GENERAL STANDARD

FOR

ATMOSPHERIC ABOVE GROUND

WELDED STEEL TANKS

FOR OIL STORAGE

FIRST EDITION

NOVEMBER 2004

This standard specification is reviewed and updated by the relevant technical committee on Aug. 2013. The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

COMPANY:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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0. INTRODUCTION

This Standard specification gives the amendments and supplements to API standard 650, Eleventh Edition , June 2007 with Addendum 1: November 2008, Addendum 2: November 2009 and Addendum 3: August 2011 “Welded Tanks for Oil Storage”.

It is intended that API standard together with this Standard shall be used for “welded steel tanks for oil storage” for use in oil refineries, chemical plants, gas plants and where applicable, in exploration and production and new ventures.

For ease of reference, the clause or section numbering of API standard 650 has been used throughout this Standard.

All Clauses in API standard 650 that are not mentioned here in this Standard remain unaltered and shall be considered as part of this Standard.

Note 1:

This Standard is a revised version and combination of three previous standards IPS-M-ME-100(0) dated May 1993, IPS-C-ME-100(0) dated May 1993 and IPS-E-ME-100(0) dated May 1993 The original (0) edition of three standards is now withdrawn.

Note 2:

This standard specification is reviewed and updated by the relevant technical committee on Aug. 2013. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 389 on Aug. 2013. These modifications are included in the present issue of IPS.

Guidance for use of this Standard:

The following annotations as specified here under, have been used at the bottom right hand side of each clause or paragraph to indicate the type of change made to the equivalent clause or paragraph of reference standards.

Sub. (Substitution): The API standard clause is deleted and replaced by a new clause.

Del. (Deletion): The API standard clause is deleted without any replacement.

Add. (Addition): A new clause with a new number is added.

Mod. (Modification): Part of the API standard clause is modified and/or a new description and/or condition is added to that clause.

SECTION 1. SCOPE

1.1 General

1.1.1 Atmospheric storage tanks are those designed to operate at ambient temperature and above and from 0.6 kPa (6 mBar) vacuum up to 5.6 kPa (56 mBar=22 in H_2O). **(Mod)**

1.1.2 This standard covers atmospheric storage tanks with fixed (cone and dome) and floating (pontoon and double deck) roofs. Storage tanks with internal floating roof are not covered here.

(Mod)

1.1.3 Units

International system of unit (SI) in accordance with IPS-E-GN-100 and appendices X & Y of this standard shall be used wherever reference is made to API/ASME or shall be substituted by any other standard equivalent SI unit system for dimensions, fasteners and flanges. **(Sub)**

SECTION 2. REFERENCES

Throughout this Standard the following standards, in addition to the referenced codes and standards mentioned in API standard 650, are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor. **(Mod)**

BSI (BRITISH STANDARDS INSTITUTION)

BS EN 14015 "Specification for Manufacture of Vertical Steel Welded Non-Refrigerated Tank with Butt – Welded Shell for the Petroleum Industry"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME B1.1 "Unified Inch Screw Threads (UN & UNR Thread Form)"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI A14.3 "Ladders – Fixed –Safety Requirements"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-GN-100 "Engineering Standard for Units"

IPS-E-CE-120 "Engineering Standard for Foundations"

IPS-E-CE-500 "Engineering Standard for Loads"

IPS-E-SF-140 "Engineering Standard for Foam Generating and Proportioning System"

2.1 Conflicting Requirements

In case of conflict between documents relating to the inquiry or purchase order the following priority of documents, shall apply:

- First priority: purchase order (including attachments) and variations thereto.
- Second priority: data-requisition sheets and drawings.
- Third priority: this specification

All conflicting requirements shall be referred to the purchaser in writing. The purchaser will issue conforming documentation if needed for clarification. **(Add)**

SECTION 4. MATERIALS

4.2 Plates

4.2.1.3.1 For sea weather conditions, the material used for shell, roof and bottom plates shall preferably be copper-bearing steel as minimum as specified below. Of course the service requirements will also affect the material selection. When materials A-283 Gr C, A-285 Gr C and A 36 are specified, the copper content by heat analysis shall be between 0.20 to 0.35% and by product analysis between 0.18 to 0.37%. **(Mod)**

4.2.1.3.2 Bessemer and rimming steels shall not be permitted to be used. **(Add)**

4.2.7 General requirement for delivery

4.2.7.4.1 The ladle chemical analysis of steel shall show

c Max 0.25%

Mn Max 1.20%

Si Max 0.40%

P max 0.04%

S max 0.05% **(Add)**

4.2.7.5.1 For the sake of good weldablity, the carbon equivalent calculated from the ladle analysis using the following formula shall not exceed 0.43% for plates 20 mm think up to and including 25 mm and/or 0.42 for plate thicker than 25 mm.

$$\text{Carbon equivalent} = C_{eq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + C}{15}$$

Formula $C + Mn/6 \leq 0.42\%$ may be used if the material standard specified " C" and "Mn" only **(Add)**

4.2.7.6 Mill chemical analysis and mechanical test certificate are required for bottom, shell and roof plates, wind girders, pipes and flanges. **(Add)**

4.2.7.7 All plates shall be properly laid on saddle and fittings, flanges and etc. shall be packed in wooden box, clear of the soil. Special care shall be taken to protect joint faces or to beveled end of plates and fittings against damage. **(Add)**

4.2.10 Toughness requirements

4.2.10.3 The design metal temperature shall be the lower of the lowest one day mean ambient temperature plus 8 °C and the minimum temperature of the contents. The mean temperature is defined as one half of the sum of maximum temperature and minimum temperature. (**Mod)**

4.10 Connections

Where connections are made to external piping the material and all other requirements for nozzles, bolting, gasketing and pipes shall be met as specified in that piping class. **(Add)**

4.11 Packaging

General requirements for packaging are covered in Appendix Z of this standard. **(Add.)**

4.12 Shipment

Refer to Appendix ZV of this standard for general requirements of shipment. **(Add.)**

