Specification for Indirect Type Oil-Field Heaters

API SPECIFICATION 12K (SPEC 12K)
SEVENTH EDITION, JUNE 1, 1989

American Petroleum Institute
1220 L Street, Northwest
Washington, DC 20005

Issued by
AMERICAN PETROLEUM INSTITUTE
Production Department

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SECTION 1
SCOPE

1.1 Coverage. This specification covers minimum requirements for the design, fabrication, and shop testing of oil-field type indirect fired heaters used in the production of oil, gas, and their associated fluids. They are usually located at some point on the producing flowline between the wellhead and pipeline. Heater components covered by this specification include the pressurized coils, the shell, heater bath, firetube and the firing system.

Termination of a heater coil shall be at the first bevel when coils are furnished beveled for welding, or the face of the first fitting when fittings are furnished as the inlet or outlet connection to the coil. All fittings and valves between the inlet and outlet of the coil are to be considered within the coil limit.

Heaters outside the scope of this specification include steam and other vapor generators, reboilers, indirect heaters employing heat media other than water solutions, all types of direct fired heaters, shell-and-tube bundles or electrical heating elements, and coils operating at temperatures less than -20°F.

1.2 Referenced Documents. Industry Codes, Specifications and Recommended Practices are referenced in this specification and, as applicable and referenced, become requirements of API Spec 12K. Unless otherwise specified, the latest editions and revisions of this specification, and the referenced industry codes, specifications, recommended practices and other requirements current at the time of publication should be considered applicable at the time of manufacture of Indirect Heaters conforming to this specification. Referenced documents may be obtained from the following sources.

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API: American Petroleum Institute, Production Department, 211 N. Ervay, Suite 1700, Dallas, TX 75201

ASME: American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017

ASTM: American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103

AISC: American Institute of Steel Construction, 101 Park Ave., New York, NY 10017

NACE: National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77218

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SECTION 2
TERMINOLOGY

2.1 Introduction. Heating of oil and gas streams close to the wellhead is normally done for the purpose of preventing hydrate or wax formation. Wellstream heating may also be done to prevent liquids from condensing in the gathering line or to facilitate subsequent fluid separations.

An indirect type oil field 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. Refer to Figure 2.1, entitled Typical Indirect Heater Assembly, showing general arrangement of heater components, piping and instrumentation.

2.2 Burner System. Firing the heater requires a burner system designed for the specific fuel to be used and may be either natural or forced draft design. When multiple U-tubes are used, they should be designed to use separate burners, pilots and stacks. The burner system includes the firing accessories. Intake flame arrestors and other optional burner accessories as listed in Appendix A may also be included.

2.3 Choke. A device to restrict and control the flow rate of well fluids. It may have a positive fixed orifice with removable bean or an adjustable variable orifice. The choke may be located upstream of the coil, between passes in the coil bundle, or on the coil outlet. A submerged or long nose choke may be used with pressure reduction taking place within the water bath to minimize hydrate formation.

2.4 Coil Area. The coil area is the heat transfer area and is normally calculated using the outside surface area of the pipe.

2.5 Coils. The fluid to be heated is passed through one or more coils which may be typically arranged as a single pass coil, split pass coil, or spiral coil, illustrated in Fig. 2.2. The coil may also be referred to as a tube bundle. The single pass coil is normally a serpentine pattern with only one flow path. This coil may also be arranged to provide two or more parallel flow paths for reduced pressure drop, but it is still referred to as a single pass coil. The split pass coil may be designed for two pressure ratings, allowing for a choke to be located between the two coil sections. Split pass coils are used when it is necessary to use two heating stages to minimize hydrate formation within the coil. The spiral coil is generally used on smaller heaters and is normally a single pass coil. Multiple coils may be used if more than one well stream is processed in the same heater shell.

2.6 Fill Connection. This connection on the top of the shell shall be provided with a pressure-vacuum venting device. If a water saver is furnished, the fill and vent connection may be integral with it.

2.7 Firebox. A complete assembly consisting of the firetube, mounting flange, intake and stack adaptors.

2.8 Firetube. Natural gas is normally used to fire the heater through a submerged furnace chamber called the firetube. The firetube normally consists of one or more U-tubes fired at one end and exhausting through a vertical stack for each U-tube. In larger heaters the firetube may consist of a large diameter first pass firetube and multiple return tubes manifolded into a common stack. The firetube is that portion of the firebox in contact with the heater bath.

2.9 Fusion. The melting together of filler material and base material, or of base material only, which results in coalescence.

2.10 Heater Bath. The indirect heating medium is referred to as the heater bath and within the scope of this specification the heater bath is limited to water or water solutions. When freezing is possible, ethylene glycol may be added for anti-freeze protection. Other additives to the water bath may include corrosion inhibitors.

2.11 Heat Density. This term is commonly applied to the heat release through the cross section of the firetube, expressed as BTU/hour/square inch of cross sectional area.

2.12 Heat Flux. This term is commonly applied to the average transfer rate through the firetube, expressed as BTU/hour/square foot of exposed area.

2.13 Indication, linear. A closed surface area marking or denoting a discontinuity requiring evaluation, whose longest dimension is at least three times the width of the indication.

2.14 Indication, rounded. A closed surface area marking or denoting a discontinuity requiring evaluation, whose longest dimension is at least three times the width of the indication.

2.15 Intake Flame Arrestor. A device placed on the air intake of the firetube to prevent propagation of flame from inside the firetube to the outside atmosphere. It normally consists of a corrugated aluminum cell mounted in a metal housing which attaches to the firebox.

2.16 Removable. Total component is field replaceable without welder assistance.

2.17 Shell. The shell is normally a horizontal vessel which contains the coil, firetube and heater bath.

2.18 Slag Inclusion. Nonmetallic solid material entrapped in weld metal or between weld metal and base metal.

2.19 Spark Arrestor. A device placed on the exhaust of the stack to prevent sparks from being emitted to the outside atmosphere. It normally consists of a metallic wire screen attached across the top diameter of the stack.

2.20 Stack Downdraft Diverter. A device attached to the top of the stack designed to reduce the effects of wind currents on the burner system.

2.21 Stack Flame Arrestor. A device placed on the exhaust of the stack to prevent propagation of flame from inside the firetube to the outside atmosphere. It normally consists of a corrugated aluminum or stainless steel cell mounted in a metal housing which attaches to the top of the stack.

2.22 Stack Rain Shield. A 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.

2.23 Undercut. A groove melted into the basic material adjacent to the toe or root of a weld and left unfilled by weld material.

2.24 Water Saver. A chamber may be directly connected to the heater shell to permit the shell to be completely filled with water. The water in this chamber exists at a lower temperature than the heater bath which reduces evaporation losses. It may also be referred to as an economizer or expansion tank. Its capacity should be sufficient to contain the water expansion between ambient and operating temperatures.

