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شرکت ملی گازایران

مدیریت پژوهش و فنآوری

امورتدوین استانداردها

IGS

مشخصات فنی خرید

تجهیزات گرم کننده گاز (غیر مستقیم-آبی)، نوع مشعل دمنده دار

Forced Draught Indirect Water Bath Heater

شرکت ملی گازایران

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ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری

باسلام،

به استحضار می‌رساند در جلسه ۱۶۲۵ مورخ ۱۳۹۳/۱۲/۱۷ هیأت مدیره، نامه شماره گ۹/۱۷۹٤۲٦/۰۰۰ مورخ ۹۳/۱۲/۱۱ مدیر پژوهش و فناوری و رئیس شورای استاندارد درمورد تصویب نهایی استاندارد تحت عنوان " تجهیزات گرم کننده گاز (غیرمستقیم ـ آبی) نوع مشعل دمنده‌دار" به شماره استاندارد IGS-M-PM-106(0) مطرح و مورد تصویب قرارگرفت .

ناصر آبگون
دبیر هیأت مدیره

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FOREWORD

This standard is intended to be mainly used by NIGC and contractors, and has been prepared based on interpretation of recognized standards, technical documents, knowledge, backgrounds and experiences in natural gas industry at national and international levels.
Iranian Gas Standards (IGS) are prepared, reviewed and amended by technical standard committees within NIGC Standardization division and submitted to the NIGC's "STANDARDS COUNCIL" for approval.
IGS Standards are subject to revision, amendment or withdrawal, if required. Thus the latest edition of IGS shall be checked/inquired by NIGC employees and contractors.
This standard must not be modified or altered by NIGC employees or its contractors. Any deviation from normative references and / or well-known manufacturer's specifications must be reported to Standardization division.
The technical standard committee welcomes comments and feedbacks about this standard, and may revise this document accordingly based on the received feedbacks.

GENERAL DEFINITIONS:

Throughout this standard the following definitions, where applicable, should be followed:
1- "STANDARDIZATION DIV." is organized to deal with all aspects of industry standards in NIGC. Therefore, all enquiries for clarification or amendments are requested to be directed to mentioned division.
2- "COMPANY": refers to National Iranian Gas Company (NIGC).
3- "SUPPLIER": refers to a firm who will supply the service, equipment or material to NIGC whether as the prime producer or manufacturer or a trading firm.
4- "SHALL ": is used where a provision is mandatory.
5- "SHOULD": is used where a provision is advised only.
6- "MAY": is used where a provision is completely discretionary.
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CONTENT PAGES

1. SCOPE

This specification covers the minimum requirements for designing, material, fabrication, testing, inspection, marking, packing and shipment of indirect water bath heaters with forced draught burner to be used in natural gas pressure reducing stations.
Each deviation of this specification, it shall be clearly stated on the technical information submitted by the supplier/manufacturer.
The supplier/manufacturer shall furnish unit completely, including all necessary parts to insure satisfactory, economical and safe operation.

2. REFERENCES

Supplier shall refer to the latest editions of all the following mentioned standards.
All heaters shall be in design and fabrication in accordance to:

2.1. Normative References

ANSI /ASME-V ASME Boiler and Pressure Vessel Code “Nondestructive Examination”

ANSI /ASME-VIII-D1 ASME Boiler and Pressure Vessel Code “Rules for Construction of Pressure Vessels” for Coil Tubes

ANSI/ASME-VIII-D2 ASME Boiler and Pressure Vessel Code, “Rules for Construction of Pressure Vessels - Alternative Rules

ANSI/ASME-IX ASME Boiler and Pressure Vessel Code “INTERPRETATIONS”

ANSI/ASME B1.20.1 “Pipe Threads, General Purpose (Inch) Revision and Redesignation of ASME/ANSI B2.1**”**

ANSI/ASME B16.5 “Pipe Flanges and Flanged Fittings, NPS ½ through NPS 24**”**

ANSI/ASME B16.9 “Factory Made Wrought Butt Welding Fittings**”**

ANSI/ASME B.16.11 “Forged Steel Fittings, Socket Welding & Threaded**”**

ANSI/ASME B16.25 “Butt Welding Ends**”**

ANSI/ASME B16.28 “Wrought Steel Butt Welding Short Radius Elbows and Returns”

ANSI/ASME B16.34 “Valves – Flanged, Threaded and Welding End**”**

ANSI/ASME B16.47 “Large Diameter Steel Flanges NPS 26 through NPS 60**”**

ANSI/ASME B18.2.2 “Square and Hex Nuts (Inch Series)”

ANSI/ASME B31.3 “Process Piping, ASME Code for Pressure Piping, B31”

ANSI/ASME B36.10 "Welded and Seamless Wrought Steel Pipe**"**

API 12K "Specification for Indirect Type Oil-Field Heaters"

API RP 500C "Classification of Location for Electrical Installation at Pipeline Transportation Facilities**"**

ASTM A36M "Specification for Carbon Structural Steel".

ASTM A105M "Standard Specification for Carbon Steel Forgings for Piping Applications**"**

ASTM A182 "Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service**"**

ASTM A193 "Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service**"**

ASTM A194 "Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service**"**

ASTM A234M "Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service**"**

ASTM A350M "Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components**"**

ASTM A370 "Standard Test Methods and Definitions for Mechanical Testing of Steel Products"

ASTM A751 "Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products**"**

DIN 580 "Lifting eye bolts"

DIN 4788-1 "Gas Burners without Blowers June; Superseded in Parts by DIN EN 298**"**

EN 50156-1 "Electrical Equipment for Furnaces and Ancillary Equipment, Requirements for Application Design and Installation**"**

EN 676 "Amd 1 Automatic Forced Draught Burners for Gaseous Fuels AMD 9857**"**

EN 837 "Pressure Gauges**"**

EN 298 "Amd 1 Automatic Gas Burner Control Systems for Gas Burners and Gas Burning Appliances with or without Fans AMD 9307"

EN 60335-1 "Safety of Household and Similar Electrical Appliances– Part 1: General Requirements**"**

EN 60529 "Amd 2 Degrees of Protection Provided by Enclosures (IP Code) AMD 10931**"**

EN 161 "Automatic shut off valves for gas burners and gas appliances**"**

IEC 60034 "Rotating Electrical Machines**"**

IEC 60079 "Exclusive Atmospheres**"**

IEC 60529C "Degrees of protection provided by enclosures (IP Code)**"**

IEC 60770 "Transmitters for Use in Industrial-Process Control Systems**"**

IEC 61520 "Metal Thermo Wells for Thermometer Sensors - Functional Dimensions**"**

IEC/EN 60204-1(ISO/IEC/EN 81346:2010) "Safety of Machinery - Electrical Equipment of Machines - Part 1: General Requirements**"**

IPS-c-el-115 "Electrical Installation**"**

IPS-c-tp-101 "Surface Preparation"

IPS-c-tp-102 "Painting"

IPS-g-gn-210 "Packing & Packages**"**

TEMA "Standards of the tubular exchanger manufacturers association

2.2 Informative References

API 5L "Standard Specification for Line Pipes**"**

API 1104 "Welding of Pipelines and Related Facilities**"**

ASTM A 53 "Standard Specification for Pipe, Steel, Zinc-Coated, Welded and Seamless**"**

ASTM A106 "Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service**"**

EN 12067-1, 2 "Gas/Air Ratio for Gas Burners and Gas Burning Appliances, Pneumatic/Electrical Type**"**

IEC 60146 "Semiconductor Convectors**"**

IEC 60622 "Secondary Cells and Batteries**"**

IEC 60896 "Stationary Lead-Acid Batteries**"**

IGS-M-IN-202 "Gas Pressure Regulators for Nominal Inlet Pressure 5 to 100 bar (72-1450 psig)**"**

IGS-M-IN-302 "Relief Valves**"**

IGS-M-PL-002-1 "for Plug Valves, part 1, 2 to 24 Inches"

IGS-M-PL-002-2 "for Plug Valves, part 2, 1/2 to 1,1/2 Inches"

IGS-M-PL-010-1 "for Ball Valves, Class 150**"**

IGS-M-PL-010-2 "for Ball Valves, Class 300**"**

IGS-M-PL-010-3 "for Ball Valves, Class 600**"**

IGS-M-PM-105 "Dry Gas Filters**"**

IPS-E-GN-100 "Engineering Standards for Units**"**

IPS-C-IN-110 "Pressure instruments**"**

IPS-E-IN-120 "Temperature Instruments**"**

IPS-G-IN-160 "Engineering and Material Standard for Control Valve**"**

IPS-M-EL-131 "Material and Equipment Standard for Low Voltage Induction Motors**"**

IPS-M-EL-132 "Three Phase Squirrel Cage Induction Motors**"**

IPS-M-EL-174 "Battery and Battery Charger**"**

IPS-M-EL-176 "Uninterruptible Power System (UPS)**"**

IPS-M-GN-130 "Metric Type Fasteners**"**

MSS SP-97 "The Integrally Reinforced Forged Branch Outlet Fittings, Socket Welding, Threaded and Butt welding Ends**"**

NFPA 85 "Boiler and Combustion Systems Hazards Code Errata**"**

NFPA 87 "Recommended Practice for Fluid Heaters**"**

3. DEFINITIONS

Indirect Water Bath Heater
Heating of gas streams close to preventing hydrate or wax formation. Heating may also be done to prevent liquids from condensing in the gathering line or to facilitate subsequent fluid separations.
An indirect type oilfield heater employs a water solution, maintained below the boiling point, as the heating medium for the purpose of heating the process fluids in the coils. Entitled Typical Indirect Heater Assembly, showing general arrangement of heater components, piping and instrumentation (Appendix D).