4.13 Guarantee

For guarantee requirement see Appendix ZW of this standard. **(Add.)**

SECTION 5. DESIGN

5.1.5 Typical joints

5.1.5.1 c) General

In single-V or single bevel shell butt joints the V or bevel shall be made on the outside of the tank, unless otherwise specified. **(Add.)**

5.1.5.2 Vertical shell joints

Para. (a)

i) Open gap square butt joints for plate thickness of 6 mm may be used

ii) Single-V butt joint may be used for plate thicknesses of 6 mm or more but shall not be used for plate thicknesses exceeding 13 mm.

iii) Double-V butt joints may be used for plate thicknesses over 8 mm but shall be used for plate thickness over 13 mm. **(Mod)**

Para. (b)

The vertical joints in the adjacent shell courses shall be staggered 1/3 of the length of the plate where practicable and not less than five times the thickness of the thicker plate. **(Mod)**

5.1.5.3 Horizontal shell joints

Para. (a)

Top angles to the shell shall be of butt welded construction with complete penetration and complete fusion.

i) Open gap square butt joints may be used where the thickness of the thinner plate does not exceed 8 mm.

ii) Single bevel butt joint may be used for plate thickness up to 8 mm and shall be used where the thickness of the thinner plate exceeds 8 mm but does not exceed 13 mm.

iii) Double bevel butt joints may be used for plate thicknesses over 8 mm but shall be used for plate thicknesses exceeding 13 mm. **(Mod)**

Para. (b) All shell plates at horizontal joints shall have a common vertical inside diameter. **(Mod)**

5.1.5.4 Lap-Welded Bottom Joints

Minimum lap shall be five times the thickness of the plate. If a full fillet weld cannot constantly be achieved, the fillet weld shall be made in two layers. **(Mod)**

5.1.5.7 Shell-To-Bottom Fillet Welds

The plates of the first shell course shall be attached to the bottom plates or the annular plates, if any, by a continuous fillet weld inside and outside with a minimum of two passes for each side regardless of the shell material groups.

The leg length of both fillet welds shall be equal to the thickness of the bottom or annular plates.

When the shell plate thickness is less than the bottom plate or annular thickness, the leg length of the fillet weld shall not exceed the thickness of the shell plate by more than 1.5 mm. **(Mod)**

5.1.5.9 Roof and top-angle joints

Para. (e) The outstanding leg of the top angle shall extend outside the tank shell. **(Mod)**

Para. (f) In no case the top edge of the shell shall be flanged in lieu of installing a top angle **(Mod)**

5.2 Design Considerations

5.2.3 External loads

For seismic loading and wind velocity reference is made to Iranian Petroleum Standard for loads "IPS-E-CE-500". **(Mod)**

5.2.3 f) In the design of storage tanks, seismic loading according to zone three of Uniform Building Code or IPS-E-CE-120 shall be considered. **(Add)**

5.2.7 Atmospheric storage tanks shall be designed for the rainfall intensity as specified on site condition except for open top floating roof tanks. For this type of tanks ,with the deck at its lowest position at operating level with drain valve(s) closed and assuming pontoon compartment is punctured , the deck support legs shall be designed to support the greater of the following loads:

a) Rainfall of 250 mm of water uniformly distributed all over the deck

b) A live load of 1200N/m2 **(Add)**

5.3.2 Corrosion allowance

Unless otherwise specified, no allowance shall be made for corrosion in determining the minimum plate thicknesses. **(Mod)**

5.4 Bottom Plates

5.4.2 When anchor bolts are required, at least a 50 mm width will project beyond the outside edge of the weld attaching the bottom to shell plates. For storage tanks up to and including 12.5m in diameter, the ends of the joints in sketch plates under the bottom course of shell plates shall be hammered down, welded and ground flat. **(Mod)**

5.4.6 Pad plates shall be used where accessories are fixed to the tank bottom or where they may touch the tank bottom. Pad plates should preferably be of circular shape, if square or rectangular plates are used, they shall have rounded corners. **(Add)**

5.5 Annular Bottom Plates

5.5.1 The material of annular bottom plates shall be of the same specification and quality as the lowest shell course. **(Mod)**

5.5.6 When the storage tank is to be placed on a concrete foundation ring no backing strips shall be used for butt welding radial seams connecting the ends of the annular segmental plates. The welding shall be done from top and underside to get a full penetration butt weld without any obstruction for the concrete ring under the annular plate. **(Add)**

5.6 Shell Design

5.6.1 General

5.6.3.1 Unless otherwise specified calculation of shell thickness shall be in accordance with 1-foot method. For tanks larger than 60m in diameter, method of calculation should be approved by purchaser. **(Mod)**

5.7 Shell Openings

5.7.4 Thermal stress relief

5.7.4.7 Thermal stress relieving documents and certifications shall receive purchaser's approval.

(Add)

5.7.6 Shell nozzles and flanges

5.7.6.5 The size of shell inlet and outlet nozzles will be specified on the requisition. Bottom outlets are permitted only in hard foundations, e.g. rock. Where soil settlements can be neglected. **(Add)**

5.7.6.6 To assist in drawing off product above the level of any water contamination and in blending operations, tanks may be fitted with swing pipes operated by a hand winch at ground level. Swing pipes shall be fitted to the outlet or service connection, never to the inlet or receipt connection. A special note will be made on the requisition when a swing pipe is required. **(Add)**

5.7.6.7 Side entry mixers

Side entry mixers may be required to improve mixing of the product or to reduce the formation of sludge. If side entry mixers will be installed, the required shell connection shall be specified on the requisition.

Side entry mixers shall be placed on manhole type shell nozzles to allow easy removal for maintenance without entering the tank. **(Add)**

5.7.6.8 Sample connections and thermo-indicators

If specified on the requisition, sample connections and thermo-indicators shall be provided adjacent to the spiral stairway. Flanged connections may be preferred to prevent leakage.