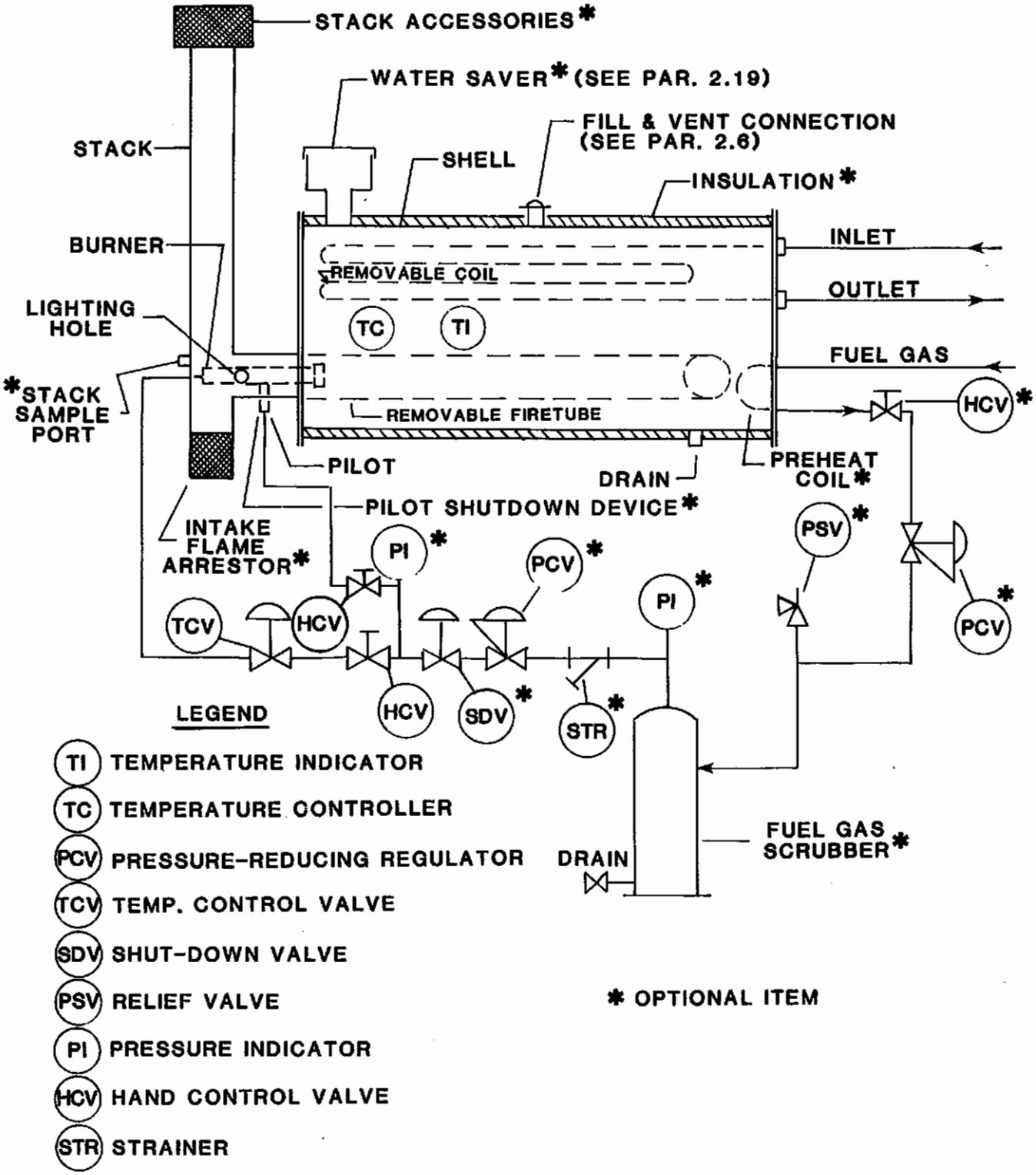


FIG. 2.1
TYPICAL INDIRECT HEATER ASSEMBLY

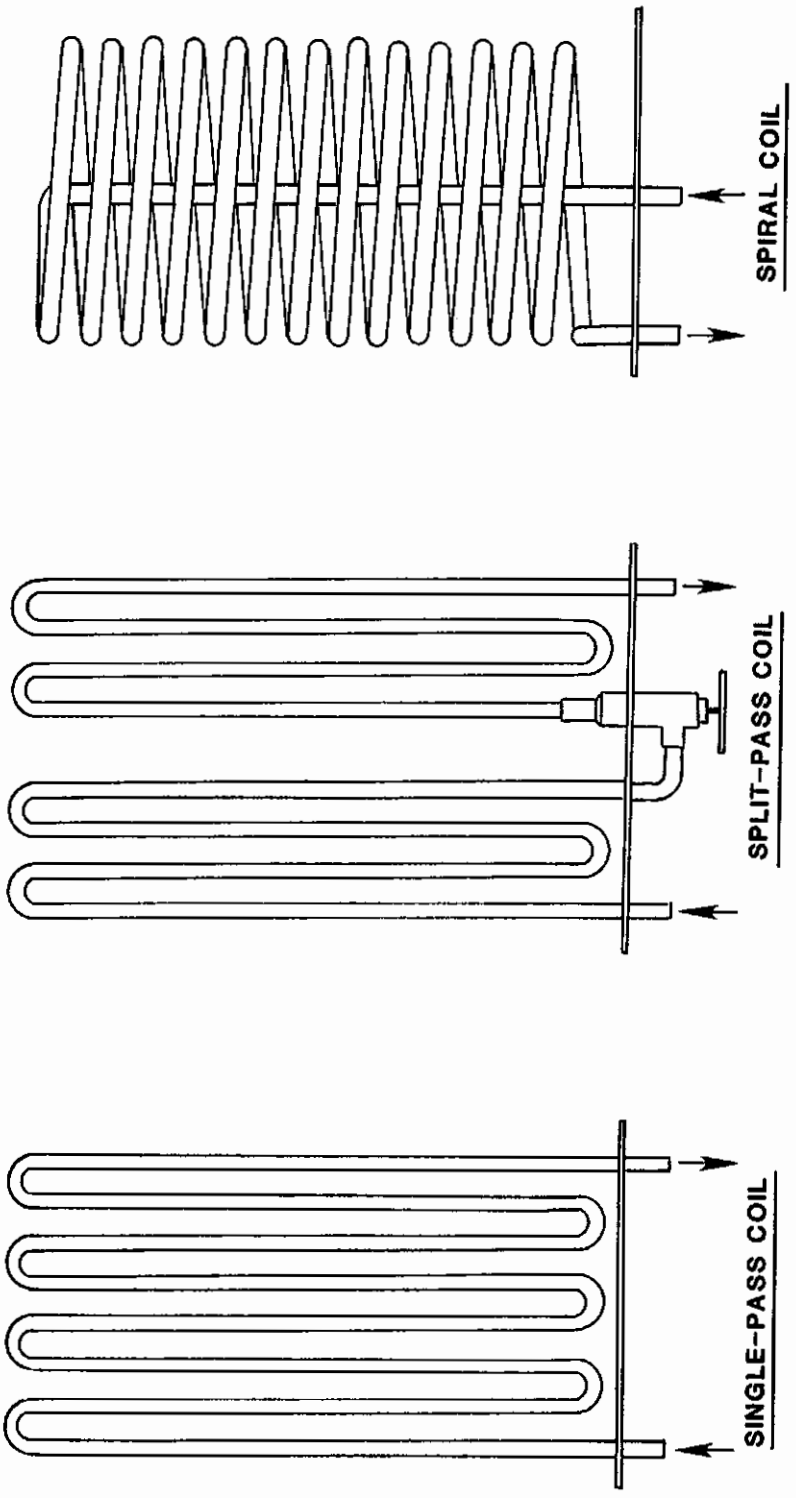


FIG. 2.2
INDIRECT HEATER COILS

SECTION 3
MATERIALS

3.0 General. Material to be used in the construction of indirect heaters is listed in this Section. When specified by the purchaser, pressure retaining components exposed to hydrogen sulfide shall meet the requirements of NACE Standard MR-01-75.

3.1 Coils. Materials for indirect heater coils, including the fuel gas preheat coil if used, shall be seamless pipe conforming to one of the following Specifications:

API Spec 5L Grade B, Seamless
ASTM A53 Grade B, Seamless
ASTM A106 Grade B or Grade C, Seamless

3.2 Flanges. Flanges and Clamp Type Connectors shall conform to ANSI/ASME B16.5 or API Spec 6A. Material shall conform to the following Specifications:

ANSI Flanges: ASTM A105
API Flanges and Clamp Type Connectors: API Spec 6A
Type 6B (2000-5000 psi), API Type 4 Material
Type 6BX (10,000 psi), API Type 2 Material
Type 6BX (15,000 psi), API Type 3 Material

3.3 Fittings. Fittings such as couplings, return bends, ells, tees, etc., shall conform to ASTM A234 Grade WPB or WPC, or to the manufacturer's standard as appropriate. The flow area of return bends, ells, and tees shall not be less than 90% of the flow area of the coil pipe.

3.4 Proprietary Fittings. Material for fittings such as chokes, valves and unions shall conform to the fitting manufacturer's standards. Where components are to be welded, the heater manufacturer shall obtain chemical and mechanical properties for the material sufficient to establish properly qualified welding procedures as required by Section 5.

3.5 Bolting. Bolting for flanges and other pressure retaining connections shall conform to ASTM A193, Grade B7 with nuts conforming to ASTM A194, Grade 2H. Where service conditions require bolting having lower tensile strength, flange working pressure shall be derated in accordance with ANSI/ASME B16.5 or API Spec 6A. Bolting for heater shells, stacks, etc., shall conform to Appendix A of API Spec 12B or ASTM A307.

3.6 Shells, Firetubes and Stacks. Material for shells, structural supports, firetubes, and stacks shall be selected from applicable ASTM or API specifications for weldable carbon steel.

Materials suitable for these applications include but are not limited to the following:

a) Plate: ASTM A36; ASTM A283 Grade C; ASTM A285 Grade C; ASTM A515; ASTM A516

b) Pipe: API 5L Grade B; ASTM A53 Grade B; ASTM A106 Grade B

Pipe may be either seamless or welded.

c) Sheet: ASTM A569; ASTM A570

d) Shapes: ASTM A36

SECTION 4
DESIGN

4.1 Coil Design. The minimum design requirements for indirect heater coils shall be in accordance with the following:

4.1.1 Coil Working Pressure. The minimum required thickness or maximum working pressure shall be determined in accordance with the following equations which are based on ANSI/ASME B31.3.

4.1.1.1 The following nomenclature is used in coil design calculations:

T = Nominal wall thickness of pipe as listed in ANSI B36.10, or from manufacturer's schedules for other than listed thickness.

t_m = Minimum wall thickness of pipe as listed in the pipe specification. For nominal thicknesses listed in ANSI B36.10, t_m = 0.875 (T)[1]. For thicknesses not listed in ANSI B36.10, pipe may be ordered and certified to minimum wall thickness. In all cases, t_m shall be equal to or greater than t_r.

t_r = Required wall thickness, as calculated for internal pressure, including mechanical, corrosion and erosion allowances.

C = The sum of mechanical allowances for thread depth plus corrosion allowance plus erosion allowance in inches. For threaded pipe, the thread allowance shown in Table 4.3 shall be used.

P = Maximum non-shock internal working pressure, psig.

S = Allowable stress, psi, as shown in Table 4.1.

Y = Coefficient of 0.4 when T is less than D/6. When T is equal to or greater than D/6,

$$Y = \frac{d}{d + D}$$

D = Outside diameter of pipe, inches.

d = Nominal inside diameter of pipe, inches. For calculating Y, d = D - 2T.

4.1.1.2 The required wall thickness (t_r) for maximum non-shock internal working pressure (P) shall be calculated by Equation 1.

$$t_r = \frac{PD}{2(S + PY)} + C \quad \ldots\ldots\ldots (1)$$

4.1.1.3 The maximum internal working pressure (P) may be calculated by Equation 2.[2]

$$P = \frac{2\,S(t_m - C)}{D - 2\,Y(t_m - C)} \quad \ldots\ldots\ldots (2)$$

4.1.2 The maximum design temperature rating shall be 250°F.

4.1.3 Working Pressure of Flanges, Valves, and Fittings

4.1.3.1 Pressure rating for flanges attached to coils shall be determined in accordance with ANSI/ASME B16.5 or API Spec 6A. Pressure ratings for clamp type connectors attached to coils and valves, chokes or fittings with flanged or clamp type connections shall be determined in accordance with API Spec 6A. The nominal bore of the butt-weld flanges and fittings shall be the same as the nominal inside diameter of the pipe to which they are welded, provided the bore does not exceed the maximum permitted by the applicable specification.

4.1.3.2 Pressure ratings for proprietary valves, fittings, unions and chokes attached to or supplied with coils shall be the rating supplied by the manufacturer of the component. Where the component is classified only by test pressure, the maximum working pressure shall not exceed 67 percent of the test pressure.

