



NATIONAL PETROCHEMICAL COMPANY
STANDARDS

MATERIAL STANDARD
FOR
FIRETUBE BOILERS

NPCS-MS-HM-06

REVISION : 0

JANUARY 1993



CONTENTS

1	<u>SCOPE</u>
2	<u>STANDARDS AND CODES</u>
3	<u>MATERIALS</u>
3.1	GENERAL
4	<u>DESIGN</u>
4.1	GENERAL
4.2	MINIMUM THICKNESS
4.3	SHELL JOINTS
4.4	ATTACHMENTS OF HEAD AND TUBESHEETS
4.5	TUBES
4.6	ATTACHMENT OF FURNACE
4.1	FIREBOXES AND WATERLEGS
4.8	STAYED SURFACES
5	<u>DOORS AND OPENING</u>
5.1	WELDED DOOR OPENING
5.2	OPENING IN WRAPPER SHEETS
5.3	ACCESS AND FIRING DOOR OPENINGS
5.4	REQUIREMENTS FOR INSPECTION OPENING
5.5	OPENING BETWEEN BOILER AND SAFETY VALVE
6	<u>DOMES</u>

THIS DOCUMENT IS THE PROPERTY OF N.P.C. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED, TO THE OWNER NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF N.P.C.



7	<u>PIPING, FITTINGS AND APPLIANCES</u>
7.1	WATER GLASSES
1.2	FEED PIPING
7.3	BLOWOFF PIPING
8	<u>BURNER</u>
9	<u>STACKS</u>
10	<u>INSTRUMENTATION AND CONTROLS</u>
11	<u>FABRICATION</u>
11.1	GENERAL
11.2	WELDING PROCESSES
11.3	WELDING QUALIFICATION AND WELD RECORDS
11.4	FILLER METAL REQUIREMENT
11.5	WELD JOINT PREPARATION
11.6	TUBE TO TUBE SHEET JOINTS
11.7	HEAT TREATMENT
12	<u>INSPECTION</u>
12.1	LIQUID PENETRANT EXAMINATION
12.2	MAGNETIC PARTICLE EXAMINATION
12.3	ULTRASONIC EXAMINATION
12.4	RADIOGRAPHIC EXAMINATION
12.5	VISUAL INSPECTION
12.6	VENDOR'S RESPONSIBILITY
13	<u>HYDROSTATIC TESTS</u>

THIS DOCUMENT IS THE PROPERTY OF N.P.C. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED, TO THE OWNER NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR ANY MANNER WITHOUT THE PRIOR WRITTEN CONSENT OF N.P.C.



14 PERFORMANCE CONDITIONS

14.1 GENERAL

14.2 AIR AND GAS

14.3 WATER

14.4 PERFORMANCE TESTS

15 GUARANTEE

16 PREDICTED PERFORMANCE CONDITIONS

17 PREPARATION FOR SHIPMENT

18 INFORMATION REQUIRED WITH QUOTATIONS

19 DRAWINGS AND DATA REQUIRED

THIS DOCUMENT IS THE PROPERTY OF NPCC. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED. TO THE OWNER. NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF NPCC.



1 SCOPE

- 1.1 This standard covers the requirements for design, fabrication, workmanship, inspection, marking, testing and packing of firetube boiler, hereafter referred to as "boiler" for brevity, and is intended to supplement the applicable codes.
- 1.2 For purchase purposes this standard alongwith the ASME Code, Section I, shall be compiled with.
- 1.3 The compliance with this standard does not relieve fabricator from his own responsibilities and guarantees for the soundness of vessel to be delivered.
- 1.4 In this standard vendor means boiler manufacturer and purchaser means NPC.