Instrumentation
Any system or combination for measurement and control.

Fail – Safe
The action of a device to go to a safe operating condition when a failure occurs.

Pressure Relief Device
A device which is installed to vent gas from a system being protected in order to prevent the gas pressure from exceeding a predetermined limit by venting the gas into atmosphere.

Ambient Temperature
Usually used to refer to the temperature of the air in which a structure or a device operates.

Primary Gas Pressure Regulator
Device on pressure skid which maintains the outlet pressure constant independent of the variation in inlet pressure and /or flow rate within defined limits.

Inlet Pressure
Pressure at the inlet of the regulator.

Outlet Pressure
Pressure at the outlet of the regulator.

Capacity

Heater Capacity
The rate of flow through a cabinet type station under standard condition with minimum inlet pressure.

Burner Capacity
Heat input range of the burner the maximum and minimum heat inputs shall be measured under the standard conditions and shall be in accordance with the values stated by the manufacturer within ± 5 %.

Slam Shut
An ancillary designed to quickly shut off the gas flow in the event of an abnormal pressure being detected within system it protects.

Burner System
System for firing the heater designed for the specific fuel to be used.

Coil Area
Heat transfer area and is normally calculated using the outside surface area of the pipe.

Firebox
Complete assembly consisting of the fire tube, mounting flange, intake and stack adaptors.

Fire Tube
Consisting of one or more U-tubes fired, normally by natural gas, at one end and exhausting through a vertical stack.

Heat Density

Heat released through the cross section of the fire tube, expressed as BTU/hr.in^2 of cross sectional area.

Heat Flux

Applied to the average transfer rate through the fire tube, expressed as BTU/hr.ft^2 of exposed area.

Heater Bath
Indirect heating medium, limited to water or water solutions.

Shell
Normally a horizontal vessel which contains the coil, fire-tube and heater bath.

Stack Rain Shield
Device attached to the top of the stack to prevent rain from falling directly into the stack. It may also serve as a stack downdraft diverter.

Water Saver
A chamber that may be directly connected to the heater shell to permit the shell to be completely filled with water.

Forced Draught Burner
Burner in which the total air for combustion is supplied by means of a fan.

Start Gas Rate
Gas rate ignited by the ignition device during the start-up of the burner.

Fire Tube
Part of the appliance in which the combustion takes place.

Gas Line
Part of the burner which is made up of the valves and controls and safety devices in which gas is conveyed between the inlet connection and the burner head.

Range-Rating Device
Component on the burner intended to be used for adjusting the heat input, within a range of heat inputs stated by the manufacturer, to suit the actual heat requirements of the installation This adjustment can be progressive.

Automatic Shut-Off Valve
Valve which opens when energized and closes automatically when de-energized.

Filter
Device that enables foreign elements, which might otherwise cause failures in the system, to be collected.

Secondary Gas Pressure Regulator
Device on gas line which maintains the downstream pressure constant to within fixed limits independent of variations, within a given range, of the upstream pressure.

Gas Pressure Protection Devices
Device which compares the actual value of the pressure with the desired value, gives a signal when the actual value exceeds or drops below the desired value and initiates the controlled shut-down.

Flame Detector Device
Device by which the presence of a flame is detected and signaled It can consist of a flame sensor, an amplifier and a relay for signal transmission. These parts, with the possible exception of the actual flame sensor, can be assembled in a single housing for use in conjunction with a programming unit.

Automatic Burner Control System
System which comprises at least a programming unit and all the elements of a flame detector device. The various functions of an automatic burner control system can be in one or more housings.

Programming Unit
Unit which reacts to signals from control and safety devices, gives control commands, controls the start-up sequence, supervises the burner operation and causes controlled shut-down, and if necessary safety shut-down and non-volatile lock-out. The programming unit follows a predetermined sequence of actions and always operates in conjunction with a flame detector device.

Safe Start Check
Procedure employing a protection circuit or circuits, to establish whether or not a fault in a safety system or a flame simulating condition exists prior to start-up.

Controlled Shut-Down
Process by which the power to the gas shut-off valve(s) is removed before any other action takes place, e. g. as a result of the action of a controlling function.

Safety Shut-Down
Process which is effected immediately following the response of a safety device or the detection of a fault in the automatic burner control system and which puts the burner out of operation by immediately removing the power to the gas shut-off valve(s) and the ignition device.

Note: Safety shut-down can also occur as a result of an interruption/decrease of the power supply.

Non-Volatile Lock-Out
Safety shut-down condition of the system, such that a restart can only be accomplished by a manual reset of the system and by no other means.

Volatile Lock-Out
Safety shut-down condition of the system, such that a restart can only be accomplished by either the manual reset of the system, or an interruption of the main power and its subsequent restoration.

Start Signal
Signal, e.g. from a thermostat, which releases the system from its start position and commences the predetermined program.

Recycling
Process by which, after a safety shut-down, a full start-up sequence is automatically repeated.

Ignition Device
Any means (flame, electrical ignition or other means) used to ignite the gas at the ignition burner or at the main burner.

Running Position of the Burner System
Position of the system in which the burner is in normal operation under the supervision of the programming unit and its flame detector device.

Purge
Forced introduction of air into the combustion chamber and flue passages, in order to displace any remaining fuel/air mixture and/or products of combustion.

Pre-Purge
Purge which takes place between the start signal and the energizing of the ignition device.

Hazardous Area
An area in which an explosive or flammable gas atmosphere is present, or may be expected to be present, in quantities.
Such as to require special precautions for the construction, installation and use of electrical apparatus.

Hazardous Area Zones
Hazardous areas are classified in zones based upon the frequency of the occurrence and the duration of a flammable atmosphere.

Standard Condition
The conditions to which a volume of gas is converted (i.e. base gas temperature15.56°C (60°F) base pressure 1013.25 mbar (14.696 psi).

Natural Gas
The natural gas Specification is according to IGS-M-CH-033(0) 2004.

4. TECHNICAL SPECIFICATION

4.1 Heater Shell

Shell material may be ASTM A 36 or equivalent. All bolt and nuts materials used in shell flanges shall be ASTM A 193 & ASTM A 194 respectively.

- Heater shell shall provide in normal operation a homogenate temperature in the water bath. Therefore the unit should be equipped with mixers, circulation pumps or other temperature homogenizing devices.

4.1.1 An expansion tank shall be provided on top of heater shell.

4.1.2 A ladder including platform, if any, with handrail and back protection, shall be provided for easy access to the expansion tank.

4.1.3 A 2" gate valve (class 150) with blind flange shall be provided at the bottom of shell for drain purposes.

4.1.4 The shell and heads shall be insulated with 50mm thickness fiber glass insulation or equivalent having an aluminum cladding with min. thickness 0.8 mm (the mineral wool shall have specific weight of 100 kg/m^3 and a thermal conductivity less than 0.7 W/K.m at an average temperature of 200 °C).

4.1.5 Before insulation, shell shall be painted according to painting procedure in this standard (sec. 8).

4.1.6 Shell permissible out of roundness after welding shall be according to ASME sec. VIII, Div.1 part UG-80.

4.1.7 Insulating gaskets used in the shell flanges shall be suitable in high temperature services and durability specification in outdoor conditions. It shall have good characteristics in water and ethylene glycol mixtures.

4.1.8 All T joints welds shall be 100% tested by radiography.100% of nozzle welded connections to shell shall be tested by LPT (liquid penetrate test) method.

4.1.9 Tightening procedure shall be considered by manufacturer for flanges bolt & nuts fastening.

4.1.10 Shell shall be reinforced enough to prevent any deformation because of coils, fire-tubes and water-ethylene glycol mixture weight.

4.1.11 Heater shell shall include permanent lifting lugs.

4.1.12 Shell shall be equipped with 1" threadolet and 1"×1/2" thermo well with1/2" NPT male, stainless steel temperature gauge,100 mm dial an appropriate stem length with safety glass and red and black lettering, dual scale in centigrade and Fahrenheit, adjustable pointer. (Gauge range (-30 ~ +100)°C) .Thermometer shall be installed on shell via adequate thermowell and threadolet.

4.1.13 Shell shall be equipped with 1" threadolet and1"×1/2" thermo well with 1/2" NPT male temperature sensor PT100 type (by transmitting capability), also an appropriate stem length for controlling of shell high temperature. Thermometer shall be installed on shell via adequate thermowell and threadolet.

4.1.14 Construction of heater shall be such that the removal of the coil and fire tube/firebox shall be from opposite ends of the shell.

4.1.15 If pump is utilized for homogenizing temperature, it shall be as follow:

- Single-stage in line centrifugal casing pump according to ANSI B16.5.
- Preferred canned rotor type, without shaft seal and with bearings lubricated by the pump liquid.

4.2 Expansion Tank

4.2.1 Expansion tank material may be ASTM A 36 or equivalent. All bolt and nuts materials used in expansion tank flanges shall be ASTM A 193 & ASTM A 194 respectively.