4.1.3.3 Pressure ratings for forged steel socket-welded and threaded couplings and fittings attached to or supplied with coils shall not exceed the applicable pressure class of the fitting as described in ANSI/AMSE B16.11.

[1]0.875 is a factor which allows for the pipe manufacturer's mill tolerance (12½% of nominal wall thickness).

[2]When computing the internal working pressure the value of P may be rounded up to the next higher unit of 10 psig.

4.1.4 The maximum internal working pressure for various commonly used nominal pipe sizes is tabulated in Table 4.2. Where a coil assembly contains components such as unions, chokes, flanges, etc., having a lower working pressure, the coil shall be rated at the lowest working pressure of any component.

4.1.5 Higher Coil Working Pressure. Heater coils for pressures greater than those determined in accordance with Equation 2 of Par. 4.1.1.3 shall not be furnished under this specification.

4.1.6 Coil Removal. The coil section shall be removable from the shell opposite from the firebox end to facilitate inspection and repair. The coil section shall be adequately supported for normal operation and shipment.

4.2 Shell Design. The minimum requirements for indirect heater shells shall be in accordance with the following (See Appendix E):

4.2.1 Shell Working Pressure. The shell shall be designed to operate at or near atmospheric pressure. In no case shall the operating pressure exceed 1 psig.

4.2.2 Shell Form. The shell may be either cylindrical with flat end closures that may either be welded or bolted to the shell, or rectangular with a structural framework to which flat plates are welded on the top, bottom, and sides.

4.2.3 Minimum Thickness. The minimum thickness of cylindrical and rectangular shells shall be $^3/_{16}$ inch in the case of plate or 7 gage (0.1793 inch nominal) in the case of sheet. These minimum thicknesses also apply to end closures for cylindrical shells. The minimum thickness shall be increased as necessary to meet design requirements.

4.2.4 Allowable Stresses. The allowable stresses used in all structural calculations shall be in accordance with the *American Institute of Steel Construction Manual.* Allowable shear stress is 40% of the specified minimum yield, allowable tensile and compression stresses are 60% of the specified minimum yield, and allowable bending stresses are 66% of the specified minimum yield strength. Specified minimum yield strength is to be taken from the appropriate material specification.

4.2.5 Support Design. Cylindrical shells are normally supported on two saddles or with angle legs. Rectangular shells are normally supported on a structural steel skid. Consideration shall be given to supports to ascertain structural integrity. The manufacturer shall consider loads imposed by testing, lifting, transportation, wind, earthquake, and normal operation.

4.2.6 Some suggested structural design procedures and guidelines are given in Appendix E.

TABLE 4.1
Maximum Allowable Coil Stress (S)

Material Specification	Grade	Maximum Allowable Stress (psi) -20°F to 250°F
API 5L	B	20,000
ASTM A53	B	20,000
ASTM A106	B	20,000
ASTM A106	C	23,300

4.3 Standard Firebox Rating. Firebox ratings for heaters conforming to this specification shall be as listed in Table 4.4 and specified on the purchase order, unless otherwise agreed upon between the purchaser and manufacturer. The firebox shall be removable from the shell opposite from the coil end to facilitate inspection and repair. The firebox shall be adequately supported for normal operation and shipment.

4.4 Firetube Heat Flux. The average heat flux (BTU/hr/sq. ft. of exposed area) should be within range of 10,000 to 12,000 for glycol/water bath. The heat flux may be increased for fresh water bath applications.

Example: 8⅝" OD firetube having 44.3 square feet of firetube surface and rated @ 500,000 BTU/hr.

$$\text{Average Heat Flux} = \frac{\text{Firetube Rating (BTU/hr)}}{\text{Sq. Ft. of Firetube Surface}} = \frac{500{,}000}{44.3} = 11{,}287 \text{ BTU/hr/sq. ft.}$$

4.5 Firetube Heat Density (heat released through the cross-sectional area of the firetube) is regulated by the burner mixer and burner nozzle. Heaters conforming to this specification will have a maximum heat density of 15,000 BTU/hr/sq. in. for natural draft burners.

Example: 8⅝" OD, 0.188" wall, firetube rated for 500,000 BTU/hr

Cross Sectional Area = 53.42 sq. in.
Assume 70% Efficiency

$$\text{Heat Density} = \frac{\text{Firetube Rating (BTU/hr)}}{\text{(Cross Sectional Area, in}^2\text{) (Efficiency)}}$$

$$\frac{500{,}000}{53.42 \times 0.70} = 13{,}371 \text{ BTU/hr/sq. in.}$$

TABLE 4.2
Maximum Coil Working Pressure (P)
C = 0
t_m = 0.875T

Nominal Pipe Size, in.	T Nominal Wall, in.	P Maximum Working Pressure*, psig Grade B S = 20,000	P Maximum Working Pressure*, psig Grade C S = 23,300
1 XS	0.179	5,270	—
2 Std	0.154	2,380	—
2 XS	0.218	3,440	—
2 XXS	0.436	7,340	8,560
2½ Std	0.203	2,600	—
2½ XS	0.276	3,610	—
2½ XXS	0.552	7,770	9,050
2½	0.750	10,720	12,490
2½	0.875	12,530	14,600
3 Std	0.216	2,260	—
3 XS	0.300	3,200	—
3 XXS	0.600	6,820	7,940
4 Std	0.237	1,920	—
4 XS	0.337	2,770	—
4 XXS	0.674	5,860	6,830
6 Std	0.280	1,530	—
6 XS	0.432	2,400	—
6 XXS	0.864	5,030	5,860
8 Std	0.322	1,350	—
8 XS	0.500	2,120	—
8 XXS	0.875	3,830	4,460

*Maximum working pressure (P) has been rounded up to the next higher unit of 10 psig.

TABLE 4.3
Thread Allowance For Pipe Wall Thickness Calculations

Nominal Pipe Size, in.	Thread Depth, in.*
½ - ¾	0.0571
1 - 2	0.0696
2½ - 8	0.1000

*From ANSI/ASME B2.1 — 1968

TABLE 4.4
Standard Firebox Rating
Based on Heat Input to the Water Bath

BTU/hr	BTU/hr
100,000	2,000,000
250,000	2,500,000
500,000	3,000,000
750,000	3,500,000
1,000,000	4,000,000
1,500,000	5,000,000

4.6 Stack Height. The height of the stack shall be no less than required to provide draft sufficient to overcome the pressure drop in firetube, stack, returns, and any stack or flame arrestors. The operating site elevation shall be considered in the draft calculations. The purchaser shall advise the manufacturer of the site elevation.

SECTION 5
FABRICATION

5.1 General. The manufacturer of the completed indirect heater shall be responsible for assuring that all material, design, fabrication procedures, examinations, inspections and tests required by this specification have been met. The purchaser may make any investigations necessary to satisfy himself of compliance by the manufacturer and may reject any item that does not comply with this specification.

5.2 Coil Fabrication. The following specific requirements shall apply to coils, including fuel gas preheat coils, and all pressure retaining parts within the scope of this specification attached to coils.

5.2.1 Welding Processes. The following welding processes as defined by Section IX of the ASME Boiler and Pressure Vessel (B&PV) Code are acceptable: Shielded Metal Arc (SMAW), Submerged Arc (SAW), Gas Metal Arc (GMAW) including flux core (FCAW), and Gas Tungsten Arc (GTAW).

5.2.2 Welding Procedure Specifications. Each manufacturer shall prepare or obtain detailed written Welding Procedure Specifications (WPS) outlining all essential, nonessential and supplementary essential variables as required by Section IX of the ASME B&PV Code. Materials used in welding that are not classified under the ASME P-Number base material groupings shall be qualified in accordance with the methods specified in Section IX. It is the responsibility of the heater manufacturer to justify any base material and/or filler metal groupings that are not classified in Section IX.

5.2.3 Welding Procedure Qualifications. Each manufacturer shall qualify the procedures he intends to use in production by producing weldments and having mechanical tests performed as required by Section IX of the ASME B&PV Code. Where controlled hardness is required by NACE MR-01-75, the maximum hardness of the base materials, the weld metal, and the heat affected zone may be determined on the Procedure Qualification. The results of all tests shall be recorded and certified on Procedure Qualification Records (PQR) by the manufacturer to support each WPS. Qualification by one manufacturer shall not qualify a WPS for any other manufacturer.

5.2.4 Welder Qualifications. Each manufacturer shall qualify all welders and welding operators employed in coil welding in accordance with the requirements of Section IX of the ASME B&PV Code. The results of all tests shall be recorded and certified on a Welder Performance Qualification (WPQ) by the manufacturer for each welder and welding operator. Qualification of individuals employed by one manufacturer shall not qualify them for employment by any other manufacturer without requalification.

5.2.5 Pipe Bends. Pipe may be bent by any hot or cold method which will result in arc surfaces free of cracks and substantially free of buckles.

5.2.5.1 The minimum center-line radius of bends shall be 1½ times the nominal pipe size.

5.2.5.2 Flattening of a bend as measured by the difference between the maximum and minimum diameter at any cross section shall not exceed 8% of the nominal outside diameter.

5.2.5.3 The minimum wall thickness of a bend after bending shall not be less than the minimum wall thickness (t_m) as defined in Par. 4.1.1.1.

5.2.5.4 After cold bending, stress relieving is required when the extreme fiber elongation of the outside periphery of the bend exceeds 15%. Stress relieving, when required, will be done in accordance with the provisions for Heat Treatment as described in ANSI/ASME B31.3.

5.2.6 Nondestructive Examination. All components and welds shall as a minimum be visually examined during and after fabrication. Visual examination is the observation of the portion of components, joints and other piping elements that are exposed to view before, during, or after manufacture, fabrication, assembly, or testing to assure compliance with this specification and the manufacturer's drawings.

5.2.6.1 In addition to the requirements of Par. 5.2.6, coils fabricated from extra strong (XS) pipe through double-extra strong (XXS) pipe inclusive shall have 10% of the circumferential butt welds radiographed. The weld selection is to be random and each weld selected is to be radiographically examined over its entire length. The method of radiography shall be in accordance with the latest edition of the

ASME B&PV Code, Section V, Article 2. The limits of imperfections are given in Table 5.1.

