

Mfg. Dept. Engr.
Instruction SF-104

APPENDIX NO.III

SAFETY INSTRUCTION SHEET - FIRED HEATERS

FORM MFG. 600-3

<u>NO.</u>	<u>SUBJECT</u>	<u>DISCUSSION</u>
1 to 31		Refer to Appendices I and II for the discussion.
32	TEST APPLIED NEW	The tests applied new for both strength and leakage may be noted as those specified by the designing engineer and issued to the construction forcer as the required tests. The strength test is governed by either (a) the cold test limitations of the terminal fittings or directly connected piping that can not be blinded off, or (b) by the stress being limited to 75% of the proportional limit of the material, i.e, the test pressure should not exceed $(1.5) \times (\text{proportional limit}) \times (t)/O.D.$ The leakage test is usually between $2/3$ of the strength test and a minimum of 1.5 times the cold equivalent of the safety valve setting protecting the heater.
33	LIMITED BY	Note the limitation for the specified test pressure as "tubes," "headers," "flanges," etc.
34	BANK OR COIL	Give the location of the tubes and headers in the bank or coil as "convection," "radiant," "roof," "shock," etc. For the terminal fittings note as "inlet," "outlet," "crossover," etc.
35	HEADER: TYPE	The type of headers should be specifically designated where possible, for example "Key. 1900," etc. If type is not known designate by the general type as "mule ear," "breeck lock," "screw lock," etc.
36	DESIGN PRESSURE	The operating pressure limit should be established as the maximum possible pressure that can be reached by any method of operation. The temperature should be the maximum for safe operation within the limitations of the equipment and material.
37	BASED ON	Note the limiting features of the equipment at minimum thickness or other controlling factor. The limitation may be the "tubes," "headers," "flange ratings," etc., with temperature limits restricted by "oxidation," "embrittlement," "graphitization," etc.

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FIRED HEATERS (Cont'd)

<u>NO.</u>	<u>SUBJECT</u>	<u>DISCUSSION</u>
38	TEST PRESSURES	The routine test pressure for strength should be as close as practicable to the initial strength test, as these tests are applied to test newly-rolled repair joints. A note should be added stating that the test pressure shall not exceed $(1.5) \times (\text{proportional limit}) \times (\text{current minimum tube thickness}) / \text{O.D.}$ The leakage test is a function of the strength as noted in "32" above.
39	PRESSURE	The pressure for calculating the minimum tube wall thickness should be taken as either of the following: (a) For low pressure-drop heaters, assume that the entire coil is protected by the safety valve on the top transfer line or on the vessel into which the furnace discharges. (b) For cracking, reforming, or similar heaters with appreciable coil pressure drop, take a different pressure for each bank or section of the coil. These pressures are to be determined from the maximum inlet and outlet pressures and either the known or an assumed pressure drop through the coil. In assuming a pressure drop, remember that it will not be a straight line function of distance through the coil, and this will be particularly true in a reformer or other heater where vaporization is appreciable.
40	TEMPERATURE	The temperatures used for calculating the minimum tube wall thickness should be the maximum allowable operating tube wall temperature. Different temperatures may be indicated for radiant and convection tubes. Some judgment is required here on the part of the engineer. For example, if the fired heater is to operate with moderate outlet temperatures in the neighborhood of 700°F., it is usually a good idea to set the maximum temperature for carbon steel tubes at about 100°F.

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FIRE HEATERS (Cont'd)

NO. SUBJECT
41 MINIMUM THICKNESS

DISCUSSION

After establishing the pressure and temperature, the minimum tube wall thickness shall be calculated according to the equation

$$t_m = \frac{PD}{2S \times 1.33}$$

where P = Pressure, lbs. per square inch.

D = O.D., inches.

S = Stress in lbs. per square inch for 1% creep in 10,000 hours at the maximum operating metal temperature.