2 STANDARDS AND CODES (LATEST EDITION AND ADDENDA)

- ASME Boiler and Pressure Vessel Codes, Section I, VIII and IX.
- ASTM Section II Material Specifications.
- ANSI B 16.5 and B 31.3
- ABMA American Boiler Manufacturers Association.
- AWS American Welding Society.
- NPCS-CS-ST-02 Steel structures.
- NPCS-ES-PV-01 Pressure Vessels.
- NPCS-MS-PV-01 Pressure Vessels.
- NPCS-MS-HM-10 Refractory Linings.
- All Codes Referred to, in the above Mentioned Codes such as API-605, etc.

DOCUMENT IS THE PROPERTY OF NPC. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED. TO THE OWNER NEITHER THE VEHICLE NOR ANY PART OF THIS DOCUMENT MAY BE LOANED, REPRODUCED, COPIED, OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF NPC.



3 MATERIALS

3.1 GENERAL

3.1.1 Materials used in the construction of pressure parts for firetube boilers shall conform to one of the specifications given in Section II, ASME Code, and shall be limited to those for which allowable stress values are given in tables PG-23.1 and PG-23.2 or as otherwise specifically permitted in Parts PG and PFT.

3.1.2 Waterleg and doorframe rings of vertical firetube boilers and of locomotive and other type boilers shall be of wrought iron or steel, or cast steel as designated in the SA-216. The ogee or other flanged construction may be used as a substitute in any case.

4 DESIGN

4.1 GENERAL

The rules in paragraph PFT-8 ASME, Section I, apply specifically to the design of firetube boilers and parts thereof and shall be used in conjunction with the general requirements for design in part PG as well as with the specific requirements for design in the applicable parts of Section I, ASME which apply to the method of fabrication used.

4.2 MINIMUM THICKNESS

4.2.1 Plates

The minimum thicknesses of shell plates and dome plates, after forming, shall be as follows:

<u>DIAMETER OF SHELL I.D.</u>	<u>MINIMUM THICKNESS</u>
914 mm (36") or under	6 mm (1/4")
914 to 1371 mm (36" to 54")	8 mm (5/16")
1371 mm to 1829 mm (54" to 72")	10 mm (3/8")
Over 1829 mm (72")	13 mm (1/2")

THIS DOCUMENT IS THE PROPERTY OF NPCC. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED. TO THE OWNER NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF NPCC.



4.2.2 Except as otherwise provided in 4.2.3 the minimum thickness of tubesheets for firetube boilers shall be as follows:

<u>DIAMETER OF TUBESHEET</u>	<u>MINIMUM THICKNESS</u>
1067 mm (42") or under	10 mm (3/8")
1067 mm to 1372 mm (42" to 54")	11 mm (7/16")
1372 mm to 1829 mm (54" to 72")	13 mm (1/2")
Over 1829 mm (72")	14 mm (9/16")

4.2.3 Tubesheets with a straight flange longer than 1 1/2 times the tubesheet thickness, when butt welded to the shell of a firetube boiler, shall have a minimum thickness as specified in 4.2.2, but in no case shall be less than 0.75 times the required shell thickness, based on the maximum allowable working pressure.

4.3 SHELL JOINTS

Longitudinal and circumferential welded joints of a shell or drum shall comply with the rules in Part PW, Section I, of ASME.

4.4 ATTACHMENT OF HEADS AND TUBESHEETS

Flat heads and tubesheets of firetube boilers shall be attached by one of the following methods.

4.4.1 By flanging and butt welding in accordance with Parts PG and PW, Section I ASME.

4.4.2 By attaching an outwardly or inwardly flanged tubesheet to the shell by fillet welding provided the following requirements are met.

4.4.2.1 The tubesheet is supported by tubes, or stays, or both.

4.4.2.2 The joint attaching and outwardly flanged tubesheet is wholly within the shell and forms no part thereof.

4.4.2.3 Inwardly flanged tubesheets are full fillet welded inside and outside.

4.4.2.4 The throat dimension of the full fillet weld is equal to not less than 0.7 of the thickness of the head.

4.4.2.5 The shell at the welds is not in contact with primary furnace gases.

4.4.2.6 The construction conform in all other respects to the requirements of Section I, ASME including welding and postweld heat treating, except that radiographic examination is not required.