5.2.6.1.1 Any defective weld shall require two additional welds of the same kind, by the same welder, be given the same type of examination. If the two items are found satisfactory, the defective item shall be repaired or replaced and reexamined and all the items represented by the additional examination shall be accepted. However, should the additional weld examination reveal a defect, all the welds shall either be repaired or replaced and reexamined as required or fully examined and repaired or replaced as necessary, and reexamined as necessary to meet the requirements of this section.

5.2.6.2 In addition to the requirements of Par. 5.2.6, coils fabricated from pipe having a wall thickness greater than double-extra strong (XXS) shall have 100% of the circumferential butt welds radiographically examined. Each circumferential butt weld is to be radiographically examined over its entire length. The method of radiography shall be in accordance with the latest edition of the ASME B&PV Code, Section V, Article 2. The limits of imperfections are given in Table 5.1.

5.2.6.2.1 Defective welds shall be repaired or replaced and the new work shall be reexamined by the same method, to the same extent, and by the same acceptance criteria as required for the original work.

5.2.7 **Telltale Holes.** When specified by the purchaser, return bends in heater coils shall be drilled with telltale holes to provide some positive indication when the thickness has been reduced by corrosion or erosion. The depth shall be 50% plus or minus 0.015" of the minimum wall thickness (t_m) of the pipe as defined in Par. 4.1.1.1. The drill shall be a 60° tapered drill with a diameter of from $\frac{1}{16}$" to $\frac{3}{16}$". The depth shall be measured at the tip of the drill. The hole shall be drilled normal to the surface where deterioration is expected. When safety drilling is specified on the purchase order, 180° return bends shall be drilled as indicated in Figure 5.1 or in other locations as specified by the purchaser.

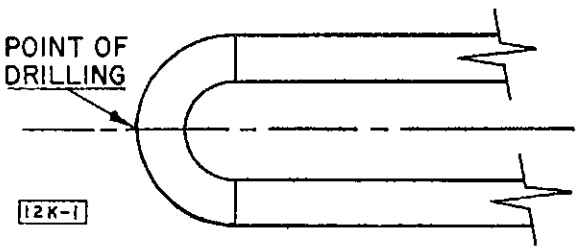


FIG. 5.1
SAFETY DRILLING OF RETURN BENDS

5.2.8 **Postweld Heat Treatment.** When the nominal wall thickness of a welded joint is equal to or greater than ¾", the welded joints shall be stress relieved in accordance with the provisions for Heat Treatment as described in ANSI/ASME B31.3.

5.2.9 **Hydrostatic Test.** Heater coils shall be hydrostatically tested to one and one-half times the maximum internal working pressure as calculated by Formula 2 of Par. 4.1.1.3 with no allowance for corrosion or erosion, or the limiting maximum working pressure as determined by Par. 4.1.4. Where test pressures higher than specified above are required, the maximum coil working pressure shall be reduced if required to assure that the test pressure will not cause any material to be stressed above 90% of the minimum specified yield strength. Following the application of the hydrostatic test pressure, a visual inspection shall be made of all welded joints. This inspection shall be made at a pressure not less than two-thirds of the test pressure. Any leaks revealed during this visual inspection will be repaired by welding after the water is drained. The coil shall be retested. It is recommended that the liquid temperature during hydrostatic test be not less than 60°F.

5.3 Shell, Firetube, Stack and Accessories shall be fabricated and assembled using good workmanship to assure compliance with the manufacturers drawings and this specification. The completed heater shell shall

be leak tested after the coil(s) and firetube(s) have been installed, examined for excessive distortion of flat sections, and any deficiencies repaired.

5.4 Painting. Before shipment, heaters shall be mechanically cleaned of rust, grease, loose scale, and weld spatter, and the outside of the shell coated with one application of a good grade of commercial metal primer. Finish coats or special painting systems shall be applied if so agreed upon between the purchaser and the manufacturer.

TABLE 5.1
LIMITATIONS ON IMPERFECTIONS IN CIRCUMFERENTIAL BUTT WELDS
VISUAL AND RADIOGRAPHIC EXAMINATION

Paragraph	5.2.6 Visual	5.2.6.1 Random	5.2.6.2 100%
Cracks	none permitted	none permitted	none permitted
Lack of fusion	none permitted (1)	none permitted	none permitted
Incomplete penetration	note (1) (2)	note (2)	none permitted
Internal porosity	N/A	note (4)	note (3)
Slag inclusion or elongated indications	N/A	note (6)	note (5)
Undercutting	lesser of 1/32 in. or T/4	lesser of 1/32 in. or T/4	lesser of 1/32 in. or T/4
Surface porosity and exposed slag inclusion	none permitted		
Concave root surface (suck-up)	note (1) (7)		
Reinforcement or protrusion	note (8)		

(1) Applicable only where the interior surface at the weld is accessible for direct visual examination.
(2) The depth of incomplete penetration shall not exceed the lesser of 1/32 in. or 0.2T. The total length of such imperfections shall not exceed 1.5 in. in any 6 in. of weld length.
(3) Criteria as given in the latest edition of the ASME Code, Section VIII, Division 1, Appendix 4.
(4) Porosity shall not exceed the following: for T not over 1/4 in., same as note (2); for T greater than 1/4 in., 1.5 times the limits of note (2)
(5) The developed length of any single slag inclusion or elongated indication shall not exceed T/3. The total cumulative developed length of slag inclusions and/or elongated indications shall not exceed T in any 12T length of weld. The width of a slag inclusion shall not exceed the lesser of 3/32 in. or T/3.
(6) The developed length of any single slag inclusion or elongated indication shall not exceed 2T. The total cumulative developed length of slag inclusions and/or elongated indications shall not exceed 4T in any 6 in. length of weld. The width of a slag inclusion shall not exceed the lesser of 1/8 in. or T/2.
(7) Concavity of the root surface shall not reduce the total thickness of the joint, including reinforcement, to less than the T.
(8) The height is measured from the surfaces of the adjacent components. The lesser of two measurements, in any plane through the weld, shall not exceed the applicable value below. Weld metal shall merge smoothly into the component surfaces.

T, inches	Weld Reinforcement or Internal Weld Protrusion, inches
1/4 and under	0.0625
over 1/4 to 1/2	0.125
over 1/2 to 1	0.15625
over 1	0.1875

SECTION 6
MARKING

6.1 Nameplate. Indirect heaters furnished to this specification shall be identified by two corrosion resistant nameplates, one on the shell and one on the coil.

6.2 Shell Nameplate. One nameplate shall be securely attached to the shell bearing the information shown in Figure 6.1 which is:

1. Spec 12K.
2. Manufacturer's name.
3. Manufacturer's serial number.
4. Year built.
5. Shell weight empty, lbs (excluding coil weight).
6. Firebox rating, BTU/hr.
7. Firetube area, sq. ft.
8. Shell size, OD × length.
9. Additional markings desired by the manufacturer or requested by the purchaser are not prohibited.

6.3 Coil Nameplate. One nameplate shall be securely attached to the coil cover plate bearing the information shown in Figure 6.2 which is:

1. Spec 12K.
2. Manufacturer's name.
3. Manufacturer's serial number.
4. Year built.
5. Coil pipe size and schedule for each section.*
6. Coil area, sq. ft.*
7. Coil weight empty, lbs.
8. Coil maximum working pressure, psig.*
9. Additional markings desired by the manufacturer or requested by the purchaser are not prohibited.

*Where split-pass coils are provided, the number, size, area, and maximum working pressure shall be indicated for each coil section. Coil maximum working pressure shall be determined using the lowest pressure rating of any component in the coil as defined in Par. 4.1.4.

6.4 Coil Connection. It is recommended that the coil connections be permanently marked as inlet and outlet, particularly in the case of split-pass coils.

*Users of this specification should note that there is no longer a requirement for marking a product with the API monogram. The American Petroleum Institute continues to license use of the monogram on products covered by this specification but it is administered by the staff of the Institute separately from the specification. The policy describing licensing and use of the monogram is contained in Appendix G, herein. No other use of the monogram is permitted.

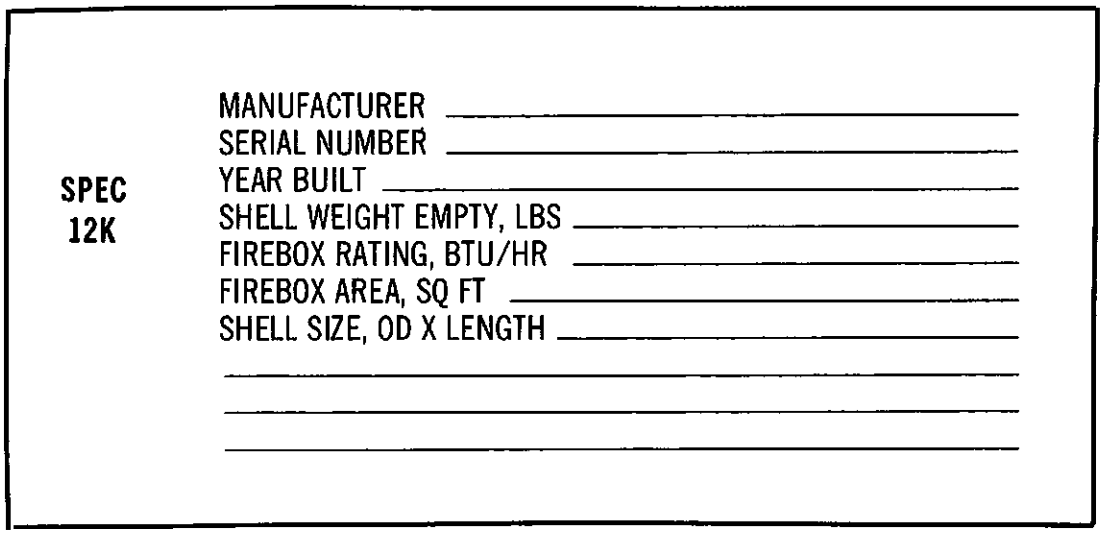


FIG. 6.1
SUGGESTED INDIRECT HEATER SHELL NAMEPLATE FORMAT
(See Par. 6.2)

MANUFACTURER _____

SERIAL NUMBER _____

YEAR BUILT _____

COIL WEIGHT EMPTY, LBS _____

SPEC 12K COIL	SIZE AND SCHEDULE	COIL AREA SQ. FT.	MAXIMUM WORKING PRESS., PSIG

12K-6.2

FIG. 6.2
SUGGESTED INDIRECT HEATER COIL NAMEPLATE FORMAT
(See Par. 6.3)

SECTION 7
INSPECTION AND REJECTION

7.1 Inspection by the Purchaser. Where inspection is required by the purchaser, the extent of such inspection should be stated on the purchase order. Where the inspector representing the purchaser desires to inspect heaters purchased or witness any specification tests or evaluate the results of any nondestructive examinations, the manufacturer shall give reasonable notice of the time at which such inspections should be made.