1.33 = is a factor applied to get the effect of the two dimensional stress in the tube wall caused by internal pressure. It represents the ratio between two dimensional creep stress and that determined by an ordinary tensile specimen in one direction only, which is the value appearing in the literature.

The recommended values of creep stress are given in the Richmond Materials Laboratory report of November 20, 1946 entitled "Recommended Values of Creep and Rupture Strength."

The minimum tube wall thickness in the case of fired heaters subjected to high pressure tests may be determined by the routine test stress in the tube being limited to 75% of the proportional limit for the material. When the minimum thickness is so limited, the basis should be clearly stated, in the asterisk note as it may be desirable to reduce test pressures at a later date to obtain maximum service life for the tubes.

In the event the calculated minimum thickness is less than 0.10", the minimum shall be established arbitrarily at 0.10".

The above apply except where tube thickness requirements are mandatory as for power boilers in which case the requirements of the State of California Boiler Safety Orders and the ASME Boiler Code govern.

42 CORROSION ALLOWANCE

The corrosion allowance can now be determined by subtracting the minimum thickness calculated from the tube wall thickness supplied.

DATA AND OPERATING LIMITS SHEET - FIRED HEATERS

EQUIPMENT DATA

SERVICE _____ 1 _____ NO. 2
 NFR. _____ YEAR BUILT _____
 TUBE NUMBERING DIAGRAM _____ EXT. HEATING SURFACE _____ SQ. FT.
 DRAWINGS _____
 TEST APPLIED NEW: STRENGTH 32 _____ psi LEAKAGE 32 _____ psi
 LIMITED BY 33 _____
 TUBES: LOCATION, I.e. BANK OR COIL 34 _____
 ORDER NO. _____
 MATERIAL _____
 SPEC. & GRADE _____
 NUMBER _____
 O.D.-WALL, AV. OR MIN.-LGTH. _____
 HEADERS & FITTINGS: LOCATION 34 _____
 ORDER NO. _____
 MANUFACTURER _____
 TYPE 35 _____
 MAT'L-HEADERS & PLUGS _____
 MAT'L-HOLDING MEMBERS & SCREWS _____
 INLETS, OUTLETS & CROSSOVERS: LOCATION 34 _____
 FLANGE SIZE & RATING _____
 FLANGE FACING _____
 CROSSOVER SIZE & WEIGHT _____

REVISIONS

APPROVALS

ENG. DEPT.

OPRG DEPT.

DATE

DR.
CH.
ENGR.

OPERATING LIMITS (CONSULT DESIGN ENGINEER BEFORE EXCEEDING THESE LIMITS)

DESIGN PRES.: INLET 36 _____ psi 0 _____ F., OUTLET 36 _____ psi 0 _____ F
 BASED ON 37 _____
 MAX. ALLOW. TUBE WALL TEMP. 24 _____
 PROTECTED BY SAFETY VALVE ON 24 _____
 TEST PRESSURES: STRENGTH 38 _____ psi LEAKAGE 38 _____ psi
 MINIMUM THICKNESS OF TUBES AND HEADERS AT PRES. & METAL TEMP. GIVEN

TUBES	t _m	c	PRES.	TEMP.	HEADERS	t _m	c	PRES.	TEMP.
	41	42	39	40					

*t_m based on:

SAFETY PRECAUTIONS

REFER TO GENERAL SAFETY INSTRUCTION SHEETS ME-51C2 Sheets 1, 2, 3, 6, 7, FOR NOTES ON HAZARDS OF EQUIPMENT FAILURE, WITH RECOMMENDATIONS FOR THEIR AVOIDANCE AND FOR INSPECTIONS AND TESTS.
 NOTE BELOW ANY SPECIAL HAZARDS, RECOMMENDATIONS, INSPECTIONS, OR TESTS THAT ARE IMPORTANT FOR THE ABOVE EQUIPMENT:

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SAFETY INSTRUCTION SHEET FIRED HEATERS

DWG.
NO.

Sheet _____ of _____

(Refinery)

(Plant)