIDE 1
OT2	1½"		TEMPERATURE BULB UPTAKE SIDE 2
OTS	1½"	SCPD	FLUE GAS OUTLET TEMP SPARE
FGS	6"	SCPD	FLUE GAS SAMPLING



REAR VIEW



SECTIONAL ELEVATION



HALF SECT. B-B HALF SECT. A-A

DOMINION BRIDGE COMPANY LIMITED

DEPT. BOILER PRODUCTS

DESCRIPTION 1,200,000 B.T.U.H. FORCED CIRCULATION H.W. UNIT

DETAIL GENERAL ARRANGEMENT

PROPRIETOR

PURCHASER

VAULT NO. E1

FILE-BB2049

PART II

DRAWINGS

PART III

OPERATION & MAINTENANCE

PART 111

Operating and Maintenance Instructions

Unit Operating and Design Data

Working pressure		100 psig.
Design pressure - tube and headers		400 psig.
Design pressure - mountings		250 psig.
Hydrostatic Test pressure		600 psig.
Water inlet temperature		180°F.
Water outlet temperature		240°F.
Normal Load		15,000,000 BTU/HR.
Normal water flow		250,000 LB/HR.
Water head loss through unit at Normal water flow		15 psig.
Ambient air temperature		80°F.
Heating Surface:		
Furnace (Projected Area)		293 sq.ft.
Convection Part		1,237 sq.ft.
	TOTAL	1,530 sq.ft.
Furnace Volume		360 cu.ft.
Safety valve relieving capacity		16,849 lb/hr Steam
Weight of cold water to fill each unit		2,100 lbs.

Unit General Description.

The installation consists of three (3), Dominion Bridge high temperature water units.

The units supplied by Dominion Bridge Company are of forced circulation drumless type, shop erected arranged for natural gas or sludge gas firing equipment as shown on drawing E-1/Y-2576.

The units can be operated individually or in any combination in the closed circulation HT water system. The pressure at any point in the system will be maintained constantly above the saturation pressure of water.

Water heated in the units flow to a hot water storage tank and thence to all areas through circulating pumps. The return water after passing through the storage tank shall be returned to the units by separate water return pumps.

The firing rate on any individual unit is adjusted to the rate of flow so as to maintain constant the set outlet water temperature.

Orifices are installed in the inlet headers at the entrance to each separate tube circuit to distribute the water according to the heat absorbtion of each element.

The orifice sizes and locations are shown on drawing E-6/Y-2576.

The orifice retracting tool is shown on drawing No.10.

All tube circuits are drainable.

Each unit is fired by a Raskin Model DGG-9FA Dual Burner, forced draft, fully automatic, modulating packaged gas burner assembly.

Preparation for Service After Drying Out and Boiling Out.

Flush the system with softened water and make sure that water containing chemicals is not left in the system.

Install orifices and strainers as shown on drawing E-6/Y-2576 and E-9/Y-2576.

Introduce final chemicals as required to suit local water conditions. Sodium sulphite and trisodium phosphate or caustic soda may be used. Continue adding sodium sulphite until 30 to 40 ppm concentration is obtained.

Keep adding trisodium phosphate or caustic soda to keep water pH at value of 9.5 to 10.

If other methods are to be used, these should be approved by Dominion Bridge Company.

The system shall be completely filled. Vent all points where air could possibly be trapped. Circulate water through the unit and heat up to 180°F. Vent all high points; blow-down all low points. Circulate water until there is no more air collecting in high points and blow-down water is clear with no dirt or scale. Minimum 2 days.

Service during construction period.

Construction period shall be understood as the period when different parts of the system are being gradually connected to the main part already in operation. This period is characterized by:-

- Possible cutting-in of new buildings or parts of distribution system and consequently by

- Large amounts of new water being introduced into the system.

- Frequent blow-down of boilers and flushing of low points of the system to remove dirt and scale that might have remained in piping in spite of thorough washing out of the new parts of the system.