7.2 Inspection. While work on the contract of the purchaser is being performed, the inspector representing the purchaser shall have free entry at all times to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford, without charge, all reasonable facilities to satisfy the inspector that the material is being manufactured in accordance with this specification. All inspections shall be made at the place of manufacture prior to shipment unless otherwise specified on the purchase order, and shall be so conducted as not to interfere unnecessarily with the manufacturer's operations.

7.3 Rejection. Material which shows injurious defects on initial inspection or subsequent to acceptance at manufacturer's works, or which proves defective when properly applied in service, may be rejected, and the manufacturer so notified. If tests that require the destruction of material are made, the purchaser shall pay for material and tests complying with all of the provisions of this specification, but shall not pay for material or tests which fail to meet the specifications.

7.4 Compliance. The manufacturer is responsible for complying with all of the provisions of this specification. The purchaser may make any investigation necessary to be assured of compliance by the manufacturer and may reject any material that does not comply with this specification.

APPENDIX A
INDIRECT HEATER DESIGN INFORMATION

FIELD _____ Geographical Location _____

SERVICE _____

Design Conditions

GAS RATE SCFH _____ SP. GRAVITY _____ @ 60°F

CONDENSATE/OIL RATE BPH _____ API GRAVITY _____

WATER RATE BPH _____ SP. GRAVITY _____ @ 60°F

WELL SHUT-IN PRESSURE _____ PSIG INLET PRESSURE _____ PSIG

OUTLET PRESSURE _____ PSIG SITE ELEVATION _____ FEET

IF SOUR GAS: H_2S _____ Mol %; CO_2 _____ Mol %

INLET FLOWING TEMPERATURE _____ °F MINIMUM

OUTLET FLOWING TEMPERATURE _____ °F _____ PSIG

FUEL GAS AVAILABLE ____ yes ____ no PRESSURE _____ PSIG

FUEL GAS SOURCE _____ HIGH HEATING VALUE (HHV) _____ BTU/SCF

OTHER FUEL: Specify _____

Note: Flow rates should be maximum instantaneous rates based on expected flow surges.

Design Requirements

COIL BUNDLE: Single _____ Split _____

COIL WORKING PRESSURE: Preheat _____ PSIG, Expansion _____ PSIG

COIL CORROSION ALLOWANCE: ____ yes ____ no INCHES _____

CHOKE REQUIRED: Mfg. Standard: _____ Other: _____

TYPE CHOKE: _____ Adjustable, _____ Diaphragm

PAINT REQUIRED: Mfg. Standard _____ Special: Specify _____

REGULATORY REQUIREMENTS/LIMITATIONS such as: Stack Height, Emissions, API RP 14C:

Specify _____

APPENDIX A
Continued

Optional Requirements

COIL CONNECTIONS: Flanged _____ THREADED _____ OTHER _____

COMPANION FLANGE BOLTED ON (CFBO): _____ yes _____ no, BORE _____ inches

SKID MOUNTED* _____ LIFTING LUGS _____

INSULATION: Specify _____

SHELL LIFTING LUGS: _____ yes _____ no

INTAKE FLAME ARRESTOR _____ STACK FLAME ARRESTOR _____

STACK SPARK ARRESTOR _____ STACK DOWN DRAFT DIVERTER _____

*If so, state how unit will be loaded, unloaded, and supported in normal operation.

STACK RAIN SHIELD _____ STACK GAS SAMPLE CONNECTION _____

FUEL GAS SCRUBBER _____ ELECTRIC SPARK IGNITOR _____

PILOT FLAME FAILURE SHUTDOWN _____

TELLTALE HOLES: _____ yes _____ no

FUEL GAS REGULATOR _____

OTHER ACCESSORIES _____

WATER BATH ADDITIVE _____

CONTROLS: Mfg. Standard _____ Other: _____

NACE MR-01-75 Required _____

Manufacturers Heater Data

FIRETUBE CAPACITY _____ BTU/HR

FIRETUBE SIZE _____ inches OD SURFACE AREA _____ ft^2

COIL NO.	Size & Schedule	Material	Coil Area Sq. Ft.	Max. W.P. psig	Limited by
1					
2					
3					

WATER BATH CAPACITY: _____ Gallons, EMPTY SHIPPING WEIGHT _____ lbs

APPENDIX B
GAS FLOW RATE

B.1 Gas throughput should be analyzed based on factors such as pressure drop available, presence of sands or other solids, and presence of liquids. Single phase gas flow is normally limited by the amount of available pressure drop while two phase flow with liquids and solids present may be limited by an erosional velocity.

B.2 Flow rates for a single phase gas stream, free of entrained solids, may be approximated from the values given in Table B.1 for a wide range of nominal pipe sizes and flowing pressures, based on actual flowing velocities of 80 ft./sec. and 120°F. These flow rates should be used with caution since corrosion and erosion conditions are not always recognized to be present. These rates may produce high pressure drops when liquids are present and excessive erosion when solids are present.

TABLE B.1
GAS FLOW RATE

1	2	3	4	5	6	7	8	9	10	11
	Operating Pressure of Coil, psig									
	6000	5000	4000	3500	3000	2000	1500	1000	750	500
Nominal Pipe Size, in.	Gas throughput to provide 80 ft/sec coil velocity @ 120°F, MMSCFD									
1 XS	—	12	11	9	8	6	4	2	1.5	1
2 Std	—	—	—	—	—	25	18	11	8	5.7
2 XS	—	—	—	—	33	22	16	10	7	5
2 XXS	30	28	25	23	20	13	10	6.5	4	2
2½ Std	—	—	—	—	—	36	26	17	12	8
2½ XS	—	—	—	53	47	32	23	15	11	7
2½ XXS	41	38	34	31	28	19	13	9	6	4
3 Std	—	—	—	—	—	53	40	25	18	11
3 XS	—	—	—	—	74	47	36	22	16	10
3 XXS	70	65	58	54	46	31	23	14	10	7
4 Std	—	—	—	—	—	95	70	43	30	20
4 XS	—	—	—	—	130	85	60	38	27	18
4 XXS	—	123	110	101	90	61	44	28	20	13
6 Std	—	—	—	—	—	—	158	100	73	47
6 XS	—	—	—	—	—	197	143	90	66	42
6 XXS	—	291	257	236	210	142	103	65	47	31
8 Std	—	—	—	—	—	—	274	173	126	82
8 XS	—	—	—	—	—	345	250	158	115	74
8 XXS	—	—	—	466	415	281	203	128	93	60

The velocity of a single phase gas stream may be determined by the following equation:

$$V_g = \frac{60\, Q_g T Z}{d_i^2\, P}$$

Where:

V_g = gas velocity, ft/sec
Q_g = gas flow rate, MMSCFD (14.7 psia and 60°F)
T = operating temperature, °R
Z = gas compressibility
d_i = pipe inside diameter, in.
P = operating pressure, psia