For fixed roof tanks a DN 25 threaded connection shall be furnished for thermowell installation. **(Add)**

5.7.6.9 Water spray system

If specified on the requisition, a water spray system shall be supplied. The system shall be designed to keep the fixed roof tanks cool in the event of a fire in an adjacent tank. **(Add)**

5.7.8.1 Clean out doors shall be fitted in storage tanks. **(Mod)**

5.8 Shell Attachments and Tank Appurtenances

5.8.1.3 Ground reading automatic gages shall be provided for storage tanks. Cone roof tanks shall have gages complete with enclosed tape and hydraulic seal, float and guide wires. All Tapes shall be graduated in standard metric system. Float wells shall be provided for automatic tank gages in floating roof tanks. **(Add)**

5.8.4 Roof manholes

The minimum number and size of shell and roof manholes shall be as per table1 below:

TABLE 1 – NUMBER AND SIZE OF MANHOLES

NOMINAL TANK DIAMETER	SHELL		ROOF			
	ALL TANKS	TYPES	FIXED ROOF TANK		FLOATING ROOF TANK	
m	Number	mm	Number	mm	Number	mm
3-6	1	600	1	500	1	900
>6-9	2	600	2	500	1	900
>9-12	2	600	2	500	2	900
>12-18	1 1	600 900	2	500	2	900
>18-27	1 1	600 900	2	600	2	900
>27-60	2 1	600 900	2	600	2	900
>60	2 2	600 900	2	600	2	900

Note: In addition, floating roofs shall be provided with at least one 500 mm manhole for each pontoon compartment. Where two deck manholes are required, they shall be located at diametrically opposite positions. An emergency vent cover shall be fitted to one man way on each cone roof tank. (Mod)

5.8.5 Roof venting

5.8.5.7 Threaded roof nozzles shall not be used. **(Sub)**

5.8.5.8 Wire netting in the openings of free vents and breather valves to prevent nesting of birds shall have openings of 6 mm squares as minimum. The use of fine mesh screens as anti flash protection is not recommended because of the danger of blockage, especially under winter conditions. **(Add)**

5.8.7 Water draw off sumps

5.8.7.1 Storage tanks in hydrocarbon service shall be provided with a minimum of one water draw off sump for tanks over 6m in diameter and a minimum of two draw off sumps for tanks over 30m in diameter. **(Add)**

5.8.7.2 End of draw off pipe shall be 100 mm above bottom of sump. **(Add)**

5.8.7.3 Draw off sump shall be fitted so as to clear the lap joints in the bottom plates and shall not be placed in the annular plate. **(Add)**

5.8.7.4 When flush type suction nozzles are used. The maximum size water draw off connection shall be DN 150. **(Add)**

5.8.7.5 Water draw off line shall be fitted with non freezing stainless steel trim drain valve. **(Add)**

5.8.10 Platforms, walkways, and stairways

d. Tanks requiring gagging or sampling from the roof shall be provided with a spiral stairway and a platform for access to gage or sampling hatch.

A spiral stairway shall be provided for access to floating roof tanks. In addition, a top platform with a guard railing shall be provided from the top of this stairway to the gage well and the roof ladder. **(Add)**

Table 5-18- Requirements for stairways

2. Minimum effective width of stairs shall be 750 mm except where connecting to 600 mm wide walk ways in which case effective width shall be 600 mm. **(Mod)**

3. Maximum angle of the stairway with horizontal line shall be 45 degrees. **(Mod)**

11. Stair landings shall not be less than 750 mm in the direction of the stairway. **(Add)**

12. On the cone roof storage tanks, a handrail shall be provided extending all around the periphery of the tank. **(Add)**

If the tank diameter is equal to or greater than the height, a rolling type roof ladder with self leveling treads shall be furnished having a minimum angle of 30 degrees from the vertical line. If the tank diameter is less than the tank height, it shall have a vertical roof ladder. **(Mod)**

5.8.12 Heating coils

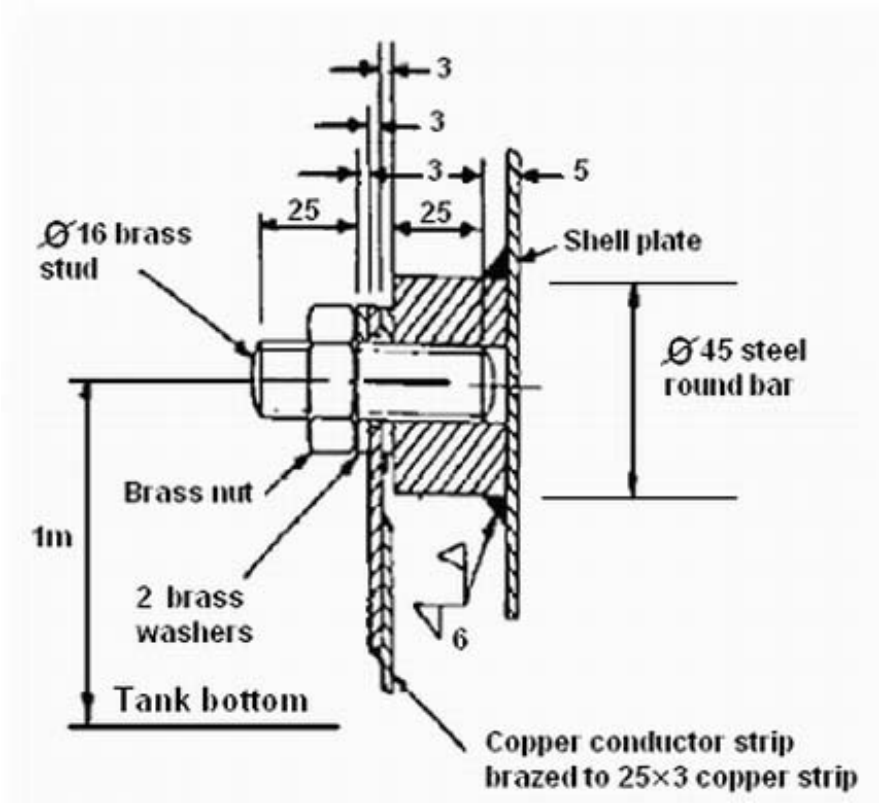
If specified on the requisition, heating coils shall be fitted to tanks when products will be maintained at above ambient temperatures to facilitate pumping, e.g. on lubricating oil, furnace oil, or bitumen storage tanks. In tanks where water may be present on the bottom e.g. crude oil tanks the heating coils shall be placed sufficiently above the bottom to prevent heating of the water. The heating surface shall be in accordance with the requirements specified. Schedule 80 pipe shall be used for all heater coils. If heating coils are not specified, heater nozzles shall be provided upon request. In that case the heater nozzles shall be furnished with a 200 mm long internal projection beveled for welding. **(Add)**