- Frequent venting of high points of the system for removal of air released from heated water and entrained in the system. The bulk of dissolved air and gases will be released in the initial or high points. It is of primary importance to have the system completely free of air and gases.

Inspection.

- The boiler firesides must be clean and the furnace brickwork in good condition.

- Make sure the orifices and strainers are installed.

- Check the installation of handhole fittings.

- Check all casing panels and all access doors.

- Check the safety valves and make sure that the gags have been removed.

- Check that vent valves are closed.

- Check that drain valves and blow-off valves are closed.

- Make sure that pressure gauge valves are open.

- Check all piping.

- Check pump as per instructions.

- Check that no person is in the furnace.

- Make sure that the proper persons are advised that lighting off is going to take place.

Starting.

- Isolate the boilers except that which is to be used.
- Start the boiler circulating pump, checking that flow rate is minimum 150,000 lbs/hr to ensure boiler tube protection. Do not start firing if the flow is not established.
- Start fire: See instruction under oil burner section.
- Heat water up to the normal operating temperature of 240°F.
- Start another boiler if load conditions require it.
- Put automatic combustion control equipment into operation.
- Adjust scavenging air flow to observation doors by means of the cap screw provided.

Operation.

- Make periodic inspection of the furnace, the boiler passes and firing equipment.
- Check water once a day for hardness, pH and sodium sulphate.
- Blow-down boilers and at all low points of the system as long as water is not clean.

Water control during the construction period.

Filling of new parts of the system shall be accomplished with soft water. To do so pressure in the system shall be lowered to the atmospheric pressure and new part filled with water from the system by opening the valves in branches in tunnel and the return valve as well as the vent valves in the building at building entrance.

During the construction period, water samples shall be taken every day and each time a new section of the system has been cut in. In the latter case, samples shall be taken after water has been circulated in the new section for about 4 hours. Samples will be tested for hardness, sodium sulphite content and pH value. Corrections shall be made as described for initial water treatment to obtain 30-40 ppm of sodium sulphite and pH value 9.5 to 10.

Do not introduce any more chemicals than required to obtain the prescribed values. It is preferable to introduce initially less chemicals than required and obtain the prescribed values by steps than to introduce chemicals in excess in one operation.

Once a week send water samples to your chemical consultant for analysis and proceed as suggested by their authority.

The construction period shall be considered ended when all buildings included in the contract have been cut in.

Service during the normal system operation.

When the last building has been cut in, normal system operation starts.

No more boiler blow-down shall be made.
No more flushing of low points shall be made.
No more venting of the system shall be made.

Inspection.

In addition to the inspection items specified on page 4 make sure that:-

I) There is no air left in the system.
II) Boilers have been blown down and low points flushed after the last building or part of distribution system has been cut-in.
III) Water hardness, sodium sulphite concentration and pH value are as required.
IV) There is no leakage from drain and vent valves, blow-down valves, valve glands, pump seals and flanges.

Starting.

Same as specified on page 5 for service during the extended construction period.

Operation.

Same as specified on page 5 for service during the extended construction period, except no blow-down shall be made.

Water control during normal system operation.

Water tests shall be performed daily.

Samples shall be checked by your chemical consultant for analysis weekly as long as the system has not attained the period of steady operation.

Should three successive analyses show no change in water content, sending of samples for analysis will not be required more often than once a month. After six months of operation with established water conditions in the system, send samples for analysis once in two or three months only. Weekly analyses shall be undertaken again after cutting-in of a new part of the system or should any anlysis show a distinct change of water characteristics. Follow then the recommendations of your chemical consultant.

When cutting-in a new building or a new part of the distrubution system follow the recommendation as for construction period page 6.

Protection against corrosion.

Should it be found during normal system operation that corrosion process is developing in the system, (value of iron "Fe" rising in succeeding analyses) or on the recommendation of the chemical consultant in the earlier period, protection against corrosion has to be applied. Contact the Engineers for advice.

Taking Unit Out of Service.

The following instructions pertain to the conditions wherein two units connected to the same expansion drum are on the line and it is desired to cut one out.