4.2.2 The expansion tank is designed to reduce internal corrosion within the heater shell by keeping the heater shell liquid packed and moving the wet dray interface of the expanding bath media from the heater shell into the expansion tank.

4.2.3 The expansion tank is designed to contain 100% of the expanded bath media from a temperature of 40 °C to the maximum operating temperature. Whereas manufacturer and client agreement is preferred.

4.2.4 Bath media expansion reservoir designed to hold 6% of the total bath media. Whereas manufacturer and client agreement is preferred.

4.2.5 Expansion tank shall be insulated same as main shell insulation instruction. Shell heads shall be insulated same as main shell insulation instruction (mass loss should be Consider).

4.2.6 Expansion tank shall be equipped with low level alarm and filling connection. Also for prevention of mass lost, the roof of expansion tank shall be always closed.

4.3. Skid

4.3.1. Skid material may be ASTM A36 or other carbon steel material recommended by manufacturer.

4.3.2 Lifting lugs shall be provided with sufficient strength to allow lifting the entire assembly without causing any damage to the shell and the other parts.

4.3.3 The heater should be self-contained and skid mounted.

4.3.4 Structural strength of skid shall be sufficient to withstand forces due to shipping and handling as well as support the vessel and equipment. Skid shall be self supporting

rigid steel assemblies having adequately sized members to permit handling of the unit without deformation of the skid members.

4.3.5 Before insulation, skid shall be painted according to painting procedure as follow by sec 8

4.4 Pressure Skid

4.4.1 The purpose of the pressure reducing skid is to reduce the natural gas pressure to provide low pressure fuel gas to feed the secondary regulator.

4.4.2 All components shall be easily accessible and removable. For that reason, all in-line components shall be flanged. Threaded ends are allowed for small components smaller than 1" such as drain and vent valves, manometer valves, and valves on water circuit.

4.4.3 Base frame with adequate supports for the equipment, piping and instrumentation is called SKID.

4.4.4 The pressure reducing skid shall be provided with two stainless steel earth lugs.

4.5 Coil

4.5.1 Coil shall be made of seamless pipe, ASTM A 53 Gr. B or ASTM A 106 Gr. B/C or API 5L Gr.B, Schedule No.80.

4.5.2 Inter connections of coil passes and header shall be fabricated according to ANSI B16.9, (or standard bend collector according to TEMA) same size and schedule of coil pipe, seamless and with ASTM A 234 WPB/C material.

4.5.3 Proprietary fittings should be ASTM A 105 or ASTM A 182 material.

4.5.4 Coil heat transfer area shall be design for gas outlet pressure of 38 °C.

4.5.5 Coil shall be easily field removable and shall be such that the removal of the coil and fire tube/firebox shall be from opposite ends of the shell for periodic inspection and maintenance.

4.5.6 Supporting wheels shall be run on guiding rails, for coil section weight is over than 2000Kg.

4.5.7 The entire coil shall be supported on wheels or roll bearing which shall withstand 15 years of operation.

4.5.8 Precaution shall be taken against buoyancy of the coil.

4.5.9 All coil tubes shall be supported having allowances for thermal expansion.

4.5.10 Maximum allowable gas velocity in coil shall be 20 m/sec.

4.5.11 Inside coil header cross sectional area shall be at least equal to total inside coil branched area.

4.5.12 Inlet and outlet flanges shall be welding neck, raised face, ANSI 600.

4.5.13 All joints, shall be butt welded and tested 100% by radiography test methods according to ASME Section IX.

4.5.14 All weldolet and threadolet shall be down 100% NDT (for accessible parts 100% RT).

4.5.15 All 2" and smaller connections between coils and headers shall be weldolet and more than 2" shall be sweapolet (d≥1/3D) – weldolet (d<1/3D) , according to MSS SP-97.

4.5.16 Inlet and outlet shall be equipped with 1" threadolet and 1"×1/2" thermowell with 1/2" NPT male, stainless steel temperature gauge,100mm dial with safety glass and red and black lettering, dual scale in centigrade and Fahrenheit, adjustable pointer.
(Gauge range (-30 ~ +100)°C).

4.5.17 Coil outlet header shall be equipped with 1" threadolet and 1"×1/2" thermowell with 1/2" NPT male temperature transmitter type PT100 for controlling of gas outlet temperature.

4.5.18 Inlet and outlet shall be equipped with 1/2" NPT male, stainless steel pressure gauge,100mm dial with safety glass and red and black lettering, dual scale in psi and bar, bourdon tube type, oil filled, adjustable pointer. Gauge ranging shall be 2 to 4 times the operating pressure.

4.5.19 Inlet and outlet shall be equipped with 1/2" NPTF ball valve as a drain.

4.5.20 All threaded connection on headers shall be done by threadolet class 3000 lb rating.

4.5.21 Coils shall be supported. Spacing, holes diameters and thickness of support baffle plates shall be considered base on TEMA requirements.

4.5.22 Coil weight shall be supported by traverse pipe / U beam which are connected to inside shell. Coils shall not have any mechanical stress on its removable flange bolts.

4.5.23 The Telltale holes shall be provided.

4.6 Fire Tube

4.6.1 Fire tubes material shall be pipes ASTM A 106 Gr.B, A53 Gr.B, API 5L Gr.B or ASTM A 516 Gr.70, wall thickness 0.250” up to 24” diameter and 0.312” for 26” diameter and larger.

4.6.2 The fire tube section consists of combustion chamber and flue gas return.

4.6.3 The fire tube shall be fully welded. Complete penetration shall be down on all joints and visually inspected by a welding inspector.

4.6.4 Fire tube shall be field removable.

4.6.5 Average heat flux for fire tube shall not exceed 12000 BTU/hr.ft^2 (33,000

kcal/hr.m^2).

4.6.6 Fire tube heat density (heat released through the cross-sectional area of the fire tube) is regulated by the burner mixer and burner nozzle. Heater conforming to this specification will have a maximum heat density of 15000 BTU/hr.in^2.

Example:

OD = 8 5/8". Wall Thickness = 0.188", Fire tube rate = 500000 BTU
Cross Sectional Area = 53.42 in^2 , Efficiency = 85%

$$\text{Heat Density} = \frac{\text{Fire Tube Rating}(\frac{\text{BTU}}{\text{hr}})}{(\text{Cross Sectional Area, in}\cancel{2}) * (\text{Efficiency})} = \frac{500000}{53.42 * 0.85} = 11012 \frac{\text{BTU}}{\text{hr}} / \text{in}\cancel{2}$$

4.7 Exhaust Stack

4.7.1 A self-supporting, removable exhaust stack designed with adequate height and diameter for maximum draft requirements with 3mm minimum wall thickness shall be provided.

4.7.2 Exhaust stack system shall be properly designed, sized and equipped with the suction/exhaust accessories ensuring required flue draft at all time.

4.7.3 The stack shall have three tapping (distance from bottom of stack shall be 2d (d=inside stack diameter) for connecting of a temperature gauge, a gas sampling port and a draft gauge.

4.7.4 Formation of condensates from flue gas has to be avoided. The bottom of the exhaust stack shall be equipped with a drain and a ball valve with plug.

4.7.5 The stack shall be insulated with minimum 50mm rock wool or glass wool and clad with aluminum sheet also applying exhaust stack flashing .The maximum surface temperature shall not exceed 60°C.

4.7.6 The stack shall have a suitable guard to a sufficient height for protection against burn when accidentally touched.

4.7.7 The end of the exhaust stack conduit shall be equipped with an anti-bird protection and hinged with suitable rain hood.

4.7.8 The Stack shall be designed for maximum wind load (maximum speed 120 km/hr). The stack may have three suitable eye rings for the guy wires for protection against wind load. The same eye rings shall also be used for lifting the stack.

4.7.9 The gasket in fire tube and stack connection shall be suitable for high temperature resistance.

4.7.10 Stack bottom connection to fire tube shall be flanged type.

4.7.11 Noise level shall not be exceed to 75 db at 1m.

4.8 Burner

4.8.1 Material

The quality and thickness of the materials used in the construction of the burner shall be selected in such a way that the constructional and performance characteristics of the system do not deteriorate during operation. In particular, all the components of a burner shall withstand the mechanical, chemical and thermal loads that may be encountered during operation. Under normal conditions of use, maintenance and adjustment, they shall not show any changes that could affect their normal functioning.
If the housing contains any metal parts not made of corrosion-resistant material, these shall be suitably protected with an effective anti-corrosion coating.
Regarding Safety issues, Asbestos or asbestos-containing materials shall not be used.

Copper shall not be used for gas carrying parts where its temperature is likely to exceed 100 °C. Solder that has a melting point below 450 °C after application shall not be used for gas carrying parts (EN 676).

4.8.2 Design

4.8.2.1 Combustion

The design and construction of the burner shall be such that within the intended input range and within the prescribed pressure range, the used fuel gas is burned completely and safely.
The burner(s) turn down ratio shall be at least 10:1.

Note: The burner head can be lengthened as long as the performance of the burner is not affected in an unsafe manner.

The geometry and the distance of the mixing device in the fire tube should remain unchanged.