5.8.13 Suction heater

If specified on the requisition, suction heaters shall be provided to tanks fitted with coils when additional localized heat is required at the outlet connection. These heaters are usually of the nested tube type, and are suitable for steam or hot oil systems. **(Add)**

5.8.14 Earthing connections

Storage tanks shall be provided with earthing connections. Tanks up to 30m diameter shall have two earthing connections. Tanks over 30m diameter shall have three earthing connections. Each earth connection shall have sufficient cross section to earth the whole tank and shall not be less than 35 mm^2. A typical detail of earthing is shown in figure 1. **(Add)**



TYPICAL DETAIL OF EARTHING BOSS

Fig. 1

Note: All dimensions are in millimeters, unless otherwise stated. For fillet weld dimensions refer to leg length.

5.8.15 Dip hatches

Unless otherwise specified, all tanks shall be supplied with one DN 200 dip hatch. If additional dip hatches are required, a special note shall be made when ordering. Dip hatches are also available as a fitting incorporated in the top of the free vent thereby reducing the number of nozzles that would otherwise be required on large tanks. All hatches shall be spark proof self closing type. **(Add)**

5.8.16 Ladders

Tanks not equipped with spiral stairways shall be provided with an external vertical ladder. Ladders and safety cages shall be as per ANSI A14.3 except as modified below:

a) Where ladders are the only means of access, they shall provide for side step access to platforms unless through ladder type is approved by the purchaser.

b) Where ladders serve as a secondary access to platforms, they may be the side step or through ladder type installation.

c) Chains with safety hooks shall be provided with a cross ladder opening at each platform landing.

d) Ladder safety device shall not be used in lieu of cage protection.

e) Ladders shall be designed for a moving concentrated load of 227kg. **(Add)**

5.8.17 Fire fighting system

Normally for fixed roof tanks the system to be used shall be of the sub surface or semi sub surface type. Floating roof tanks depending on the area of the roof shall be provided with a foam dam and one or more foam risers. The atmospheric storage tanks whether fixed or floating roof type shall be provided with appropriate fire fighting system. Foam connections shall be supplied as specified.

For more information and detail engineering of fire fighting procedure, reference is made to IPS-E-SF-140 "Foam Generating and Proportioning system"
(Add)

5.10 Roofs

5.10.2 General

5.10.2.1 Unless specifically agreed by the purchaser, the weight of any insulation shall be added to the minimum superimposed load. **(Mod)**

5.10.2.3 Plates of fixed roof shall be lapped with the lower edge of the upper plate underneath the upper edge of the lower plates, in order to avoid the risk of condensed moisture becoming trapped in the lap joint on the underside of the roof. The lap shall be at least 25 mm. **(Mod)**

5.10.2.5.1 For tanks exceeding 12.5m in diameter, roof plates shall not be attached to the roof supporting structure. **(Add)**

5.10.4 Supported cone roofs

5.10.4.1 Roof plates shall be laid in the manner that rain water can run off towards the tank outside. **(Mod)**

5.10.4.11 column supported roofs will not be specified where significant foundation settlement is anticipated but may be specified in cases where relatively small different center to edge settlement is anticipated during the hydrostatic test. Column(s) shall therefore be designed to permit relevelling after completion of this hydrostatic test. **(Add)**

5.10.8.4 Breather valves

The number and size of breather valves and free vents required should be specified separately owing to the large variations in pumping rate requirements etc. The flow capacities of the breather valves shall be based on data received from the valve manufacturer. **(Add)**