THIS DOCUMENT IS THE PROPERTY OF N.P.C. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED. TO THE OWNER NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF N.P.C.



THIS DOCUMENT IS THE PROPERTY OF N.P.C. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED, TO THE OWNER NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF N.P.C.

- 4.4.2.7 This construction shall not be used on the rear head of a horizontal-return tubular boiler and inwardly flanged tubesheets shall not be used on a boiler with an extended shell.
- 4.4.2.8 On inwardly flanged tubesheets, the length of flange shall conform to the requirements of PW-13 and the distance of the outside fillet weld to the point of tangency of the knuckle radius shall be not less than 6 mm (1/4").
- 4.4.3 By attaching an unflanged tubesheet to the shell by welding provided the following requirements are met.
- 4.4.3.1 The tubesheet is supported by tubes, or stays, or both.
- 4.4.3.2 The welded joint is wholly within the shell or wrapper sheet and forms no part thereof.
- 4.4.3.3 The weld is a full penetration weld equal at least to the full thickness of the tubesheet and applied from either or both sides.
- 4.4.3.4 The shell or wrapper sheet, where exposed to primary furnace gases and not water cooled, does not extend more than 3.2 mm (1/8") beyond the outside face of the tubesheet.
- 4.4.3.5 The weld attaching a furnace or a lower tubesheet of a vertical firetube boiler to the furnace sheet is wholly within the furnace sheet and is ground flush with the upper or water side of the tubesheet.
- 4.4.3.6 The construction conforms in all other aspects to the requirements of Section I, ASME including welding, and postweld heat treatment, except that radiographic examination is not required..
- 4.4.3.7 This construction shall not be used on the rear head of a horizontal-return tubular boiler.
- 4.5 TUBES
- 4.5.1 Allowable Working Pressure
- 4.5.1.1 The maximum allowable working pressure of tubes or flues of firetube boilers shall be as given in table PFT-12.1, Section I, ASME.
- 4.5.1.2 The maximum allowable working pressure for copper tubes or nipples subjected to internal or external pressure shall be as given in table PFT-12.2, Section I, ASME.



THIS DOCUMENT IS THE PROPERTY OF N.P.C. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED. TO THE OWNER NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF N.P.C.

The maximum allowable working pressure for copper-clad tubes subjected to external pressure shall be determined by the formula in table PFT-12.1 Section I, ASME in which t may be increased by one-half the thickness of the cladding.

4.5.2 Attachment of Tubes

4.5.2.1 A firetube boiler shall have the ends of the tubes firmly rolled and beaded, or rolled and welded around the edge of the tube; see Figure PFT-12.1, Section I, ASME. Tube ends attached by rolling and welding are subject to the following provisions.

4.5.2.1.1 The tubesheet hole may be beveled or recessed to a depth at least equal to the thickness of the tubes. Where the hole is beveled or recessed, the projection of the tube beyond the tubesheet shall not exceed a distance equal to the tube thickness. The depth of any bevel or recess shall not be less than the tube thickness or 3.2 mm (1/8") whichever is greater, nor more than one-third of the tubesheet thickness; see Figure PFT-12.1, Sketches (f) and (g), Section I, ASME.

4.5.2.1.2 Where no bevel or recess is employed, the tube shall extend beyond the tubesheet not less than a distance equal to the tube thickness, nor more than twice the tube thickness; see Figure PFT-12.1, Sketch (e), Section I, ASME.

4.6 ATTACHMENT OF FURNACES

4.6.1 Fillet Welded Construction

In a scotch type boiler, a furnace may be attached to an outwardly flanged opening in a front tubesheet by a circumferential fillet weld, or a furnace may be attached to either tubesheet by flaring the end which extends beyond the outside face of the head to an angle of 20' to 30" ($\pi/9$ to $\pi/6$ rad) and using a circumferential fillet weld, provided the following requirements are met.

4.6.1.1 The area of the head around the furnace is stayed by tubes, stays, or both in accordance with the requirements of Section I, ASME.