When taking a unit out of service, the combustion control equipment should be switched from "automatic" to "manual" control.

Shut Down Burner as per instructions in Burner Section.

Keep all access doors closed so that the unit will cool down slowly.

Throttle water flow through the boiler adjusting flow regulating valve to maintain water outlet temperature. Finally close the water flow.

After the unit has cooled sufficiently to drop to a pressure of 50 psig. the boiler should be given a botton blow.

When the pressure has dropped to 5 psig. open the outlet header vent.

When the pressure is off, the unit should be filled completely with cold (70°F) soft water or emptied completely and dried out.

If unit is not to be out of service for an extended period, a small flow of heated water should pass through the unit. This will keep the unit at close to operating temperature and will facilitate returning unit to service.

Furnace Observations.

Regular and frequent visual inspection of the furnace, oil burner and different parts of settings should form a part of the operator's routine duties.

The fireman after some time of experience should be able to judge the conditions of his fire from observation doors and make necessary adjustment.

Emergency Operation.

Water Circulation Failure.

Should there be any interruption of water flow to a unit for any reason whatsoever, the fires must be secured immediately.

Do not attempt to circulate water through the unit until the unit has cooled down sufficiently so that there is no likelihood of damage due to water coming in contact with overheated pressure parts. After it has been ascertained that the unit has cooled sufficiently establish water circulation. After it has been ascertained that no damage has been done, start the fires in accordance with instructions.

Tube Failure.

Shut off the burner immediately.

I) If the tube failure has resulted from lack of water (failure of circulating pump) do not feed any additional water to the unit. Secure the main discharge valve on the unit outlet header. Slowly relieve the pressure through the unit safety valve.

II) If the tube failure was not caused by lack of water, maintain a flow through the unit until the unit has cooled to the temperature of the circulating water.

Do not blow down the unit unless the failure is so severe as to endanger operating personnel.

General Maintenance Procedures.

Care of units out of service.

Units to be held out of service must be carefully handled and closely watched in order to minimize any tendency for corrosion of the pressure parts.

A unit which is to be held out of service for more than 24 hours should either be filled completely with water (wet lay-up) or drained and dried out (dry lay-up).

A unit which is to be held out of service should have the fire-side thoroughly cleaned. Soot on the unit surfaces will absorb moisture from the air and cause external corrosion.

I) Wet lay-up method:

The wet lay-up is preferable as it requires less preparation, the unit can be returned to service quickly and protection of the water side is adequate. This method can be safely used for a lay-up of any length of time if the boiler-room temperature is not below freezing.

The unit water should have a phenolphthalein alkalinity value of 400 p.p.m.

After the unit water alkalinity has been raised to the desired level, a hydrostatic pressure of 50 to 75 psig. should be placed on the unit. After the unit has cooled to boiler-room temperature the unit outlet header vent valve should be cracked to vent any trapped air. Hold a hydrostatic pressure of about 25 to 50 psig. on the boiler.

II) Dry lay-up method:

To lay-up a unit dry, drain the unit tubes while the unit water is fairly warm. Remove a few handhole plates from all headers to be sure no water remains in the unit and to provide access to the waterside of the unit.

If necessary use an electric heater in the furnace to drive off all the moisture on the fireside.

When completely dry, place bags of silica-gel in all headers and replace all handhole fittings. Close all air inlet to the furnace and close all fan dampers.

If the lay-up is to extend over a considerable period, periodic inspection of the silica-gel should be made. If it has become saturated, dry it out in a 350°F. oven and replace.

Hydrostatic Tests.

The maximum hydrostatic test pressure to be applied is 600 psig. (1½ times the design pressure). This test is intended to prove the strength of the pressure parts and should be applied only for inspection by authorized representatives.

To check unit for leakage a test pressure of about 85% of the discharge header safety valve popping pressure is sufficient (85 psig.)

Use care to avoid accidentally raising pressure enough to open a safety valve (100 psig.)