4.8.2.2 Mechanical safety, stability and control devices

Moving parts shall be shielded if the enclosure provided does not ensure adequate protection.
The construction of the burner shall be in such a way that no instability, distortion or breakage likely to impair its safety can occur.
Levers and similar devices which have to be operated by the installer or user shall be appropriately identified.
Constructional parts accessible during use and maintenance shall be free from sharp edges and corners that might cause damage or personal injury during use or maintenance.
The design of the burner shall be such that it can be handled safely. It shall be designed and packaged so that it can be stored safely and without damage.
Where the weight, size or shape of the burner or its components prevents them from being moved by hand, they shall be fitted with means to lift them easily."

4.8.2.3 Soundness

Holes for screws, studs, etc. intended for the assembly of parts shall not open into gas-ways. The wall thickness between drillings and gas-ways shall be at least 1 mm. This requirement shall not apply to orifices for measurement purposes or to components within the burner head.
The soundness of parts and assemblies making up the gas circuit and likely to be dismantled during regular
maintenance in situ shall be achieved by means of mechanical joints, for example metal-to-metal joints, gaskets, or o-ring joints, but excluding the use of all sealing materials such as tape, paste or liquids. All sealing materials shall remain effective under normal conditions of burner use.

4.8.2.4 Accessibility for maintenance and use
Burners that can be withdrawn or swiveled out of position without the use of tools shall be interlocked (for example, by means of limit switches) in such a way that they cannot be operated in the withdrawn or swiveled position.

4.8.3 Mounting
The burner shall be designed in such a way that it can be effectively mounted on the heater.
The burner components shall be arranged and secured in such a manner that their correct operating position, and above all, the correct position of the burner orifices, cannot change during operation. The correct operating position shall be maintained when accessories are dismantled and re-fitted.
Parts of the burner that are set or adjusted at the stage of manufacture and which should not be manipulated by the user or installer shall be sealed.
Components requiring regular maintenance shall be arranged or designed so that they are easily detachable.
Furthermore, incorrect replacement shall be prevented by design or, when this is not possible, by marking and/or instructions."

4.8.4 Connections
Inlet connections with pressure-tight joints made on the threads, connections within the burner with pressure-tight joints made on the threads that are not loosened for maintenance. Connections which have to be loosened for maintenance purposes.

4.8.5 Ignition system
Supplier shall provide an ignition system complete with transformer, electrodes, interconnecting wiring and all necessary devices. Power supply operated ignition system shall be provided for each burner with, 220 VAC power supply.
The high voltage igniter electrode shall be separated from UVZ (AC).

4.9 Equipment

4.9.1. Motors and fans
Motors and fans shall be so protected by suitable guards, shields or grilles of adequate size, strength and durability that they are not liable to be touched accidentally. The degree of protection shall be at least IP 56. Removal of such guards, shields or grilles shall be possible only with the use of commonly available tools.

Belt drives, where used, shall be so designed or positioned as to afford protection to the operator.
Means shall be provided to facilitate adjustment of belt tension. Access to such means shall be possible only with the use of commonly available tools.
Motors and fans shall be mounted in such a way as to minimize noise and vibration.

4.9.2. Electrical safety

For the electrical equipment and connections of the burner the following requirements of EN 50156-1, EN 60335-1 shall apply:

a) Rated value

b) Protection against accessibility to live parts
- leakage current and electric strength
- internal wiring
- components
- supply connection and external flexible cords
- connection terminals for external conductors
- provision for earth
- Creep age distances, clearances and distances through insulation

c) Radiation
- Resistance to heat, fire and tracking.

The leakage current and electrical strength tests on the complete burner need not be performed if the components and sub-assemblies have been separately tested and the interconnection is carried out in accordance with the manufacturer's instructions.
If the measurements of the leakage current as required in EN 60335-1, are not possible, because the circuits of protective impedance or radio interference filters cannot be disconnected, then the leakage limit specified for leakage current is to be calculated taking into account the current through those circuits.

Note: In addition BSI 60204-1 should be applied.

In addition the documentation of the electrical connections for the individual components shall be provided by means of an electrical wiring and connection diagram.

4.9.3 Adjustable air damper

Every burner shall be fitted with an adjustable air damper or a similar device for controlling the air flow.

4.9.4 Gas line components

4.9.4.1 General

All gas line components shall be designed for the individual inlet pressure of the burner or be protected against any excessive increase in pressure by means of relevant safety devices.

4.9.4.2 Hand operated valve (manually operated shut-off device)

A quick-acting hand operated valve shall be provided upstream of all controls to isolate the burner.

If this valve is not supplied by the manufacturer, appropriate information shall be given in the installation instructions.

In addition burners shall be provided with such hand operated valves as are essential for their commissioning and normal operation.

The manual gas valve shall be readily accessible and capable of rapid operation (e.g. 90° turn valve). The manual valve shall be capable of operating at a pressure equal to 1.5 times the maximum supply pressure.

The manual valves shall be so designed as to prevent inadvertent operation but shall be easy to operate when required. They shall be so designed that in operation the "OPEN" and "CLOSED" positions are readily distinguishable." Manual valves used solely for OPEN/CLOSED operation shall be provided with mechanical stops at the "OPEN" and "CLOSED" positions.

4.9.4.3 Filter

A filter shall be fitted at the inlet of the safety shut-off valve system to prevent the ingress of foreign elements. The maximum strainer hole dimension shall not be greater than 1.5 mm and the mesh shall not permit the passage of a 1 mm pin gauge.

4.9.4.4 Automatic safety shut-off valves

All burners shall be fitted with automatic safety shut-off valves in series.

All burners shall be fitted with two automatic safety shut-off valves in series as defined in below Table and complying with EN 161.

Where the main flame establishment is by means of a start-gas flame, the start gas supply shall be either:

a) Under the control of the downstream main gas safety shut-off valve incorporating a start gas limit position, or

b) Under the control of safety shut-off valves as indicated in below Table.

TABLE 1 – Safety Shut-Off Valve Requirements

Heat Input kW	With Pre-Purge		
	Main Gas	Start Gas	
		≤ 10%	> 10%
≤ 70	2 × B	B[a]	2 × B
> 70 ≤ 1200	2 × A	2 × A	2 × A

CLASS A: can be used for applications more than 70 KW Class B: can be used for applications up to 70 KW

4.9.4.5 Flame detector device

The main flame and the flame of any ignition burner shall be monitored by a flame detector device.

The mounting of the flame sensors on the burner shall be such that the flame sensors do not receive any extraneous light.
Where the ignition burner and the main burner are each provided with their own flame monitor the ignition burner flame shall not influence the detection of the main flame. The main gas supply shall be opened only after the ignition means is switched off and the ignition burner flame has been established and detected.
For systems where the ignition burner remains in use during main burner operation, separate flame sensors to monitor the ignition and main flames shall be fitted. The main flame sensor shall be so positioned that it cannot in any circumstance detect the ignition burner flame.
For systems where the ignition burner is extinguished during main burner operation a single sensor will suffice. The ignition burner flame shall not influence the detection of the main flame.
The flame detector device shall be such that upon flame failure there is no noticeable delay between the flame extinction and the failure of the flame signal.
The flame detector device shall be suitable for the particular thermal rating and mode of operation of the burner (intermittent or permanent operation). When installed on the burner it shall comply at least with protective category IP 40, and with protective category IP 56 for installations in the open air, in accordance with EN 60529.
The flame detector device shall be subjected to a safe start check which shall lead to safety shut-down or nonvolatile lock-out, if the flame detector signals flame presence at any time during the pre-purge. The safe-start check may cease during the 5 s preceding an attempt at ignition. If a flame simulating condition exists, non-volatile lockout shall occur.
The time for the safety shut-off valves to be de-energized upon flame failure shall be not more than 1 s during normal operation and not more than 2 s where a self-checking test is made at the same time as the flame failure.

4.9.4.6 Air proving device
The burner shall be fitted with a device for proving adequate air flow during the pre-purge, ignition and operation of the burner.
Air flow failure during pre-purge shall at least proceed to safety shut-down.
For burners of heat input up to and including 120 kW safety shut-down
Proof of adequate air flow may be achieved by one of the following methods:

a) By pressure sensing
b) By flow sensing
c) By any other system which does not rely only on fan rotation.

An air damper interlock or an air damper actuator interlock alone is not sufficient.
The air proving device shall be proved in the no flow state prior to start-up. Failure to prove the device in the no flow state shall prevent start-up or cause quenching explosion.
This check is not necessary if failure of the air proving device leads to a safe condition.
The air proving device shall be adjusted in such a way that if there is insufficient air supply at the highest or lowest burner operating stage, the device operates before the CO content at the controlled stage of the combustion products exceeds 1 % by volume, air-free/dry.

4.9.4.7 Air/gas ratio control devices

Each burner shall be provided with an adjustment device for the air flow.
The air and gas adjustment devices shall be interconnected such that the relationship between combustion air and gas is fixed in a repeatable way at any operating point of the burner.
For burners with intermittent operation, the function of the air/gas ratio control system, except for pneumatically operated devices, shall be checked during the start sequence, e. g. by means of pressure or position switches.
On multi-stage or modulating burners where the air and gas flows are not altered simultaneously, there shall be either:

a) Air lead on increasing firing rate and gas lead on reducing firing rate, or
b) Sufficient excess air to prevent gas-rich firing.
The combined control or the sequential switching shall be affected in such a manner that, even in the case of fault, the system will tend towards higher excess air or proceed to safety shut-down.