APPENDIX C
COMBUSTION EFFICIENCY

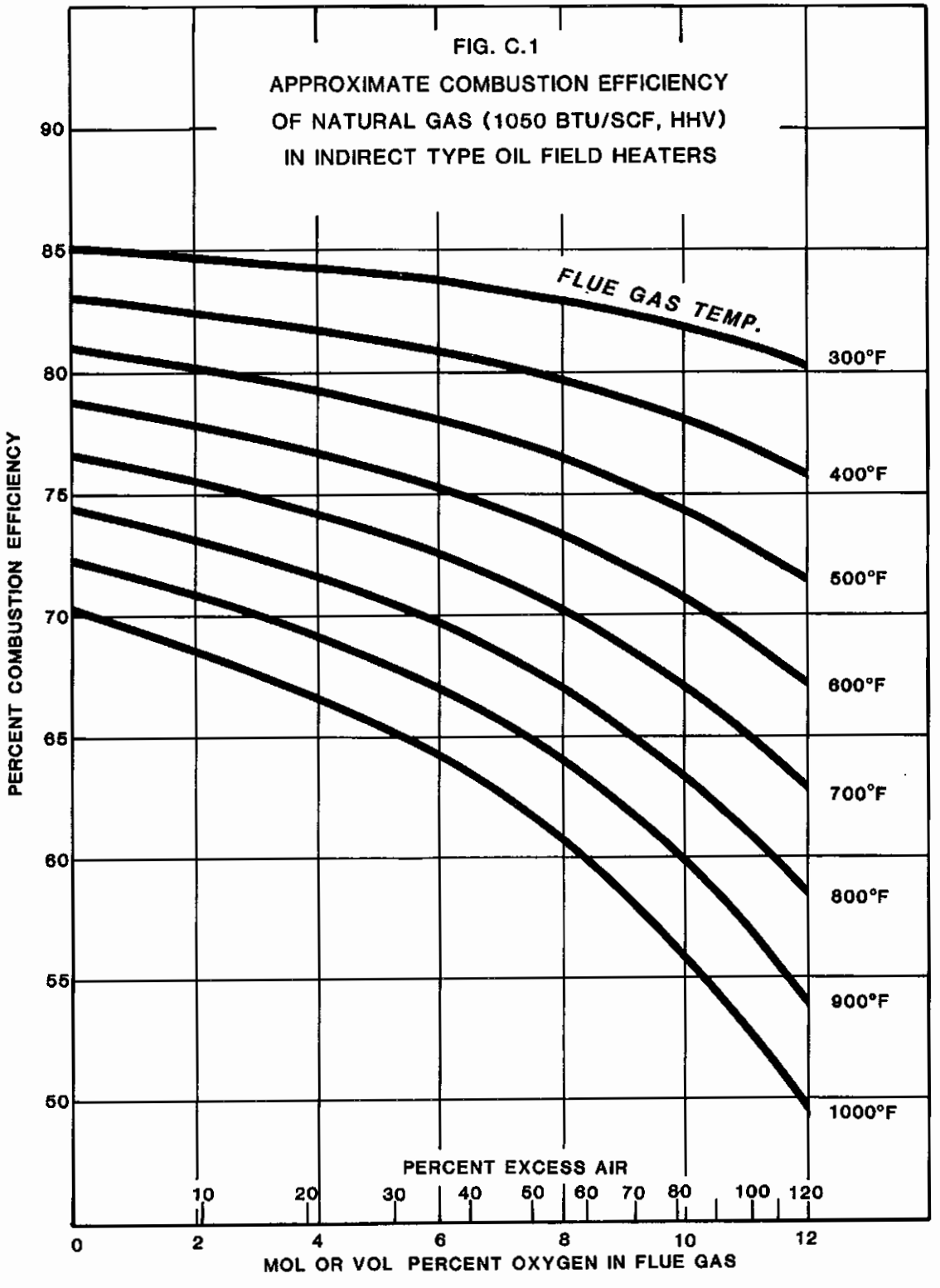
C.1 Proper operation of any heater depends on efficient burner performance and adequate firetube design and is commonly expressed as combustion efficiency. Good burner performance depends on proper adjustment of fuel gas pressure, primary and secondary air and the gas orifice size. Good firetube design depends on heat flux, heat density, bath temperature and firing accessories.

C.2 Heater performance can be easily determined by an analysis and temperature of the flue gas taken from the base of the stack. Fig. C.1 is a convenient chart for estimating combustion efficiency in a heater, based on residual oxygen (O_2) content and exit temperature of the stack gas, employing a methane-rich fuel gas with a high (or gross) heating valve (HHV) of approximately 1050 BTU/SCF. This chart assumes the residual level of combustibles in the flue gas is below 0.1% which is the maximum level for safe and efficient operation. While this chart is limited to natural gas, there is no intent to preclude other fuels.

C.3 **Minimum Stack-Gas Temperature.** If a sulfur-free fuel gas is used with uninsulated stacks, a minimum exit flue gas temperature of 250°F should be maintained to avoid internal stack corrosion. If sulfur is present in the fuel gas, the minimum exit flue gas temperature should be maintained in the range of 300 to 400°F for sulfur contents ranging from approximately 0.05 to 1.0 percent by volume in the fuel gas. This 300-400°F temperature range can be reduced by roughly 50°F for insulated stacks.

FIG. C.1

APPROXIMATE COMBUSTION EFFICIENCY OF NATURAL GAS (1050 BTU/SCF, HHV) IN INDIRECT TYPE OIL FIELD HEATERS



APPENDIX D
HEAT TRANSFER

D.1 It is often necessary to perform heat transfer calculations in connection with indirect type oil-field heaters. This Appendix is intended to give some guidelines for determining the BTU/hr rating and required area of coils.

D.2 Basic Heat Transfer Equation. The basic heat transfer equation that may be used in indirect heater sizing is as follows:

$$Q = U_o(A)(T_m) \text{ or } A = \frac{Q}{U_o(T_m)}$$

Where: Q = Total heat transfer (heat required), BTU/hr

U_o = Overall heat transfer coefficient, BTU/hr-sq ft-°F

A = Total heat transfer area (coil area), sq ft

T_m = Log mean temperature difference, °F

D.3 Heat Required. For high pressure gas streams, the heat required may be determined from the following equation:

$$Q = 109.8(G)(h_2\text{-}h_1) \text{ or } Q = M(c)(T_2\text{-}T_1)$$

Where: Q = Heat required (total heat transfer), BTU/hr

G = Gas Flow rate, MMSCFD

$h_2\text{-}h_1$ = Enthalpy difference at initial temperature and final temperature, BTU/lb-mol

M = Gas mass flow rate, lb/hr

c = Specific heat at average or mean temperature, BTU/lb-°F

$T_2\text{-}T_1$ = Temperature difference of inlet and outlet flowing temperature °F

For oil and/or water streams the heat required may be approximated from the following equations:

For oil/water emulsions:

$$Q = W[6.44 + 8.14(X)](T_2\text{-}T_1)$$

The above equation is based on 35° API oil with a specific heat of 0.52 BTU/lb-°F and 1.0 specific gravity water with a specific heat of 1.0 BTU/lb-°F.

For oil or water:

$$Q = F(\rho)(c)(T_2\text{-}T_1)$$

Where: Q = Heat required (total heat transfer), BTU/hr

W = Emulsion flow rate, Bbl/day

X = Percent by volume of water in emulsion, expressed as a fraction

$T_2\text{-}T_1$ = Temperature difference between initial temperature and final temperature, °F

F = Liquid flow rate, gal/hr

ρ = Liquid specific weight, lbs/gal

c = Specific heat of liquid at mean or average temperature, BTU/lb-°F

D.4 Overall Heat Transfer Coefficient. The overall heat transfer coefficient is normally established by the manufacturer, based on laboratory and field experience, or it may be determined using such publications as "Standard of Tubular Exchanger Manufacturer's Association" which involve a detailed calculation. This calculation could take into account several factors such as film coefficient of fluid outside tubes, film coefficient of fluid inside tubes, fouling resistance, tube wall resistance, thermal conductivity of tube wall, etc. Addition of glycol to the water bath will lower the overall heat transfer coefficient. A detailed explanation of the calculations is beyond the scope of this specification.

D.5 Log Mean Temperature Difference. The log mean temperature difference between the fluid in the shell side and the fluid in the coil side can be determined from the following equation:

$$T_m = \frac{GTD - LTD}{1n\,(GTD/LTD)}$$

Where: T_m = Log mean temperature difference, °F

GTD = Greater temperature difference = (water bath temperature) - (inlet fluid temperature).

LTD = Least temperature difference = (water bath temperature) - (outlet fluid temperature).

1n = Natural logarithim

The water bath and fluid temperatures must be known or assumed for the calculations.

D.6 Coil Area. The coil area required for an indirect type oil-field heater can be calculated using the basic heat transfer equation listed in Par D.2. A heater should be selected which has a firebox rating and a coil area at least equal to or greater than that calculated. It must be noted that the heat required as determined from equations in Par D.3 is only the heat input required to the flow stream. No provision is made for heat loss from the vessel which is usually small.

APPENDIX E
STRUCTURAL DESIGN GUIDELINES

E.1 Saddles for cylindrical shells should be designed in such a manner that excessive stresses are not induced in the shell. Some useful guidelines and references may be found in Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code. Caution is advised when angle legs are used to support the shell, because they may overstress the shell. The saddles or legs shall be adequate to support the heater assembly under normal operating conditions.

E.2 Rectangular heaters should be supported by a structural steel skid. The skid should be designed to support 150% of the dry weight of the entire heater assembly with the skid supported at its ends. It should also support the heater assembly under normal operating conditions. The user should inform the manufacturer how the skid will be transported, unloaded, and supported under normal operating conditions. Deflection should be limited to L/400, where L is the length of the skid. The same considerations apply to skid mounted cylindrical heaters.

E.3 Rectangular shells should be supported by a rigid frame that will limit deflection in the top, bottom and sides to L/500 with 1½ psi internal pressure or full of water, whichever is greater. The dimension L is the length of the longest side or the distance between rigid structural frame members, whichever is less. Cylindrical shells should be designed for 1½ psi of internal pressure or full of water, whichever is greater.

E.4 The deflection of flat end closures should be limited to the diameter divided by 500 with 1½ psi internal pressure or full of water, whichever is greater.

E.5 Heaters that are furnished with insulation shall also be furnished with two lift lugs unless lifting lugs are furnished on skid-mounted units. Each lug should be designed for 75% of the empty weight of the entire assembly. A maximum lift angle of 30° with the vertical shall be assumed. The effect of the lugs on the shell should be investigated and reinforcement should be provided if required. The lugs should be designed for double shear tear-out and tension on the net section at the pin hole. The lifting lugs on skid-mounted heaters, if furnished, should be designed as above, except that each lug should be designed for 50% of the empty weight of the entire assembly. Many manufacturers attach lift lugs to various components on the heater assembly that are intended for lifting that component only; however, they may not be suitable for lifting the total assembly.

E.6 Wind forces on the stack can cause a moment on the cover plate which should be investigated.

E.7 No more than two saddles should be used on a cylindrical shell.

E.8 Piping and coil loads may need to be evaluated.

E.9 The firetube becomes bouyant when immersed in the heater bath and must be restrained from floating.

APPENDIX F
CORROSION GUIDELINES

F.1 Considerations. The following guidelines are recommended for determining corrosion considerations for an applicable heater.

F.1.1 Well streams that contain water as a liquid and any or all of the following gases are considered to be corrosive and should be considered under these specifications (reference API RP 14E, NACE MR-01-75):

a) Oxygen — O_2
b) Carbon Dioxide — CO_2
c) Hydrogen Sulfide — H_2S

F.1.2 The following guidelines are not mandatory but may be used to judge the extent of the corrosive environment, with respect to carbon steels:

a) Oxygen

1) Less than 0.005 ppm in natural brine — non-corrosive
2) From 0.005 ppm to 0.025 ppm requires consideration
3) Greater than 0.025 ppm in natural brine — corrosive

b) Carbon Dioxide

1) Less than 600 ppm in natural brine — non-corrosive
2) From 600 ppm to 1200 ppm requires consideration
3) Greater than 1200 ppm in natural brine — corrosive

c) Hydrogen Sulfide

1) No lower limit of hydrogen sulfide has been identified as being non-corrosive. With hydrogen sulfide present, the environment should be considered corrosive.