4.6.1.2 The joint is wholly outside the furnace.

4.6.1.3 The throat dimension of the full fillet weld is not less than 0.7 times the thickness of the head.

4.6.1.4 Unless protected by refractory material, the furnace does not extend beyond the outside face of the tubesheet a distance greater than the thickness of the tubesheet. Any excess shall be removed before welding.



- 4.6.1.5 The construction conforms in all other respects to the requirements of Section I, ASME including welding and postweld heat treating, except that radiographic examination is not required.
- 4.6.2 Full Penetration Weld Construction
- A furnace may be attached by a full penetration with the furnace extending at least through the full thickness of the tubesheet but not beyond the toe of the weld, and the toe shall not project beyond the face of the tubesheet by more than 10 mm (3/8") unless protected from overheating by refractory material or other means.
- 4.6.3 Throat Sheets
- Throat sheets and inside and outside front furnace sheets when fully stayed may be attached as required in 4.4.3 this standard.
- 4.6.4 Furnace Sheets Attached by Welding
- Vertical firetube boilers may be constructed by welding the ogee bottom of the furnace sheet to the outside shell as shown in Fig.PFT-20, Section I, ASME provided the following requirements are met.
- 4.6.4.1 The tube or crown sheet is fully supported by tubes, or stays, or both.
- 4.6.4.2 The joint is wholly within the shell and forms no part thereof.
- 4.6.4.3 The weld is not in contact with primary *furnace gases*.
- 4.6.4.4 The throat dimension of the full fillet weld is not less than 0.7 times the thickness of the furnace sheet.
- 4.6.4.5 The maximum depth of the waterleg does not exceed 102 mm (4"), and the radius of the ogee is not greater than the inside width of the waterleg.
- 4.6.4.6 The pitch of the lower row of staybolts meets the requirements of PFT-26.6, Section I, ASME.
- 4.6.4.7 The construction conforms in all other respects to Code requirements including welding and postweld heat treating, except that radiographic examination is not required.



4.1 FIREBOXES AND WATERLEGS

4.7.1

Welded construction may be used in the fireboxes of internally fired boilers provided the welds are between two rows of staybolts, or in the case of flat surfaces the weld is not less than one-half of a staybolt pitch from the corner. In vertical tubular and firebox types of boilers the bottom edges of the plates may be attached by fusion welding provided the load due to internal pressure is carried by staybolting and the inside width of the waterleg does not exceed 102 mm (4"). An acceptable construction is as shown in Fig. PWT-12.2, Section I, ASME with both plates flanged. As an alternative construction one plate only need be flanged, provided the weld joining the flanged plate to the straight plate is a groove weld having penetration for its full depth and the weld is outside of the header. The plates may be considered to be fully supported if stayed in accordance with the requirements of PFT-26.8, Section I, ASME.

The welds shall be postweld heat treated but radiographic examination is not required.

4.7.2

Mud rings of plate material permissible under this standard may be used in the construction of waterlegs of vertical firetube boilers and may be attached as shown in Fig. PG-31, sketch (g) in compliance with the requirements of PG-31 provided.

4.7.2.1

The width of the waterleg does not exceed 102 mm (4").

4.7.2.2

The thickness of the mud ring plate is at least 13 mm (1/2").

The abutting ends of mud rings may be welded. The welds shall be postweld heat treated but radiographic examination is not required.

4.8

STAYED SURFACES

4.8.1

General

The rules of part PG, Section I, ASME pertaining to stayed surfaces which are applicable to firetube boilers shall be used in conjunction with the following requirements.

4.8.2

Working Pressure for Curved Surfaces

4.8.2.1

The maximum allowable working pressure for curved stayed surfaces subject to internal pressure shall be obtained by the following two methods, and the minimum value obtained shall be used,

THIS DOCUMENT IS THE PROPERTY OF N.P.C. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED, TO THE OWNER NEITHER THE WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF N.P.C.