Use a test pump for applying hydrostatic pressures to the units. Avoid shocking the unit by sudden application of the pressure. Control the flow of water to or from the unit by means of a small valve.

Before applying a hydrostatic pressure it is advisable to cool the unit to approximately boiler room temperature. The water for filling should be warmer than the boiler metal to avoid condensation of moisture on the fireside. Hydrostatic pressure should not be applied if the temperature of the boiler and filling water is less than 70°F.

Place test clamps (gags) on safety valves if test pressure is to be higher than 100 psig.

The pressure gauge to be used should be checked with a gauge tester before applying test pressure.

As the boiler is being filled open the vents on the boiler inlet and outlet headers to bleed off all air.

Before lowering the test pressure take up the slack in the nuts on the handhole fittings which have new gaskets fitted. The nuts should be pulled just snug with the wrenches. Do not use a pipe or other extension on the handle.

When inspection is completed, lower the pressure slowly by cracking a small drain valve.

Before starting to drain the unit be sure to open the vent valves.

Remove the safety valve gags.

Maintenance of brickwork.

I) Drying out:

A new refractory furnace lining or one that has been extensively repaired should be carefully warmed up and dried out to avoid damage.

If the unit is clean and ready for service, fire wood on the furnace floor for a period of forty-eight hours, allowing "off" periods to prevent the pressure from going above 75 psig.

II) Furnace walls:

Inspect the walls and point up any spalls with a high temperature air setting cement.

If necessary to remove slag or crusted ash, work carefully to avoid breaking brick or tiles. Replace the brick or tile before it has burned so thin there is danger of destroying insulation.

III) Firebrick:

Firebrick should be laid with dipped joints. Either an air setting mortar or heat setting mortar may be used. The air setting mortar does not require heat to develop its strength while the heat setting mortar does not develop a good bond until it has been raised to a temperature above 1800°F.

Mix air setting mortar to such consistency that a firebrick laid in the mix (on the $4\frac{1}{2}$ by 9 inch face) will float with about 1 inch of the $2\frac{1}{2}$-inch sides above the surface.

Brick should be dipped into the mortar, shoved into place and tapped down with hammer, forcing out all excess mortar, to procure a brick to brick contact with mortar only in the voids.

Excess mortar may be struck off, but the joints must be full and never undercut.

Expansion joints must be left as specified.

Plastic Refractory:

Plastic refractory is used for any section of the furnace where its use eliminates the need of special tile. Plastic refractory may be used to repair a section of the furnace if it is impractical to rebuild with original material.

Plastic refractory should not be placed in close contact with unit tubes or headers as they cool the refractory and prevent it developing full strength. Castable refractory should ordinarily be used in close contact with boiler pressure parts.

Plastic refractory or castable refractory should not be in direct contact with metal, either pressure parts or hangers. Always coat metal with a heavy coat of bitumastic paint, wrap tubes with tar paper which will burn out to allow some expansion clearance otherwise refractory will be cracked and eventually fail.

Plastic refractory has a stiff clay consistency and should be used as it comes from the container with no additional water added.

Castable Refractory:

Castable refractory is used principally in locations requiring a refractory shield over pressure parts of the unit or water wall headers to protect them from furnace heat.

The refractory should be one that will set and develop strength without the application of heat. This characteristic is necessary because the close contact with the water wall surfaces prevents it from reaching the temperature required to vitrify.

This material like concrete is mixed with water. The quantity of water is important and should be as recommended by the manufacturer. The setting time is usual 6 to 8 hours after which a fire can be started.

To patch small portions of the header protection refractory, remove the old material to its full depth.

Replace the anchor bolts as necessary. Coat all anchor bolts or reinforcing with a heavy coat of "Bitumastic" paint. Forms can be made of wood or sheet metal, if needed.

Where the refractory is to be placed around tubes, wrap the tube with tar paper or coat heavily with "Bitumastic" paint. This material burns out and will allow an expansion space and avoids cracking the refractory.

Boiler Tubing.