2) NACE Standard MR-01-75 (latest edition) should be used for all cases of hydrogen sulfide content for judgment of the possibility of sulfide stress cracking (SSC).

F.1.3 Some of the other factors that influence corrosion include: temperature, pressure, fluid velocities, metal stress and heat treatment, surface condition, and time.

F.2 Corrosive Environment Practices.

F.2.1 If the environment is judged as being subject to sulfide stress cracking (SSC) from the criteria of NACE MR-01-75 as stated in Par. F.1.2 above, then all provisions of this NACE Standard as apply to the pressure retaining coils and accessories shall be followed.

F.2.2 If the environment is judged as corrosive from any of the other criteria stated in Par. F.1.2 above, the intent of this specification will be met provided any one or combination of the following practices are used:

a) An allowance for corrosion to the parts may be made according to ASME Section VIII, Division 1, Appendix E, Suggested Good Practices Regarding Corrosion Allowance.

b) Corrosion effects may be disregarded provided they can be shown to be negligible or entirely absent on a historical basis. However, the system should be monitored periodically for possible new corrosion.

c) Corrosion effects may be reasonably controlled with chemical inhibitor treatments.

F.2.3 Post weld heat treatment should be considered for coils handling hydrocarbons containing hydrogen sulfide and/or carbon dioxide. Post weld heat treatment may be required by other sections of this specification regardless of corrosion considerations.

APPENDIX G
USE OF API MONOGRAM

The API monogram is a registered trademark of the American Petroleum Institute.

Manufacturers desiring to warrant that articles manufactured or sold by them conform with this specification shall obtain the license to use the Official API Monogram.

The original resolutions adopted by the Board of Directors of the American Petroleum Institute on Oct. 20, 1924, embodied the purpose and conditions under which such official monogram may be used.

The following restatement of the resolution was adopted by the Board of Directors on Nov. 14, 1977.

WHEREAS, The Board of Directors of the American Petroleum Institute has caused a review of the Institute's program for licensing the use of the API monogram and

WHEREAS, It now appears desirable to restate and clarify such licensing policy and to confirm and make explicitly clear that it is the licensees, not API, who make the representation and warranty that the equipment or material on which they have affixed the API monogram meets the applicable standards and specifications prescribed by the Institute;

NOW, THEREFORE, BE IT RESOLVED, That the purpose of the voluntary Standardization Program and the Monogram Program of the American Petroleum Institute is to establish a procedure by which purchasers of petroleum equipment and material may identify such equipment and materials as are represented and warranted by the manufacturers thereof to conform to applicable standards and specifications of the American Petroleum Institute; and be it further

RESOLVED, That the previous action under which the following monogram was adopted as the official monogram of the American Petroleum Institute is reaffirmed;

BE IT FURTHER RESOLVED, That the American Petroleum Institute's monogram and standardization programs have been beneficial to the general public as well as the petroleum industry and should be continued and the Secretary is hereby authorized to license the use of the monogram to anyone desiring to do so under such terms and conditions as may be authorized by the Board of Directors of the American Petroleum Institute, provided that the licensee shall agree that the use of the monogram by such licensee shall constitute the licensee's representation and warranty that equipment and materials bearing such monogram complies with the applicable standards and specifications of the American Petroleum Institute; and that licensee shall affix the monogram in the following manner;

BE IT FURTHER RESOLVED, That the words "Official Publication" shall be incorporated with said monogram on all such standards and specifications that may hereafter be adopted and published by the American Petroleum Institute, as follows:

OFFICIAL PUBLICATION

REG. U.S. PATENT OFFICE

G.1 API Monogram. The API monogram — — is a registered trademark/servicemark of the American Petroleum Institute. Authorization to use the monogram is granted by the Institute to qualified licensees for use as a warranty that they have obtained a valid license to use the monogram and that each individual item which bears the monogram conformed, in every detail, with the API Specification applicable at the time of manufacture. However, the American Petroleum Institute does not represent, warrant or guarantee that products bearing the API monogram do in fact conform to the applicable API standard or specification. Such authorization does not include use of the monogram on letterheads or in advertising without the express statement of fact describing the scope of licensee's authorization and further does not include use of the monogram, the name AMERICAN PETROLEUM INSTITUTE or the description "API" in any advertising or otherwise to indicate API approval or endorsement of products.

The formulation and publication of API Specifications and the API monogram program is not intended in any way to inhibit the purchase of products from companies not licensed to use the API monogram.

G.2 Application for Authority to Use Monogram. Manufacturers desiring to warrant that products manufactured by them comply with the requirements of a given API specification may apply for a license to use the monogram with forms provided in an appendix to each specification.

The "Agreement" form must be submitted in duplicate for each specification under which monogram rights are desired. One "Statement of Manufacturer's Qualifications" is required for each facility.

A manufacturer desiring to apply the monogram at more than one facility (a facility is any manufacturing location) must submit a separate application for each facility.

Applicants shall have an approved functioning quality program in conformance with API Spec Q1 prior to being issued a license to use the API monogram.

G.3 Authorization to Use the Monogram. A decision to award or withhold monogram rights will be made by the staff of the Institute. A survey of the applicant's facilities will be made by an approved Institute surveyor prior to a decision to approve or withhold

the license. The basis of the survey shall be the appropriate product Specification and all applicable portions of API Spec Q1.

For a manufacturer having more than one facility (plant), each facility will be judged separately and if determined to be eligible for authorization to use the monogram will be granted a separate license for each Specification, or part thereof, under which authorization is granted. The application of the monogram may not be subcontracted.

G.4 Fee for Use of Monogram.

Initial Authorization Fee. The applicant will be invoiced an initial authorization fee for the first Specification included in the application, and a separate fee for each additional Specification included in the application. The applicant will also be invoiced for the surveyor's fee.

Annual Renewal Fee. In addition to the initial authorization fee, licensees will be assessed an annual renewal fee for each specification under which he is authorized to use the monogram. Applicants issued monogram certificates dated November 1 through December 31 shall not be required to pay a renewal fee for the following year.

The fees assessed are to defray the cost of the Monogram Program.

G.5 Periodic Surveys. Existing licensees must be periodically surveyed by an approved Institute surveyor to determine whether or not they continue to qualify for authorization to use the monogram. The frequency of the periodic surveys will be at the discretion of the staff of the Institute. The surveyor's fee and expenses for making a periodic survey will be paid by the Institute.

G.6 Cancellation of Monogram Rights. The right to use the monogram is subject to cancellation for the following causes:

a. Applying the monogram on any product that does not meet the Specification.

b. Failure to maintain reference master gages in accordance with the Specifications.

c. Failure to meet the requirements of any resurvey.

d. Failure to pay the annual renewal fee for use of the monogram.

e. For any other reason satisfactory to the Executive Committee on Standardization of Oilfield Equipment and Materials.

G.7 Reinstatement of Monogram Rights. Manufacturers whose authorization to use the monogram has been cancelled may request reinstatement at any time. If a request for reinstatement is made within sixty (60) days after cancellation, and if the reason for cancellation has been corrected, no new application is necessary. A resurvey of the manufacturer's facilities will be made by an approved Institute surveyor prior to a decision to reinstate monogram rights. The manufacturer will be invoiced for this resurvey regardless of the Institute's decision on reinstatement. If the resurvey indicates that the manufacturer is qualified, the license will be reissued.

Request for reinstatement made more than sixty (60) days after cancellation shall be treated as a new application unless circumstances dictate an extension of this time period as agreed upon by the API staff.

G.8 Appeals.

An interested party may appeal a decision by the API staff to withhold monogram rights. Appeals shall be directed to the Director, API Production Department and handled by the General Committee of the Production Department with a further right of appeal to the API Management Committee. Competing suppliers or manufacturers of the product or service to which the standard applies or might apply may not be involved in appeals. The General Committee and the Management Committee may convene appeals boards to hear and act on appeals.

G.9 Marking. The following marking requirements apply to licensed manufacturers using the API monogram on products covered by this specification.

G.10 Nameplate. Indirect heaters furnished to this specification by authorized manufacturers shall be identified by two corrosion resistant nameplates, one on the shell and one on the coil.

G.11 Shell Nameplate. One nameplate shall be securely attached to the shell bearing the information shown in Figure G.1 which is:

1. API Monogram.
2. Spec 12K.
3. Manufacturer's name.
4. Manufacturer's serial number.
5. Year built.
6. Shell weight empty, lbs (excluding coil weight).
7. Firebox rating, BTU/hr.
8. Firetube area, sq. ft.
9. Shell size, OD x length.
10. Additional markings desired by the manufacturer or requested by the purchaser are not prohibited.

G.12 Coil Nameplate. One nameplate shall be securely attached to the coil cover plate bearing the information shown in Figure G.2 which is:

1. API monogram.
2. Spec 12K.
3. Manufacturer's name.
4. Manufacturer's serial number.
5. Year built.
6. Coil pipe size and schedule for each section.*
7. Coil area, sq. ft.*
8. Coil weight empty, lbs.
9. Coil maximum working pressure, psig.*
10. Additional markings desired by the manufacturer or requested by the purchaser are not prohibited.

*Where split-pass coils are provided, the number, size, area, and maximum working pressure shall be indicated for each coil section. Coil maximum working pressure shall be determined using the lowest pressure rating of any component in the coil as defined in Par. 4.1.4.

G.13 Coil Connection. It is recommended that the coil connections be permanently marked as inlet and outlet, particularly in the case of split-pass coils.