1) Where a pneumatically operated air/gas ratio device is fitted it shall comply with the requirements of
EN 12067-1.
2) Where an electronic operated air/gas ratio device is fitted it shall comply with the requirements of
EN 12067-2.

4.9.4.8 Pressure test points

To enable the gas inlet pressure, the gas adjustment pressure, the pressure in the burner head and the air pressure to be checked, test points or pressure measuring devices shall be provided.

Note: single pressure test point can be provided for the measurement of both the adjustment pressure and the pressure in the burner head.

Pressure test points, with a maximum internal diameter of 1 mm, an external diameter of $9.0^{\ }_{-0.5}$ mm and a length of 10mm, shall be such that they can be tightly closed, or shall be self-sealing.

4.9.4.9 Automatic burner control unit

The automatic burner control unit shall comply with the requirements of EN 298 and shall be suitable for the individual output stages of the burner. The automatic burner control unit shall be suitable for the mode of burner operation (intermittent or permanent).

Note: In this case, the burner control unit should be tolerable for EMC severity level 3, assessment criteria a) and b) of EN 298 Table 4.

4.9.4.10 Fire tube

- Fire tube will be fastened on one of the end trays of the Water Bath. It shall be easily removable for periodic inspection and cleaning.

- It shall be equipped with:
- a flame sight glass
- an evacuation pipe for condensates to be taken outside the frame

- To optimize efficiency, the combustion chamber is submerged in water and the combustion gases pushed by the burner fan are led through a combustion chamber.

4.9.4.11 Burner controller

- The burner controller has following minimum requirements:
- Combustion and control functions manager
- Gas pressure monitor
- Flame guard of automatic self-controlling type, certified for continuous burning.

- Connections for safety functions
- Digital input for high temperature switch
- Digital input for high pressure switch

- Temperature control:
Analog input 4-20 mA for water side temperature transmitter

4.9.4.12 Power supply

- Heater shall be equipped with UPS (on 24 Volts DC power supply) for the use of Alarms in case of power supply failure for minimum of 24 Hr continuous operation.

4.9.5 Adjustment

4.9.5.1 An opening shall be provided on the fire tube for easy access so that each burner could be manually adjusted while installed.

4.9.5.2 Peephole shall be provided and located such that burner flame could be observed during adjustment and operation.

4.9.6 Instrumentation and control for reduced pressure fuel-line

4.9.6.1 Fuel gas system shall be minimum equipped with following items:

- Inlet isolating ball valve.
- Filtering system, for pneumatic applications 3-5 micron filtration is necessary. Equipped by Differential Pressure Gauge & 3-way manifold.
- Regulator and high pressure shut off shall be factory adjusted within working pressure range of the main burner.
- Safety relief valve with a maximum blow down not more than 5% maximum burner capacity discharge shall be directed away from the firebox.
- Inlet & outlet pressure indicator.
- Inlet temperature indicator.
- Outlet isolating ball valve.
- One spool as same as the gas meter length.

4.9.6.2 Process control system shall be design the following characteristics:

- If automatic burner failed to shut down, it shall be reset manually.
- Low level protection systems shall be equipped with one low level alarm (LLA) switch and one low level shut down switch (LLS).
- Automatic proportional control temperature on main regulator gas pressure reducing station (gas temperature shall be set to protect regulator from ice formation at outlet reducing gas pressure station)
- Automatic proportional control on water/glycol temperature (maximum bath temperature shall be 88°C)

4.9.6.3 All safety alarms and shutdown controls of burner management system shall be design in following condition:

- Discontinuity in level switch output
- Discontinuity in Gas/Bath temperature control output
- Discontinuity in UV-Cell output
- Discontinuity in Main power supply (only alarm).
- Increasing Pressure in fuel line system.
- Failure in Ignition system (except manual mode).
- Failure in outputs of control Box to Fuel gas controlling elements.

4.9.6.4 All piping and instruments shall be adequately supported.

4.9.6.5 Each instrument shall be individually identified by a tag or name plate.

4.9.6.6 Instruments and controls shall be designed to withstand the maximum anticipated temperature and pressure.

4.9.6.7 Indication of controlled condition shall be provided on each process controller.

4.9.6.8 Temperature gauge/ indicator shall be bi-metallic type, hermetically sealed, non-reset, heavy duty type, dial size 100mm, white with black and red lettering, dual scale in centigrade and Fahrenheit, adjustable pointer. (Gauge range -30 ~ +100°C).

4.9.6.9. Pressure gauge shall be furnished with stainless steel bourdon tube elements, stainless steel rotary gear, movements with blow out disc, dial size 100mm with black and red lettering, dual scale in bar and psi.

4.9.6.10 All gauges shall be equipped by an insulating valve.

4.9.6.11 Control valve bodies shall meet ips-g-in-160.

4.9.6.12 All electrical valves and instruments shall be explosion proof in acc. with EEx-e II T4.

4.9.6.13 Electrical terminations shall be provided with EEx-d or EEx-e junction boxes.

4.9.6.14 Fuel gas system and process control shall be considered to attach informative P&ID.

4.9.7 Maintenance

4.9.7.1 Provisions shall be included so that the burner could be cleaned with a minimum of disassembly.

4.9.7.2 Burner shall be field removable.

4.10 Operating Conditions

4.10.1 Lifting lugs and tailing lugs

- Lifting lugs shall be provided with sufficient strength to allow lifting the entire assembly without causing any damage to the shell and the other parts.
- Lifting lugs and tailing lugs shall be designed taking into consideration a minimum impact factor of 2 on the weight full of water.
- Minimum two (2) lifting lugs are required on the unit.
- Center of gravity: to be marked up on Manufacturer's General Arrangement Drawing.

4.10.2 Ergonomics

- The Manufacturer of the Forced draught indirect water bath heater Package is responsible to design the installation in accordance with the ergonomics principles as per applicable standards.
- All components, equipment and instrumentation shall be installed in such a way that operation and maintenance can be performed in a safe and easy way (user friendly).
- Measuring equipment, such as temperature and pressure indicators, shall be readable from ground level. Indicator housings for temperature and pressure shall be of sufficient large size (100 mm) and shall be installed at eye level.
- In function of the weight and dismantling frequency, the Manufacturer shall provide the most appropriate access and dismantling means.
- Field equipment that shall be operated, are preferably installed above a free space. The free space should allow the placement of a platform to improve the accessibility for operation, maintenance or dismantling.

4.10.3 Electrical and instrumentation

4.10.3.1 General

- The electrical and instrumentation installation will be in accordance to IPS-e-el-115.
- Emergency shutdown button will interrupt the electrical power via a contactor installed in the Purchaser electrical control panel and will also stop the gas feed to the Forced draught indirect water bath heater Package.
- All circuit breakers will be equipped with an auxiliary contact. All these contacts will be put in series to form a low / high priority alarm.

- For every burner and pump a hand switch (Auto/1/0) will be mounted locally near or on the device. The switches are hardwired in order to control the Water Bath Heat Exchanger, without automation system, in case of emergency.
- All hand switches in the control cabinet, for manual hardwired operation of the hot water system, will be equipped with an auxiliary contact. All these contacts will be put in series to form a low priority alarm.
- A minimum spare capacity of 25% in power and space shall be provided in the electrical control panel.
- A one line diagram and an as-built P& I component list shall be delivered with the installation.

4.10.3.2. Process equipment

- Electrical requirements for the process equipment shall be communicated with the offer (Electrical users list, with voltage and power consumption). Process equipment shall be protected by individual breaker. They shall not be a source of emission of perturbing frequencies. Switching-off overloading protection shall exist on motors.

4.10.3.3 Control cabinet unit

- Electrical details shall be communicated with the offer. See the Data Sheet, in which, when requested, Purchaser's requirements are indicated.
- Process equipment shall be operable from contactor or push button accessible from outside the cabinet. Means of locking shall exist to prevent fault restart during maintenance.
- Installed signalization and test monitoring shall be visible from outside the cabinet.
- Alarm and danger signals shall be treated through adjustable delay timer to eliminate the short erratic events. Readjustment of the timers on site shall be possible.
- The door of control cabinet unit shall be provided with key forbidding access to unauthorized persons.
- In/Out entrances of cables shall be vapor tight and make impossible the accumulation of dirt and liquid at seal area. Cable entrance shall have a spare of 25 %. All entries of cable shall have its cable gland. Unused entrances have to be seal plugged.
- Monitoring of electrical circuit by test lamp and push button shall be possible.
- The construction and disposition of all items shall correspond to the electrical layout drawing and one line diagram which documents shall be placed in plastic pocket and placed inside the cabinet.
- An electrical control cabinet unit equipped with the following devices, but not limited:

- a flame controller
- a burner feed valve tightness controller
- locking relays by low level of the water bath
- by maximum temperature of the water bath
- by minimum and maximum pressure of the fuel gas
- by lack of flame
- by lack of tightness of the gas valve(s)
- a general power switch
- a general circuit breaker
- a differential protection switch (300 mA)
- Lighting (door switch and manual on/off control)

4.10.3.4 Junction boxes and cable terminals

- Cables and wires shall be fixed on screw fixation type terminals. Their position will bear the identification recorded in the electrical diagrams.
- Different types of signal shall be segregated into separate terminal bars. A reserve of connecting points of 25 % shall be foreseen.