Inspection of Fireside:

Inspect the fireside at every shutdown. Be sure the tube bank is clean and free of any accumulation of soot or slag.

Inspection of Waterside:

Make an inspection of the waterside at least once every three months until certain that the methods of analysis and treatment of water are satisfactory and will permit longer periods between inspections.

Remove a few handhole covers at all headers and check the internal appearance. See that they are free of sludge and other foreign materials.

Inspect all orifices and strainers for foreign materials.

Corrosion in the unit is usually due to oxygen in the water, low alkalinity, failure to vent the boiler when starting to raise pressure or improper care of the boiler when not in service.

Oxygen pitting is one of the most common forms of corrosion found in boilers. The pits are usually covered with a dull red, scale-like oxide underwhich a pit with a shiny black surface may be found.

Look in the headers for sludge rolled into balls which is an indication of oil in the boiler water.

After completing inspection or any repair work, be sure that all tools, bolts, etc., have been removed. Brush up all dirt, welding spatter and similar material. Wipe up any oil and wash with a high pressure water hose.

Tube Repair.

Any section of tubing may be replaced by cutting the tube at the most convenient points on either side of the faulty section and welding in a new length of tube.

Should a leak occur in the upper section (convection section) of the boiler at a point not readily accessible the following procedure may be followed:

Remove the casing panels in way of the area in which the leak is suspected.

Thoroughly clean the fireside of unit.

Place a hydrostatic test of 85 psig. on the unit using water at a temperature not less than 70°F.

Observe the tube bank and with the aid of a light identify the tube (s) which has (have) been damaged.

After the faulty tube has been identified, cut the tube where necessary to facilitate removal from the unit through access provided. It then may be repaired and replaced.

A hydrostatic pressure of 375 psig. should be applied in the presence of an authorized inspector after the completion of repairs.

A tube failure in the convection section from any cause other than that of material nature is an indication that further possible damage must be suspected and a most careful waterside inspection is in order.

The removed tube section should be examined for scale, oil and oxygen corrosion.

Handhole fittings:

Use heavy oil and graphite or high temperature lubricant on the handhole fitting studs and nuts.

The handholes are equipped with Garlock No.555 metallic gaskets.

To install these gaskets: clean the gasket seats of the fitting and handhole carefully.

DO NOT USE GRAPHITE OR OTHER COMPOUNDS ON THE GASKETS.

Center the fitting in the handhole, making sure the shoulder does not bind on the edge of the handhole.

Then slip on the yoke and start the stud up.

Run the nut on the stud hand tight plus a three-quarter turn with a wrench. It is important that the gasket is not mashed by excessive tightening of the stud nut.

If a new gasket leaks while filling the unit, slack off the stud nut enough to loosen the yoke, then shake the handhole fitting to get it squarely on its seat and set up the stud nut again. This will usually stop leakage through a new gasket. Sweats or slow drips ordinarily will take up under hydrostatic pressure.

Before closing the cover panels put a hydrostatic pressure of about 85 psig. on the boiler and then go over the fittings and tighten the stud nuts hand tight plus one-quarter turn with a wrench.

GASKETS.

STYLE. T. OBROUND
FLEX GASK.
SIZE. $3\frac{3}{8}" \times 4\frac{1}{4}" \times \frac{1}{4}" \times .175"$
CRANE PACKING. CO. LTD.
SANFORD ST.

Inserting and removal of orifices and strainers.

Two orifices and strainers are held in place with one holding bar secured by 3/4" bolt welded to the header and 3/4" stainless steel nut. No gaskets are used.

Installation (see drawing E6/Y-2576 & E9/Y-2576).

Insert orifice holders marked 29/10, 24/10 or 26/10 inside the inlets of the tubes.

Place strainers "S2" into the wedge of holders.

Place the clamps 8A, 8B or 8C and secure with the S.S. nut.

Before tightening the nut make sure that the strainers are properly placed in relation to the orifice holders and all parts are in line.

To remove orifice strainer, use retracting tool shown on drawing No. 10.

PART IV

METERING

BAILEY