5.10.8.5 Thermal venting

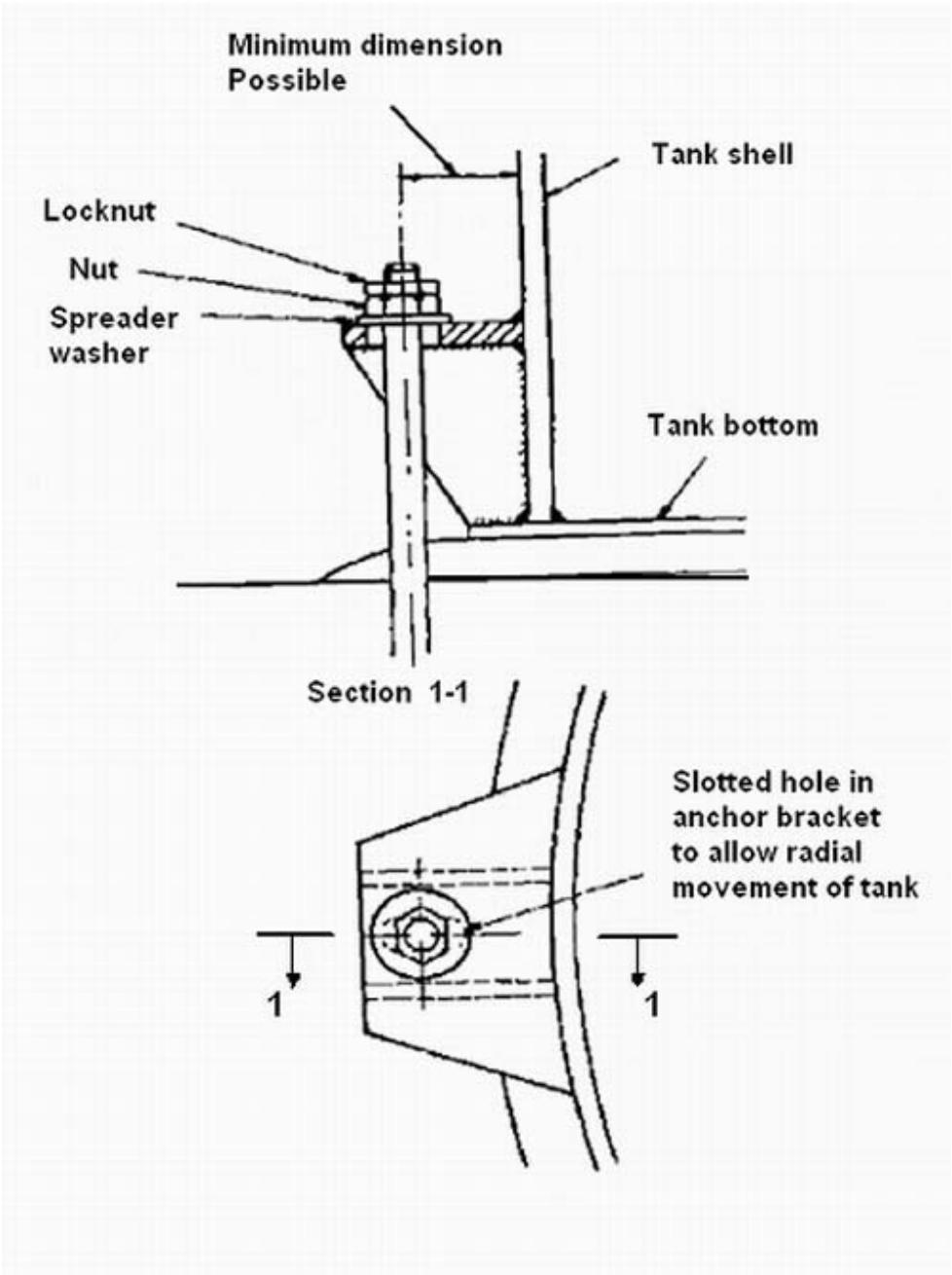
Special attention is required to the influence of a sudden drop in temperature due to rainfall, on the venting requirements of tanks containing warm oil and of tanks in tropical areas. A drop of 15-20^{o} C or more in 15 minutes may be experienced. Where these conditions apply the venting capacity for tanks with low pumping rates, in particular, shall be increased by at least 20% of the thermal venting capacity requirements. **(Add)**

5.12 Tank Anchorage

5.12.14 A typical tank anchorage detail is shown in figure 2. **(Add)**

5.13 Insulation

Design and application of insulation to atmospheric storage tanks shall be in accordance with relevant Iranian Petroleum Standard and Annex Q of BS EN 14015 “Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above”. **(Add)**



TYPICAL TANK ANCHORAGE DETAIL

Fig. 2

SECTION 6. FABRICATION

6.1 General

Manufacturer shall submit the following drawings for approval by Purchaser and before start of the work:

a) All shop fabrication drawings

b) A general arrangement drawing for each tank. This drawing shall be to scale and shall show the position of all mountings and accessories required with reference to the relevant detail drawings.

c) Static calculations for all members of the tank for which the sizes are not shown on the reference drawings. **(Add)**

6.1.2 Finish of plate edges

The dimension of cut shell plates shall meet with the specified dimensions within the following tolerances:

