



NATIONAL PETROCHEMICAL COMPANY  
STANDARDS

ENGINEERING STANDARD  
FOR  
PRESSURE VESSELS

NPCS-ES-W-01

REVISION : 0

DECEMBER 1992



CONTENTS

SCOPE

STANDARDS AND CODES

MATERIALS AND ALLOWABLE STRESS

3.1 GENERAL

3.2 MAXIMUM ALLOWABLE STRESS VALUES

JOINT EFFICIENCY

DESIGN AND ALLOWABLE WORKING PRESSURE

DESIGN TEMPERATURE

CORROSION ALLOWANCE

LOADINGS

VESSEL THICKNESS

SHELL & HEAD GEOMETRY

OPENING AND REINFORCEMENTS

11.1 OPENINGS IN PRESSURE VESSELS

11.2 METHOD OF ATTACHMENTS OF PIPE AND NOZZLE NECKS TO  
VESSEL WALLS

11.3 FLANGES, PIPE FITTINGS, VALVES AND STUDDER CONNECTIONS

11.4 NOZZLE NECK THICKNESS

11.5 INSPECTION OPENING

CRYOGENIC AND LOW TEMPERATURE VESSELS

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.



1 SCOPE

- 1.1 This standard covers the requirements for design and materials of fusion welded, horizontal and vertical pressure vessels (hereafter referred to as "vessels" for brevity), and is intended to supplement the applicable codes.
- 1.2 This standard does not cover the requirements for fabrication, inspection and testing of fusion welded vessels; nevertheless as far as the fabrication, inspection and testing requirements do pertain to the design of the vessels, they have been mentioned.
- 1.3 The compliance with this standard itself does not relieve the designer from his own responsibilities and guarantees for the safe mechanical design of the vessels.
- 1.4 The design of vessels shall conform to the latest edition and addenda of the codes specified in Section 2.
- 1.5 The vessel designer shall be responsible for the accuracy of all mathematical manipulations, calculations and computer programs used for the stress, deflection, buckling and other design criteria of the vessel.
- 1.6 The thickness specified shall be regarded as minimum thickness acceptable.
- 1.7 Vessels shall be designed taking into account the most severe coincident conditions of design temperature and design pressure.

2 STANDARDS AND CODES (LATEST EDITION AND ADDENDA)

- **ASME** , Sec. III, Boiler and Pressure  
Div. 1 and/or 2; Vessel Code, Boiler  
Sec. II. and Pressure vessel  
Code.
- All codes referred to, in the above mentioned codes  
such as API 605, API 941, ANSI B 16.5, etc.

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 WRITTEN CONSENT OF N.P.C.



- NPCS-MS-PV-01 Material Standard for Horizontal & Vertical Pressure Vessels.
- NPCS-ES-ST-01 Engineering Standard for Concrete.
- NPCS-ES-ST-06 Engineering Standard for Anchor Bolts.

### MATERIALS AND ALLOWABLE STRESS

#### GENERAL

Materials are specified by ASTM numbers or ASME numbers. ASTM code numbers are prefixed by "A" and corresponding ASME Specification numbers and prefixed by "SA". Vessel materials shall be in accordance with ASME Code, Sec. VIII, DIV. I, Part UW-5.

As a minimum requirement, all materials used in the design of vessel components shall be boiler quality, fully killed and normalized.

Materials conforming to other standard specifications, such as JIS, DIN or BS, equivalent to those specified, are acceptable with designer's approval. Equivalent material specifications are those that conform to chemistry, mechanical properties, quality, testing and inspection. In any case, allowable materials stresses shall be based on ASME requirements and not on the original standard requirements.

For Hydrogen service, the selection of material shall be based on Nelson chart in API 941, beside ASME requirements. Materials of non-pressure parts welded directly to pressure parts in Hydrogen service should be exactly the same as pressure parts.

No Carbon Steel part to be welded shall have a Carbon content higher than 0.23%.

For each service specified, the material selected shall be suitable for that service. Also due care shall be taken for selection of material as far as other factors such as temperature, pressure, stress corrosion, erosion corrosion, crevice corrosion, and pitting corrosion are concerned.

Where Carbon Steel is specified, for Steel plates of heads, shells and other pressure parts, SA 285 Grade C is the minimum quality acceptable subject to provisions of clause 3.1.2.

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. REPRODUCTION, STORAGE IN ANY RETRIEVAL SYSTEM OR TRANSMISSION IN ANY FORM OR BY ANY MEANS IS PROHIBITED.



- 3.1.8 Material for rings, and upper one meter of support skirts welded directly to the vertical vessel, shall be the same material as the vessel.
- 3.1.9 Material for non-pressure parts, such as skirts, supports, baffles, lugs, clips, and extended heat transfer surfaces, need not conform to the specifications for the material to which they are attached, except for conditions stated at above paragraphs.
- 3.2 MAXIMUM ALLOWABLE STRESS VALUES
- 3.2.1 The maximum allowable stress value is the maximum unit stress permitted in a given material used in a vessel constructed under these rules. The maximum allowable tensile stress values permitted for different material is in the tables of ASME Code, Sec. VIII, Div.1, Part UG-23.
- 3.2.2 The maximum allowable longitudinal compressive stress to be used in the design of cylindrical shells or tubes, either seamless or butt-welded, subjected to loadings that produce longitudinal compression in the shell or tube, shall be the smaller of the values stated in Part UG-23 of ASME, Sec. VIII, Div.1.
- 3.2.3 The wall thickness of a vessel computed by these rules shall be determined such that any combination of loadings listed in loadings design Part UG-22, ASME, Sec. VIII, Div. 1 or Part 8 of this standard, that are expected to occur simultaneously during normal operation of the vessel will induce a maximum general primary membrane stress which does not exceed the maximum allowable stress value from the table in SubSec. C of ASME Code.
- 3.2.4 For allowable anchor bolt stress, see NPCS-ES-ST-06.
- 3.2.5 For allowable bearing stress on concrete, for design of vessels anchorage attachments, see NPCS-ES-ST-01.

#### 4 JOINT EFFICIENCY

Part UW-12 of ASME, Sec. VIII, Div.1, and table UW-12 give the joint efficiency "E", to be used in the formula of ASME Code. For joints completed by an arc or gas welding process, the joint efficiency depends on the type of joint and the degree of examination of the joints (See NPCS-MS-PV-01).

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 WRITTEN PERMISSION OF NPCC.