4.10.4 Earthing

- Electric equipment and cabinet, cable trays, cable armors shall be connected to the ground via a central earth connection placed in the control unit.

5. WELDING

5.1 Welders

Welder qualifications shall be in accordance with section IX of the ASME code.

5.2 WPS and PQR

All welding shall be performed according to welding procedure specification (WPS).
The contractor shall submit welding procedure specification (WPS) and procedure qualification record (PQR) according to ASME IX for purchaser's review and approve

before welding process started.
All welding procedure specifications shall have been or shall be qualified in accordance with section IX of the ASME Code. All tests shall be performed with equipment calibrated in accordance with applicable ASTM or national standards by an accredited laboratory. Re-qualification or additional qualification tests are required if in the opinion of the purchaser the supporting PQR fails to reasonably simulate the actual conditions during production welding and this could adversely affect weld performance. It will be the responsibility of contractor to carry out all the tests required to the satisfaction of purchaser.

5.3 Welded Joints Inspection and Testing

5.3.1 General

The inspection and test should be carried out according to a non-destructive test procedure which may be issued for each work piece. Weld inspection may be performed by qualified site staff, quality control personnel or by qualified inspection company. The third part inspector shall have the right to selecting joint and witness the tests according to the provisions of the erection test plan.

5.3.2 Visual inspection

Visual inspection shall be performed prior to undertake any non-destructive tests.
The visual inspection shall be carried out according to the provision of the ASME sec. V.
Visual check shall be performed to following as a minimum:

- Cracks
- Incomplete penetration
- Lack of fusion
- Under cutting
- Reinforcement
- Porosity

- Slag
- Concave root surface
- Uniformity of welded joint
- Surface finish
- Fillet weld throat
- Fillet weld concavity
- Fillet weld convexity
- Cleanliness

5.3.3 Liquid penetrate test
Wherever dye penetrate test requested by inspector, shall be performed in compliance with the provisions of the applicable procedure and code.

5.3.4 Radiographic test
Whenever required, radiographic tests shall be carried out according to the provisions of the applicable procedure and code.

5.3.5 Progress examination
In case of random examination (i.e. exam by %) according to approved QCP, if a detective joint is found then all welded joints shall be fully tested.

5.4 Repair and Re-Inspection
Defects shall be repaired in accordance with approved repair procedures and the joint shall be re-inspected by the same methods, and re-examined to the same extent, and by the same acceptance criteria required for the original weld. All repairs shall be carried out with prior permission of client.

6. TESTS

6.1 Standard Tests

Heater coils shall be hydrostatically tested in accordance with the ASME sec. VIII (boiler and pressure vessel code) prior to shipment by the manufacture. Coils shall be tested before installation in main shell and after NDT approved reports. Manufacture shall conduct the test in the presence of the purchaser's authorized representative.

In addition to the ASME code requirements for hydrostatic testing, the following measures shall be taken:

Commercial tap water filtered with a 100 mesh screen having no additives other than wetting agent, rust inhibitors or fluorescent dye shall be used as the hydrostatic testing medium.

All openings shall be blinded, capped, or plugged prior to test.

Each heater coil shall successfully withstand the test pressure without failure, leakage, distress or distortion other than elastic distortion during test period. In the event that a leak or break occurs, manufacturer shall locate and replace the defected part(s).

The heater coil shall then be re-pressurized and a new test shall be carried out.

All instruments shall be subjected to approval by purchaser's authorized representative prior to test.

The test shall be accepted when in the judgment of purchaser's authorized representative the assembly is free of leaks.

Fire tube shall be pneumatically tested at a pressure of 30 psig before installation in the main body.

The completed fire tube shall be tightness tested (Preferably with compressed air/30 psig).

- Heater shell shall be tested for leakage and withstand the full load when filled with water.

Fuel line and shell shall be tested according to client procedure test.

Forced draught burner shall be tested according to EN 676 latest edition.

A test record shall be made and shall include all descriptive or pertinent information to identify each heater coil. The test information as specified below shall be provided in letter of certification that the heater coil was tested and met all requirements of the applicable codes. All records shall be handed over to purchaser.

- The minimum information required on each letter of certification is as follows:

Purchase order number, item number

Destination

Coil serial number

Signature of manufacturer's test witness and/or purchaser's representative

Test duration

Ambient temperature

Brief description of test results, including any leaks or breaks

Complete with remedial action taken to correct the defect.

- Exhaust gas shall be sampled properly and tested when heater works. Exhaust gas should be comply local regulations regarding to control of emissions to air. According to standards of exhaust gas for industrial workshops and factories (approved by environment protection organization).

6.2 Instrument Test

Electrical and instrument functional tests shall include simulation of field signals and loads and each instrument alarm or control loop shall be tested for operation throughout the full specified range.

7. INSPECTION

7.1 Introduction

- Inspection shall be done base on manufacturer QCP which is approved by client.

- Inspection shall be done by the client.

- Purchaser’s authorized representative shall be afforded the opportunity to witness the manufacturing and testing of any part of the heater(s).
The inspection and testing in no way however relieves the manufacturer of his responsibility for the heater(s) to meet all requirements of this specification.
Radiographs shall be made available to the purchaser’s authorized representative at the time of inspection.
The manufacturer shall arrange for all necessary inspection for compliance with the ASME boiler and pressure vessel code.
Each heater shall have a final inspection performed by the purchaser’s authorized representative prior to shipment.

7.2 Client's Inspection

The client shall have the right to make inspections during fabrication and to witness any tests when he has so requested. Advance notification shall be given as agreed between the manufacturer and the client. Inspection by the client shall not relieve the manufacturer of his responsibilities. Any additional tests required by the client, above those already agreed to, will be to the client's account. Cost for remedial work as a result of these additional tests will also be to the client's account.

7.3 Supplemental Information

Certificates of all inspection, welders and material with test report shall be supplied to purchaser.

8. SURFACE PREPARATION AND COATING

For any carbon-steel parts, surface preparation and painting shall be in accordance to IPS-C-TP-101 & 102.
The applicable standard for surface preparation shall be the latest edition or revision of the international norm ISO 8501-1or SIS 055900 Grade SA 2 1/2 (SSPC VIS1-89).
Coating shall be zinc silicate with a total dry film thickness of 150 microns.
External surface of coil, fire tube, piping and instruments and internal and external shell`s surface shall be painted.

9. THE HEAT MEDIA SPECIFICATION

Fluid content of bath shall be solution of water, when freezing is possible, ethylene glycol shall be added for anti-freeze protection. Corrosion inhibitors shall be added.
Information for this volume fraction for ethylene glycol/water solution, based to site temperature recommended APPENDIX C. But manufacturer recommended is preferred to this APPENDIX C.

10. MARKING

Each heater shall be identified by permanently attached corrosion resistant nameplate.
A stainless steel nameplate shall be located so that it is easily visible after installation.
Heater shall have nameplate containing marking and stamping in accordance with the ASME pressure vessel code plus the additional information as follows:

- Manufacture's name
- Year built
- Serial number
- Thermal absorption on coil kcal (BTU)
- Number of coils and number of flow paths
- Coil wall thickness, outside diameter and schedule number of coil pipes
- Coil outside surface area, m^2
- Fire tube outside surface area, m^2
- Coil weight, kg
- Hydrostatic test pressure, psig
- Purchase order
- Item number
- Shell weight, empty/full, kg
- Bath water capacity, lit
- Expansion tank capacity, lit

11. PACKING

For each heater packing shall be in accordance with NIGC protection, packing, marking and dispatching instructions outlined as follows:
All instruments, control systems, etc. shall be packed in accordance with above instruction but in sufficient cases of appropriate size.
All sensing lines (except those which could be packed with instruments) shall be disassembled, covered and wrapped with plastic materials and placed around the heater shell in such a way that they are not damaged during transportation. No. packing for shell is necessary.
All separately packed parts of each heater (instruments, stack, etc …) shall be supplied in the same shipment with heater itself and identified accordingly.

Note 1: After the functional test is approved, then the required disassembling for packing shall be started.

Note 2: Supplier shall submit detail installation drawing as well as detail commissioning procedures and all necessary documents prior to shipment.

12. GUARANTEE

Manufacturer shall guarantee the compliance of material and performance of the supplied equipments with this specification.
The period of guarantee shall be one year after equipment goes on stream or eighteen months after date of shipment, whichever occurs first, or according to the contract.
Supplier shall agree to repair or replace any equipment which proves to be defective during the above mentioned period.

13. INSTALLATION

13.1 The heater units shall be positioned on site and provided with sufficient access to allow removal of coil section and fire tube section from the two ends of the heater separately for routine maintenance.

13.2 The heater layout shall be identified in regard to safety and environmental aspects(such as wind direction and speed,…).

13.3 All heater accessories (all gauges, name plate,…) shall be considered according to Agronomical aspects (such as accessibility, visibility, …).

13.4 The erection activities are terminated when all the process equipment, piping, electrical materials, support structures will be correctly positioned and fixed at their location and the unit fully assembled.

14. DRAWINGS AND DATA

The following drawings and data shall be furnished to the client at quotation and ordering stages.