On plate width ± 1.5 mm

On plate length ± 1.5 mm

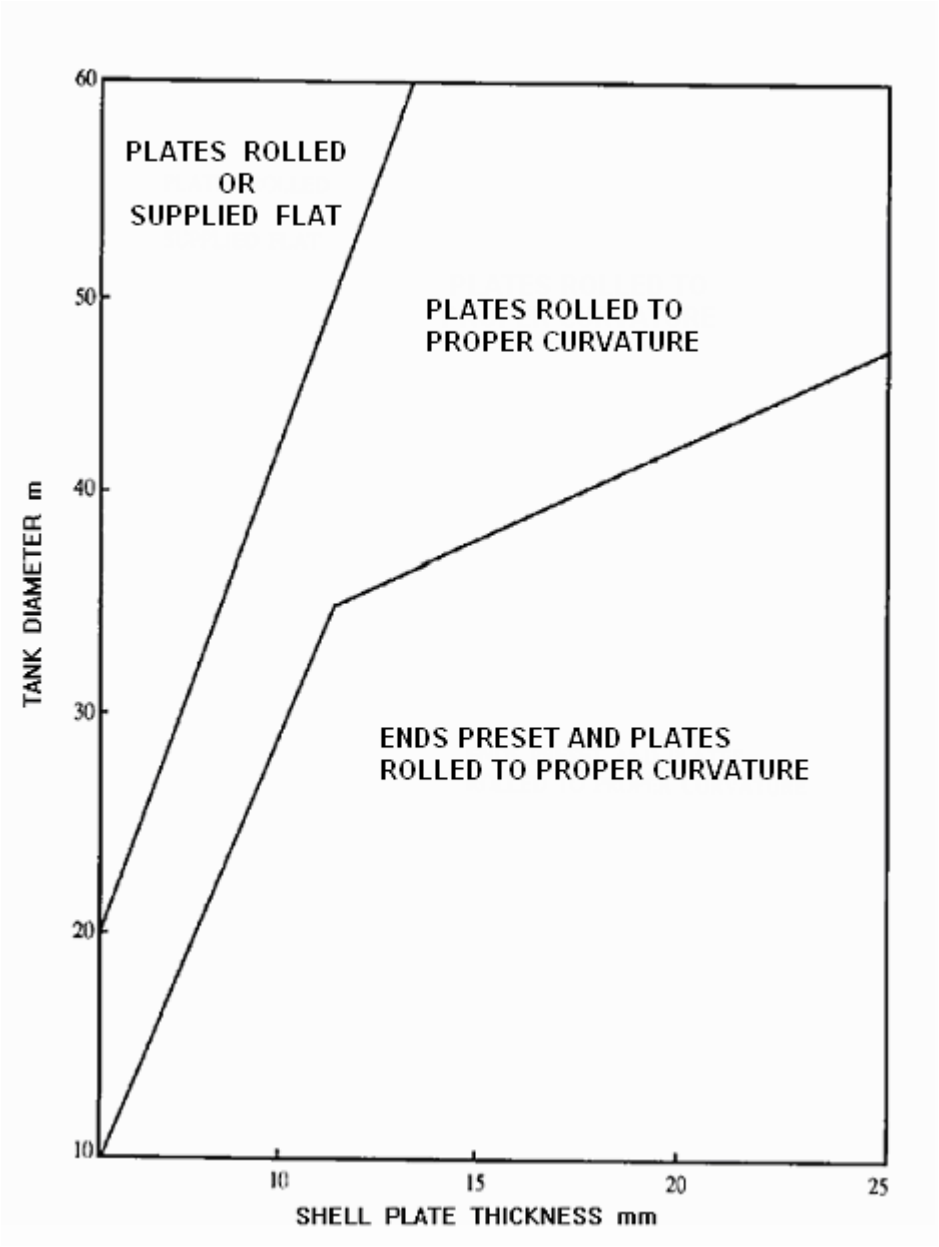
Difference in diagonals 3 mm

Straightness of surfaces of the side's ± 1 mm **(Mod)**

6.1.2.1 If holes are manually flame cut, the edges shall be machine cut, tool cut or ground smooth. **(Add)**

6.1.2.2 Shell plate edges on completion of machining shall be straight. Deviations, if any, shall not be in excess of 1 mm. **(Add)**

6.1.3 Shell plates shall be supplied flat, rolled to the proper curvature, or rolled to the proper curvature with their end preset as required by the relationship between tank diameter and shell plate thickness shown in figure 3. In the case of plates not covered in figure 3 the rolling and end pressing requirements shall be agreed with the purchaser. **(Mod)**



ROLLING AND END PRESSING OF SHELL PLATES

Fig. 3

6.1.4 Marking

All plates and structural members shall be marked in accordance with a marking diagram to be supplied by the manufacturer which shall also bear such other marks as may be required to facilitate erection.

Erection marks shall be painted clearly on plates and structural members in symbols at least 50 mm high, where practicable, and in the case of curved plates, such marks shall be on the inside surface.

When required, erection marks may be hard stamped in symbols not less than 13 mm high which in the case of plates shall be in the corner approximately 150 mm from either edge.

Painted or stenciled markings shall not be applied until the priming coat is thoroughly dry. **(Sub)**

6.1.5.1 All roof structural members, stairways and hand railing manufactured from carbon steel shall be thoroughly cleaned and freed from rust and scale by pickling or blast cleaning and painted immediately after cleaning with a primer coat of paint before shipment. **(Add)**

6.1.5.2 Special consideration shall be given to the need to protect welding margins, machined surfaces, nuts and bolts etc. from corrosion during shipment and construction. **(Add)**

SECTION 7. ERECTION

7.1 General

7.1.7 The erection manufacturer who is responsible for erecting the tank in the site shall furnish all labor, tools, welding equipment, cables, false work scaffolding, electrodes and other equipment necessary for the satisfactory erection of the tank. Power for welding shall be supplied by the erection manufacturer unless other arrangement are stated in the purchase order. **(Add)**

7.1.8 The erection manufacturer shall inspect and keep stock of all material delivered at site and be fully responsible for their safekeeping. All fittings, valves, plates, etc. shall be properly laid out on wooden supports, clear of the soil. Special care shall be taken that damage does not occur to Joint faces of valves and flanges or to beveled ends of fittings. **(Add)**

7.1.9 All materials shall be examined and repaired as necessary at the site before being erected, to ensure that any damage incurred in transit is made good to the satisfaction of the owner's representative. Particular attention shall be paid to the removal of buckles and distortions in the shell, roof and bottom plates. **(Add)**

7.1.10 Welding electrodes shall be stored in their original pockets or cartons in a dry place adequately protected from weather effects. Hydrogen controlled electrodes shall be stored and baked in accordance with the electrode manufacturer's recommendations. **(Add)**

7.1.11 Erection holes shall not be permitted in plate work **(Add)**

7.2 Details of Welding

7.2.1 General

7.2.1.2.1 The necessity and the extent of preheat for any of the conditions shall be determined and receive purchaser's approval. **(Add)**

7.2.1.6 The gap between laying surfaces of lap joints should not exceed 1.5 mm. If the separation is greater than 1.5 mm after straightening and assembly, the leg of the fillet weld shall be increased by the amount of separation but shall not exceed 4.5 mm gap. The use of filler material is prohibited. **(Mod)**

7.2.1.8 Tack welds shall be made with the same type of electrode that is used for depositing the root pass. **(Mod)**

7.2.1.8.1 The sequence employed for tack welding and welding the bottom, shell and roof plates shall be such that the distortion due to welding shrinkage is minimized. **(Add)**

7.2.1.12 The parts to be joined by fillet welds shall be brought together as closely as practicable. **(Add)**

7.2.1.13 Back up rings or strips, when permitted shall be of the same chemical analysis as the base plate. Except for low alloy base plate, the back up strip shall be low carbon steel. **(Add)**