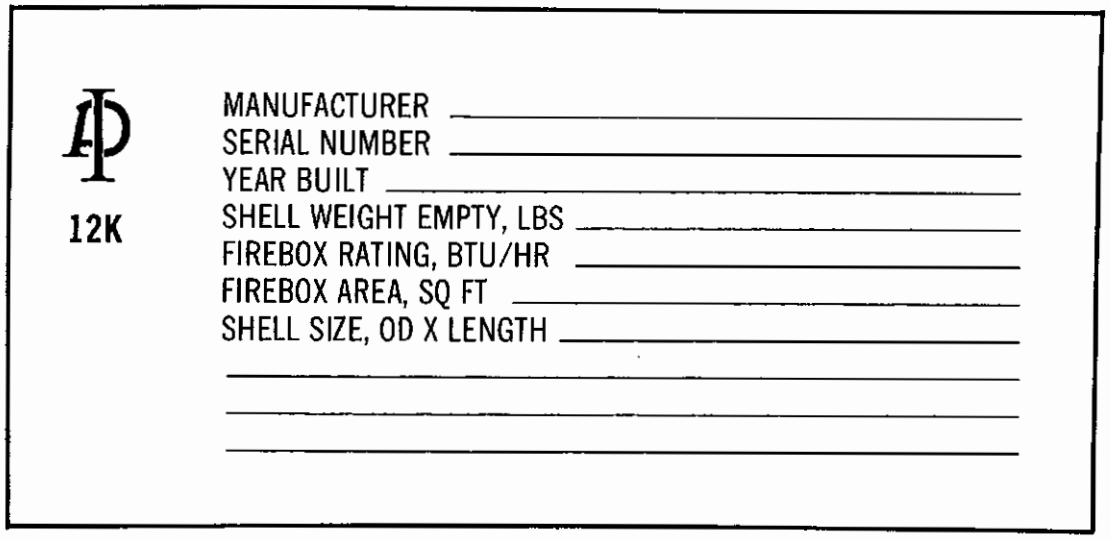


FIG. G.1
SUGGESTED INDIRECT HEATER SHELL NAMEPLATE FORMAT
(See Par. G.11)

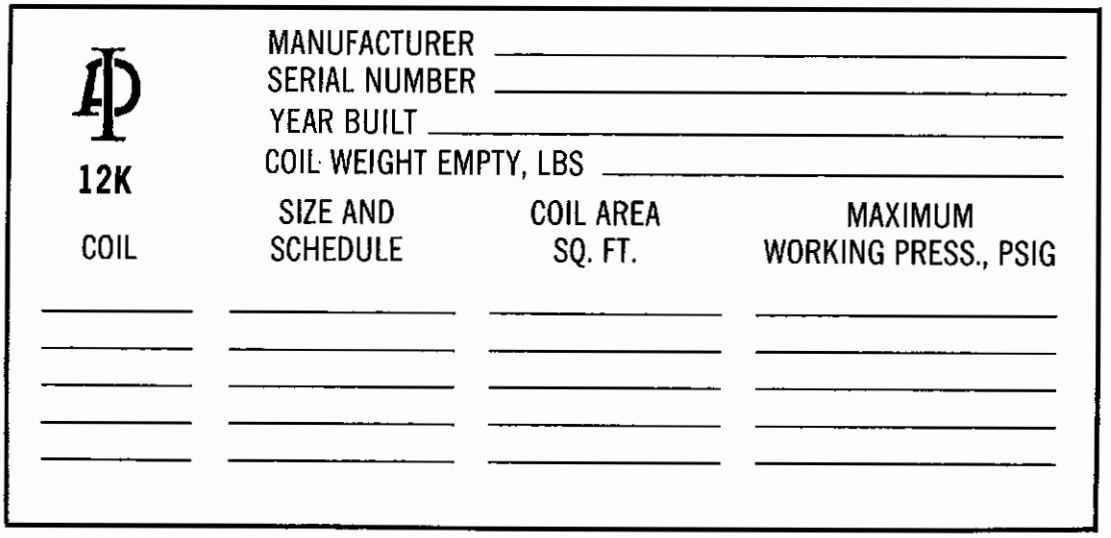


FIG. G.2
SUGGESTED INDIRECT HEATER COIL NAMEPLATE FORMAT
(See Par. G.12)

LICENSE AGREEMENT

Use of the Official Monogram of the American Petroleum Institute

This Agreement between the AMERICAN PETROLEUM INSTITUTE (hereinafter "API"), a corporation of the District of Columbia, having an office at 2101 L — Street, N.W., Washington, D.C., and _____, (hereinafter "Licensee"), a corporation of _____, having its principal place of business at _____ provides that:

WHEREAS, API is the owner of federal trademark and servicemark registrations including registration nos. 677,359; 679,642 and 840,642, as well as the owner of common law rights to such trademarks and servicemarks and various other trademarks and servicemarks;

WHEREAS, API through licensing, publications and other programs seeks to establish and promote standards and specifications for goods and services in the petroleum industry;

WHEREAS, Licensee desires a non-exclusive license from API for the purpose of promoting the standards and specifications of API by use of API trademarks or servicemarks on or in connection with the marketing of goods made in accordance with API standards and specifications.

NOW THEREFORE, in consideration of the mutual covenants hereinafter stated, the parties agree as follows:

1. API grants to Licensee a non-exclusive license to use the trademark/service mark ⏀ (the "monogram") on products made in accordance with the official publication of API entitled Spec 12K, Specification for Indirect-Type Oil Field Heaters ("the products"), including any amendments, modifications or substitutions that may hereafter be adopted.

2. API grants to Licensee a non-exclusive license to use the monogram in connection with the marketing of the products; provided, however, that Licensee shall not use the monogram on letterheads or in any advertising without an express statement of fact describing the scope of Licensee's authorization, and further provided that Licensee shall not use the monogram or the name the AMERICAN PETROLEUM INSTITUTE or the description "API" in any advertising or otherwise to indicate API approval or endorsement of the products.

3. Licensee agrees that it will do all acts required of it by API to ensure that pertinent API standards and specifications are being met at all times in the manufacture of the products, including submitting when requested by API a statement of manufacturer's qualifications and samples of the products and permitting API, or a representative thereof, upon reasonable notice to inspect pertinent manufacturing facilities. API shall be the sole judge of whether Licensee meets the appropriate qualifications to become and remain a licensee and whether the products meet the appropriate qualifications.

4. Licensee agrees that use of the monogram on the products shall constitute a representation and warranty by Licensee to API and to the purchasers of the products that the products conform to the applicable standards and specifications of API; and Licensee agrees to hold harmless and indemnify API for any and all liability, loss, damage, cost and expense which API may suffer, incur, or be put to by reason of any claim, suit or proceeding, for personal injury, property damage or economic loss based on the failure or alleged failure of the Licensee's products to conform to such standards and specifications; and Licensee further agrees to defend API, at Licensee's expense, against any and all such suits, claims or proceedings.

5. This license shall not be assignable or transferable by Licensee in any manner nor shall Licensee have the right to grant sublicenses.

6. This Agreement may be terminated at any time and for any reason satisfactory to the API.

7. This license shall run from year to year and shall be renewed yearly upon payment by Licensee to API of an annual renewal fee.

_____
(Licensee Company Name)

Date: _____ By _____

Effective Date: _____ AMERICAN PETROLEUM INSTITUTE

By _____

AMERICAN PETROLEUM INSTITUTE

DIVISION OF PRODUCTION

2535 ONE MAIN PLACE

DALLAS, TX 75202-3904

STATEMENT OF MANUFACTURER'S QUALIFICATIONS TO USE API MONOGRAM

The information indicated below, when requested by the Institute, must accompany all applications to use the API monogram. All such information is subject to investigation and application must be rejected if the information supplied so warrants.

Material: _____

(List here the equipment on which applicant desires to apply the monogram.)

API specification designation: _____

1. Name of applicant: _____
2. Location of principal office: _____
3. Where will equipment be manufactured? _____
4. Class of ownership: _____
(Corporation, partnership, or individual)
5. Capital invested: _____ 6. Year organized: _____
7. Is the applicant thoroughly familiar with all stipulations given in the API specification covering this material? _____
8. Is the applicant actually manufacturing this material now? _____
   a. State the length of time applicant has made the material and supplied it to the oil industry: _____
   (Years and Months)
   b. State the approximate percentage of production of this material to applicant's total production: _____
9. Give the names and addresses of five representative users in the oil industry to whom applicant has sold this material (give name of company, complete street address, and name of company representative to whom inquiries should be addressed):

10. If applicant has not supplied this material to the oil industry and cannot furnish the five references under item 9, give the names and addresses of five representative users in other industries to whom applicant has sold similar equipment (give name of company, complete street address, and name of company representative to whom inquiries should be addressed):

_____

_____

_____

_____

_____

11. If the applicant is not now manufacturing this material, when does he expect to begin production? _____

_____

12. If the applicant has not previously made this material, state fully (on an attached sheet) the experience of any members of applicant's present organization in the manufacture of this material, giving names of organizations where such experience was obtained.

Questions 13, 14, and 15 need be answered only if the specification requires testing or possession of API reference master gages.

13. Does the applicant now possess the necessary equipment and personnel for conducting all tests required in the API specification covering this material? _____

14. Does the applicant now possess such API reference master thread gages as required by the specification covering this material? _____

If applicant possesses such gages, give full information (on separate sheet) on types, sizes, certifying agency, and certification dates.

15. If the applicant does not now possess such gages, have they been ordered? _____

If so, give full information (on separate sheet) on types, sizes, and from whom ordered.

16. Give names of five responsible business men as references regarding applicant's general character, integrity, and reputation (give complete mailing address and name of organization with which each is affiliated):

_____

_____

_____

_____

_____

17. Name and address of applicant's representative to whom API correspondence should be directed:

_____

_____

(Signature and title of authorized officer)

Date _____

_____

(Name of organization, company, or individual)

(The above statement to be signed in the name of the applicant by an authorized officer)

Order No. 811-06600

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