14.1 Quotation Stage

14.1.1 N.I.G.C Data sheet (IGS-M-PM-106) completed by vendor.

14.1.2 General arrangement drawings showing outline dimensions and weights.

14.1.3 Preliminary played sectional view of heater internals.

14.1.4 List of recommended spare parts to cover initial commissioning and two years operation.

14.1.5 All technical information including description of fuel system, protection and control with relevant drawings and catalogue for each component.

14.2 Ordering Stage

14.2.1 Descriptive final arrangement and technical detail of drawings and last revision (as built DRWNG) included weight and load on foundation supports (Hardcopy and electronic files).

14.2.2 Comprehensive catalogues and detailed technical drawings of the supplied instruments.

14.2.3 Operating and installation instructions.

14.2.4 Maintenance manual(s)

APPENDIXES

APPENDIX A

Table A.1 Heater Data sheet

Subject		Unit	To be Filled by NIGC/Client	To be Filled by Supplier
Service Condition	Gas Flow Rate	SCMH		
	Inlet Pressure	psig/bar	min.( ) max.( )	
	Inlet Temperature	ºC	min.( ) max.(10)	
	Maximum Heater Outlet Temperature (for Coil Heat Transfer Area Design)	ºC	38	
	Controlling Temperature on Main Regulator Gas Pressure Reducing Station	ºC	Temperature limitation shall be provided according to natural gas freezing point	
	Net Absorbed Heat Duty	kcal/hr		
	Gross Heat Duty: Burner/Fire Tube	kcal/hr		
	Overall Thermal Efficiency, Min	%		
	Maximum Bath Temperature	ºC	88	
	Maximum Gas Velocity in Coil	m/sec	20	
	Maximum Pressure Drop in Coil	bar	1.75	
	Design Pressure	psig/bar	1.1 max. operating pressure	
	Design Temperature	ºC	100	
	End Connection Size	in		
	Fuel Gas Supply Pressure	bar	4 – 17	
	Ambient Temperature	ºC	min.( ) max.( )	
	Maximum Wind Velocity	km/hr		
	Maximum Rain Fall	mm/annual		
	Relative Humidity	%		
	Maximum Snow Loading	mm		
	Earth Quake Zone (OBCIV)			
	Elevation Above Sea Level	m		

	Fuel Gas Consumptions	SCMH		
	Fire Tube Heat Flux, Max	BTU/hr.ft^2	12,000	
	Fire Tube Heat Density, Max	BTU/hr.in^2	15,000	
End Connection	Type		Flange W.N., R.F.	
	Class		600	
	Inlet and Outlet Size	in		
Coil	Material		ASTM A-53, Gr.B, SCH 80 / ASTM A106, Gr.B, SCH 80	
	Outside and Inside Diameter	mm		
	No. of Flow Paths	No		
	No. of Passes per Flow Path	No		
	Total Coil Outside Surface Area		according to TABLE B.1	
	Design Pressure	Psig(bar)		
	Design Temperature	ºC	100	
Shell	Material		SA.36 or equivalent	
	Diameter	mm		
	Length	mm		
	Insulation Material and Thickness	mm	50 mm thickness fibber glass / rockwool & aluminium Cladding	
Expansion Tank	Material		SA.36 or equivalent	
	Diameter	mm		
	Length	mm		
	Insulation Material and Thickness	mm	50 mm thickness fibber glass / rockwool & aluminium Cladding	
Main Fire Tube	Material		ASTM A 53	
	No. of Tubes			
	Size	mm		
	Wall Thickness	in	0.250" for 24" and smaller 0.312 " for over 24"	

	Surface Area	mm²		
Return Fire Tube	Material		ASTM A 53	
	No. of Tubes			
	Size	mm		
	Surface Area	mm²		
	Wall Thickness		0.250" for 24" and smaller 0.312 " for over 24"	
Burner	No. of Burners			
	Total Capacity	BTU (kcal)		
	Type		Forced Draught	
	Manufacturer, Model Number		NIGC vendor list	
	No. of Pilots, Type			
	Type of Flame Arrestor			
Stack	Material		ST.37 or equivalent	
	Diameter	mm		
	Thickness	mm	3	
	Heigth	mm		
	Draft	mm WC(Pa)		
	Type of Anti Down Draft Device		Light weight non corrosive material	
Painting	Standard for Surface Preparation		ISO 8501-1 or SIS 055900 Grade SA 2 1/2 (SSPC VIS1-89).	
	Coating Material		1. Zinc Ethyl Silicate 2. Epoxy Poly Amid Top Coat	
	Total Thickness of Paint	µm		
Instrument Regulator	Type		(Fail to open)	
	Size	in		
	Manufacturer		NIGC vendor list	
	Set Pressure	psig		

Main Shut-Off Valves	Type			
	Size	in		
	Manufacturer		NIGC vendor list	
Fuel Control Valves	Type		Fail to close	
	Manufacturer		NIGC vendor list	
Relight System	Type		PLC control	
	Manufacturer		NIGC vendor list	
	Output Voltage	V_{AC}	220 V	

APPENDIX B
Heater Nominal Capacity and Duty

Heater minimum requirement in heat transfer area
Minimum operating pressure: 400(psig)
Maximum operating pressure: 1050/1305(psig)

$$Q_{Heater} \times 1.098 = Q_{Burner} \times \eta$$

Which:
Q_{Heater} =Heater Heat Capacity (BTU)
Q_{Burner} =Burner Heat Capacity (BTU)
Ɗ = Burner System Efficiency (%)
1.098: Constant number for converting net to gross

TABLE B.1 – Minimum Required Heat Duty based on Burner Capacity

Heater Capacity SCMH	Minimum Required Net Absorbed Heat Duty, BTU	Minimum Required Gross Burner Capacity, BTU	Minimum Required Coil Cross Sectional Area, m^2	Minimum Required Heat Transfer Area (Coil Surface Area), m^2
2,500	170,000	218,254	0.0013	3.3
5,000	335,000	432,540	0.0026	7
10000	670,000	865,081	0.005	10.5
20,000	1,335,000	1,722,225	0.011	22
30,000	2,010,000	2,595,242	0.016	27
50,000	3,350,000	4,325,404	0.027	45
100,000	6,700,000	8,654,776	0.052	92