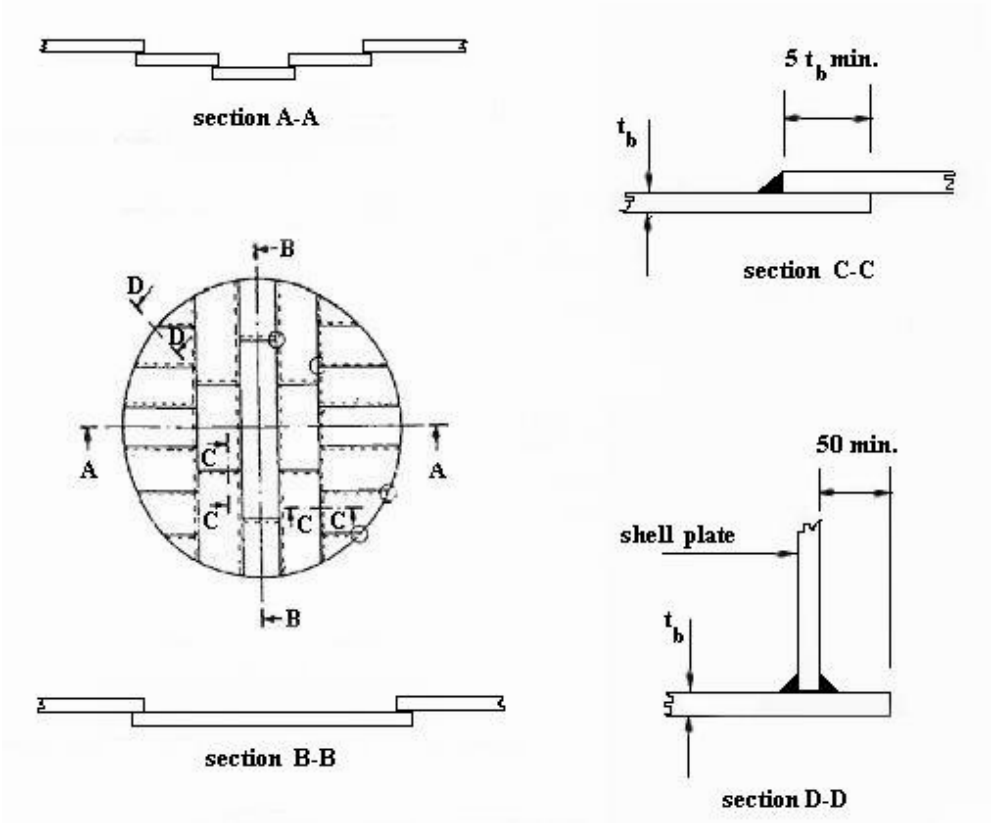
7.2.1.14 Peening of butt welds shall not be carried out except to the extent necessary to clean the weld. **(Add)**

7.2.1.15 The internal surfaces of the tank shall be aligned. **(Add)**

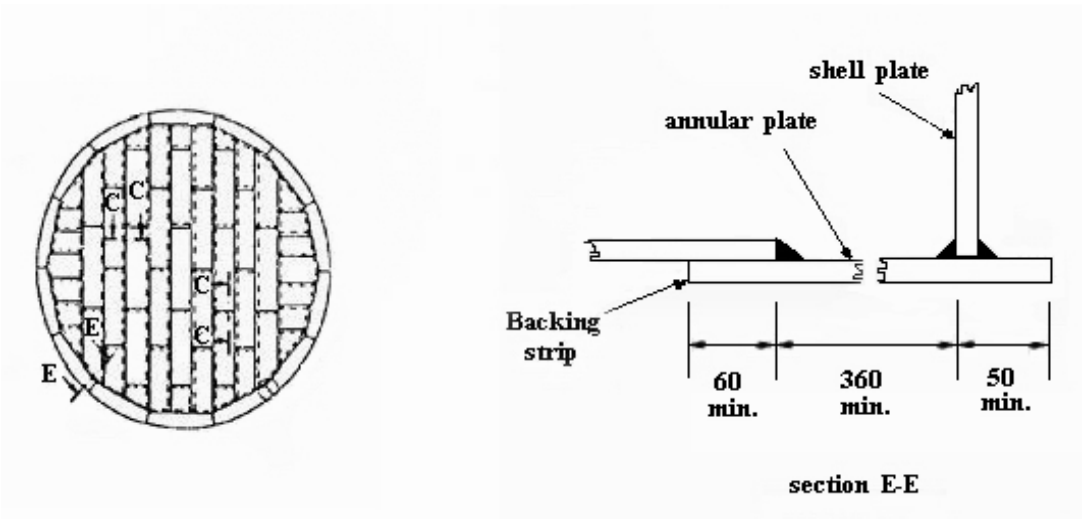
7.2.2 Bottoms

7.2.2.4 Bottom plating shall be in accordance with the storage tank constructional drawing. Attention shall be paid to erection marks made on bottom plates according to marking diagram which is supplied by the tank plate fabricator for the use of tank erection manufacturer. **(Add)**

7.2.2.5 Unless otherwise required, bottoms shall be laid commencing with the center plate and with subsequent plates lapped towards the center of the tank and the layout shall be as indicated in figure 4. **(Add)**



a) Typical bottom layout for tanks up to and including 12.5m diameter.



b) Typical bottom layout for tanks over 12.5m diameter. For layout of plates similar to sections A-A and B-B see(a).

TYPICAL BOTTOM LAYOUTS FOR TANKS

Fig. 4

7.2.2.6 No restraint of bottom plates by weights during welding is permitted. **(Add)**

7.2.2.7 When the storage tank is to be placed on a concrete foundation ring, no backing strips shall be used for butt welding of radial seams connecting the ends of the annular segmental plates. The welding shall be done from top and underside to get a full penetration butt weld without obstruction for concrete ring under the annular plate. **(Add)**

7.2.3 Shells

7.2.3.8 All vertical joints in shell plates exceeding 13 mm thick except the rootruns shall be welded by the "upward" technique. Rootruns may be welded by either the "upward" or "downward" technique. Further more, in the latter case, the weld metal shall be completely removed by gouging or other suitable means to sound clean metal, before welding on the reverse side. **(Add)**

7.2.3.9 The erection manufacturer shall employ suitable methods for the protection of the shell against temporary loads during erection. Full details of these methods shall be made available for purchaser's approval. **(Add)**

7.2.3.10 A mouse hole (20 mm radius) shall be made in the joining sections next to the tank shell to prevent fusion between butt weld and tank shell. **(Add)**

7.2.4 Shell – to- bottom welds

7.2.4.4 The inner fillet weld shall be inspected prior to welding the outside fillet weld. Leak testing shall be performed with penetrating oil after removal of slag. Oil shall be removed before welding the outer fillet. **(Add)**

7.2.4.5 Examination for cracks in inner fillet weld shall be preformed, using either the liquid penetrant or magnetic particle method. **(Add)**

7.2.4.6 Radiographic examination of fillet welds shall not be required. **(Add)**

7.2.5 Roofs

7.2.5.1 Before erection of the roof framing begins, the tank shell shall be carefully checked for uneven settlement and any misalignment of the top of the shell shall be corrected before the roof members are positioned. **(Add)**

7.2.5.2 Temporary supports for erection of the roof framing shall not be removed until the erection of the main and secondary framing is completed.