* 1BTU = 0.2519958 kcal

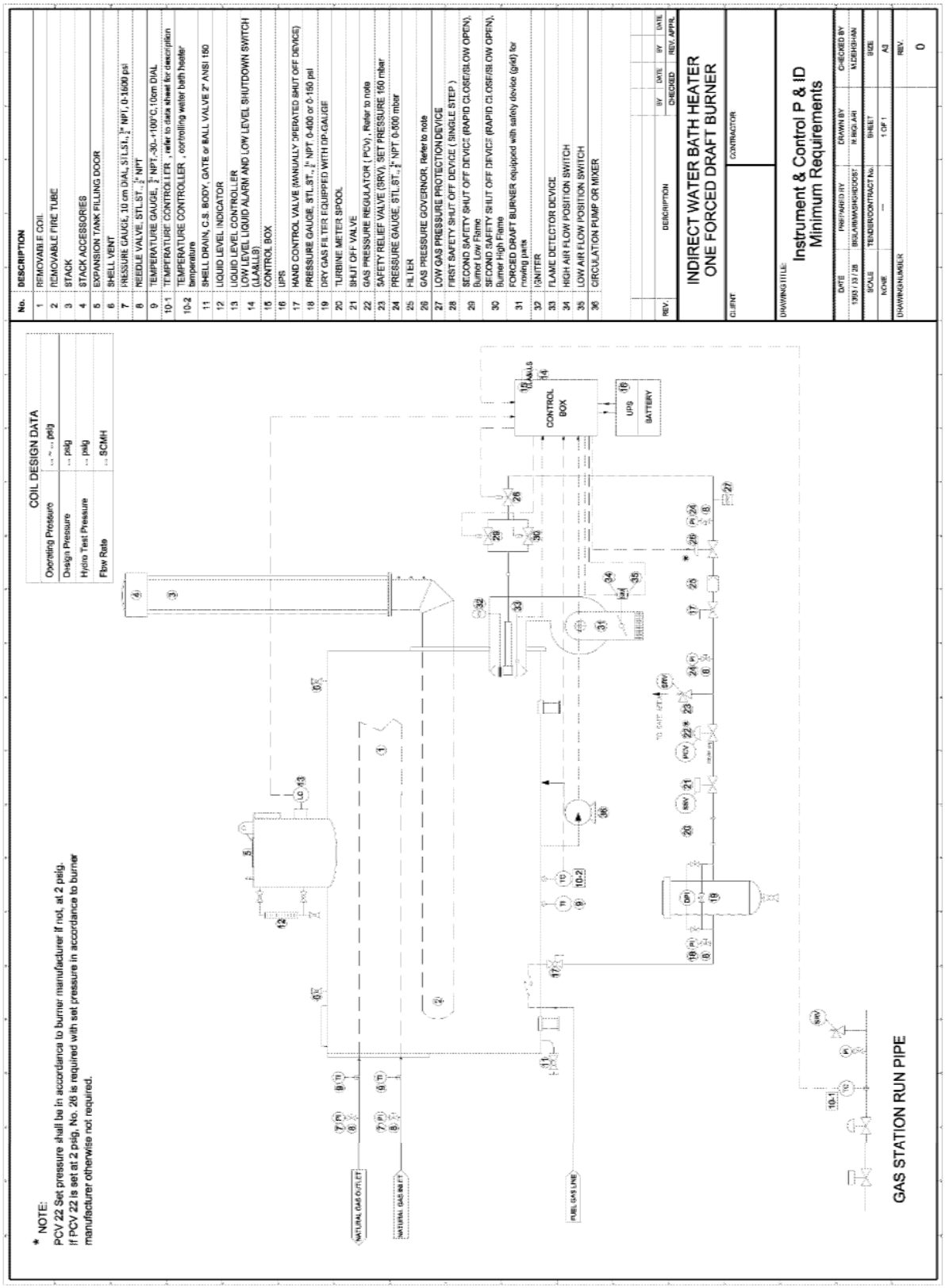
APPENDIX C
Informative EG/ W sol vol. %

TABLE C.1 – Concentration of Anti-Freezing Solution based on Minimum Temperature

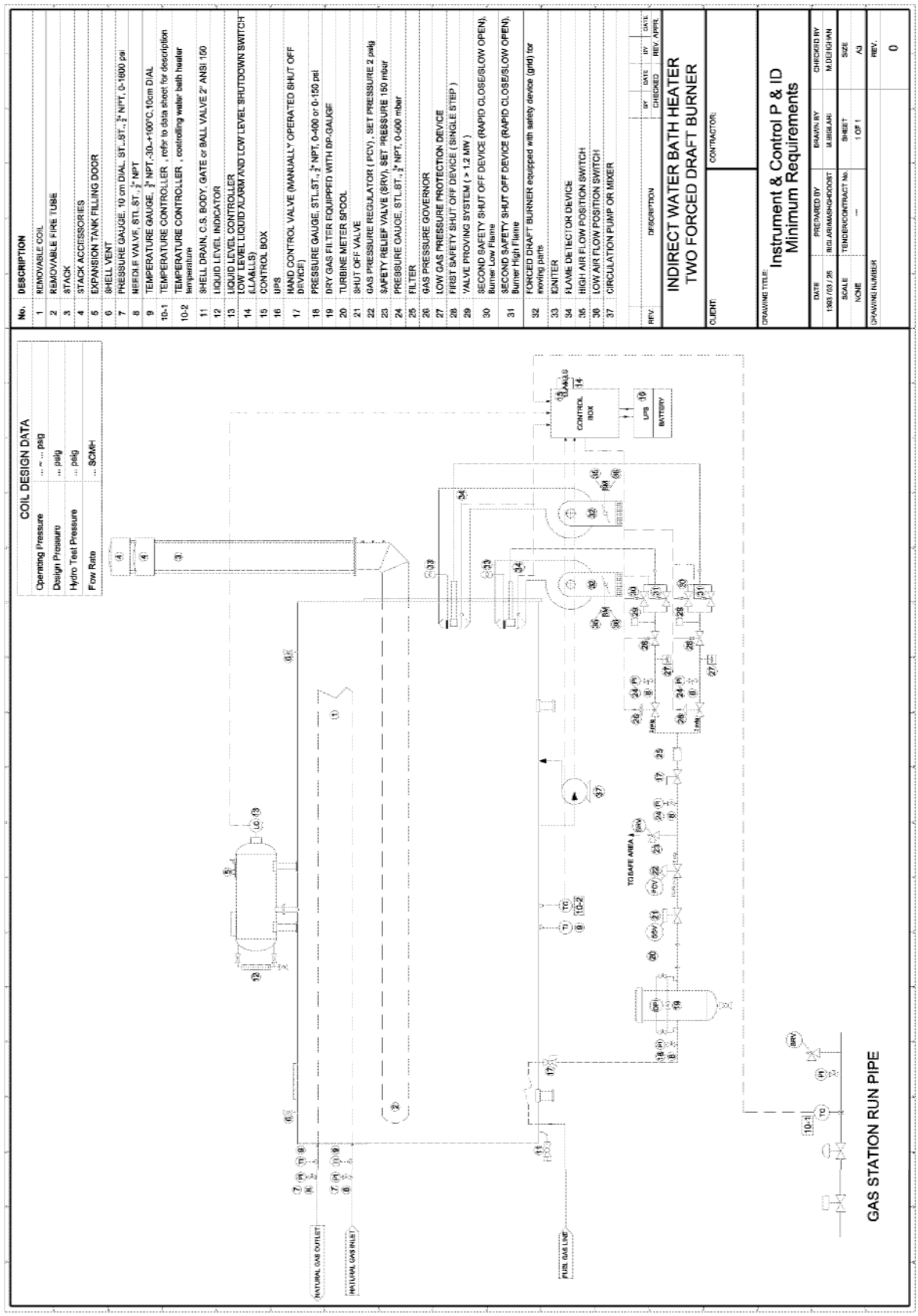
Minimum Site Temperature (°C)	Ethylene Glycol Liquid Vol. Fraction	Minimum Site Temperature (°C)	Ethylene Glycol Liquid Vol. Fraction
-5	0.125	-28	0.450
-6	0.147	-29	0.460
-7	0.170	-30	0.470
-8	0.190	-31	0.480
-9	0.210	-32	0.485
-10	0.230	-33	0.495
-11	0.240	-34	0.500
-12	0.260	-35	0.510
-13	0.270	-36	0.515
-14	0.280	-37	0.520
-15	0.300	-38	0.530
-16	0.320	-39	0.535
-17	0.330	-40	0.540
-18	0.340	-41	0.545
-19	0.360	-42	0.550
-20	0.370	-43	0.555
-21	0.380	-44	0.560
-22	0.390	-45	0.565
-23	0.400	-46	0.570
-24	0.415	-47	0.575
-25	0.425	-48	0.580
-26	0.435	-49	0.585
-27	0.445	-50	0.590

APPENDIX D
Informative P & ID

1 .ONE BURNER



2. TWO BURNER


COIL DESIGN DATA
Operating Pressure ... ~ ... psig
Design Pressure ... psig
Hydro Test Pressure ... psig
Fow Rate ... SCMH
No. DESCRIPTION
1 REMOVABLE COIL
2 REMOVABLE FIRE TUBE
3 STACK
4 STACK ACCESSORIES
5 EXPANSION TANK FILLING DOOR
6 SHELL VENT
7 PRESSURE GAUGE, 10 cm DIAL, ST., ST., 1/2" NPT, 0-1600 psi
8 NEEDLE VALVE, STL.,ST., 1/2" NPT
9 TEMPERATURE GAUGE, 1/2" NPT,-30..+100°C,10cm DIAL
10-1 TEMPERATURE CONTROLLER , refer to data sheet for description
10-2 TEMPERATURE CONTROLLER , controlling water bath heater temperature
11 SHELL DRAIN, C.S. BODY, GATE or BALL VALVE 2" ANSI 150
12 LIQUID LEVEL INDICATOR
13 LIQUID LEVEL CONTROLLER
14 LOW LEVEL LIQUID ALARM AND LOW LEVEL SHUTDOWN SWITCH (LAL&LLS)
15 CONTROL BOX
16 UPS
17 HAND CONTROL VALVE (MANUALLY OPERATED SHUT OFF DEVICE)
18 PRESSURE GAUGE, STL.,ST., 1/2" NPT, 0-400 or 0-150 psi
19 DRY GAS FILTER EQUIPPED WITH DP-GAUGE
20 TURBINE METER SPOOL
21 SHUT OFF VALVE
22 GAS PRESSURE REGULATOR (PCV) , SET PRESSURE 2 psig
23 SAFETY RELIEF VALVE (SRV), SET PRESSURE 150 mbar
24 PRESSURE GAUGE, STL.,ST., 1/2" NPT, 0-600 mbar
25 FILTER
26 GAS PRESSURE GOVERNOR
27 LOW GAS PRESSURE PROTECTION DEVICE
28 FIRST SAFETY SHUT OFF DEVICE (SINGLE STEP)
29 VALVE PROVING SYSTEM (> 1.2 MW)
30 SECOND SAFETY SHUT OFF DEVICE (RAPID CLOSE/SLOW OPEN). Burner Low Flame
31 SECOND SAFETY SHUT OFF DEVICE (RAPID CLOSE/SLOW OPEN). Burner High Flame
32 FORCED DRAFT BURNER equipped with safety device (grid) for moving parts
33 IGNITER
34 FLAME DETECTION DEVICE
35 HIGH AIR FLOW POSITION SWITCH
36 LOW AIR FLOW POSITION SWITCH
37 CIRCULATION PUMP OR MIXER
REV. DESCRIPTION BY DATE CHECKED BY DATE REV. APPR.
INDIRECT WATER BATH HEATER
TWO FORCED DRAFT BURNER
CLIENT: CONTRACTOR:
DRAWING TITLE:
Instrument & Control P & ID
Minimum Requirements
DATE 1393 /03 / 28 PREPARED BY BIGLARIMASHHOOST CHECKED BY M.DEHGHAN
SCALE NONE TENDER/CONTRACT No. --- SHEET 1 OF 1 SIZE A3
DRAWING NUMBER REV. 0
CONTROL BOX
UPS
BATTERY
TO SAFE AREA
NATURAL GAS OUTLET
NATURAL GAS INLET
FUEL GAS LINE
GAS STATION RUN PIPE