With dome roofs the temporary center support shall not be removed until radial rafters, purlings and bracings are erected, completed and welded, and all roof sheets are tack-welded into position. The positioning of the roof trusses shall be done very accurately to prevent misalignment. **(Add)**

7.2.5.3 When assembling roof sheets on the framing, excessive unsymmetrical loads shall be avoided and not more than three roof sheets shall be stacked at anyone point.

For dome roofs, the roof sheets shall be assembled symmetrically working from the center outwards. **(Add)**

7.2.5.4 The strength of erection poles used for temporary support of the roof structure shall be checked by calculation for the maximum load to be carried. In particular the resistance to buckling shall be checked. The erection manufacturer shall make a calculation showing strength and safety of the erection poles to be used. **(Add)**

7.3 Inspection, Testing, and Repairs

7.3.1 General

7.3.1.5 After removal of any temporary back up rings or strips the weld area shall be dressed and examined using magnetic particle or liquid penetrant. **(Add)**

7.3.3 Examination and testing of the tank bottom

7.3.3.1 All bottom plate welds shall be tested using a vacuum box which enables any leak in the seams to be positively located by visual examination (in accordance with section 8.6 of API standard 650). Alternatively, if a vacuum testing box is not available, the bottom seams may be tested by pumping air beneath the bottom plates to a pressure just sufficient to lift them off the foundation, but to a maximum of 0.7kPa (7mBar).

The pressure shall be held by sealing off the periphery with a temporary dam of clay or other suitable material around the tank bottom. This method shall not be used for floating roof tanks and be limited to smaller tanks only, if used at all.

For detection of leaks, soap suds or other alternative substance shall be applied to all joints.

The test shall preferably be made as soon as possible after welding of the bottom, removal of slag and wire brushing, but before any surface coating is applied. The bottom plates shall in any case be tested before water is let into the tank for hydrostatic testing.

After jacking–up of tank for relevelling, the tank bottom shall again be tested for leaks. **(Add)**

7.3.5 Testing of the shell

3. Continuous inspection shall be maintained for the whole filling period. All leaks found shall be repaired with the water level at least 300 mm below the point being repaired**.** **(Add)**

7.3.7 Testing of the roof

7.3.7.1

a) Unless otherwise specified when the tank shell is tested with water, the roof joints shall be tested by applying an internal air pressure equal to 0.75kPa (7.5mBar) for non pressure tanks and 0.3kPa (3mBar) above the design pressure of the tank for pressure tanks.

b) In the case of column supported roof tanks, the air test pressure shall be limited to that pressure equivalent to the weight of the roof plates unless specified otherwise. **(Mod)**

7.3.7.3 Roof manholes shall be open while filling or emptying a fixed roof tank for test purposes, so that the tank is not damaged by excessive vacuum or pressure loading. **(Add)**

7.3.7.4 Pressure and vacuum relief vents shall normally be installed after completion of tank water test or alternatively shall be blanked–off during the testing of the roof. After installation or immediately following the roof pressure test, all vents shall be carefully examined to ensure that all packing and blanks have been removed and all moving parts function normally. **(Add)**

7.3.8 Additional requirements for testing

a) The manufacturer shall provide detailed procedure of all required testing as mentioned below and submit 3 copies of all documents for purchaser's approval. The reports shall be made in the forms which will be indicated in the detailed testing procedure manual.

1. Reinforcement – plate test method

2. Bottom, shell and roof test method
3. Other internal component / attachment test method: such as heating coils, alignment and suspension of mixer and etc.
4. Filling and unfilling method as a part of hydrostatic test
5. Load / settlement measurement method during hydrostatic test
6. Source of water to be used for the test and any requirements for inhibition, purification or treatment of water
7. Required measurement instrumentation devices during testing
8. Safety precautions and practices
9. The complete schedule of proposed equipment and material and where they will be installed during testing
10. The list of personnel and their qualifications, responsible for carrying out the test program.

b) While it is normal practice to test all tanks by filling with water before commissioning this filling should be done under controlled conditions to ensure that foundation failure does not occur during filling. The hydrostatic test pressure is an integral part of the foundation design and should be agreed with a soil mechanic specialist.

c) Particular care is to be taken during both the filling and emptying operation to ensure that there is adequate venting of tank to avoid damage to the roof.

d) Number of points and rate for measuring of settlement shall be adapted to design specification.

e) All tank tests will be carried out to provide adequate measure of load / settlement records.

f) Uneven settlement of the tank on its foundation shall be reported immediately to the owners representative and filling shall be stopped at any signs of excessive settlement pending a decision by the owner's representative on the action to be taken.

g) The first tank in a new area will be the most critical and subsequent testing arrangement on other tanks should be adjusted in the light of the first results where the tanks are on similar sub-soil conditions. **(Add)**

7.3.9 Testing of heating coils

Heating coils or other heating devices containing fluid under pressure, if fitted, shall be tested hydrostatically, whilst the tank is empty, to a pressure of 1.5 times working pressure, but not less than 700kPa (7Bar) gage. **(Add)**

7.3.10 Anchorages

If tank anchorages are provided, they should be checked and readjusted, if necessary, with the tank full of water and prior to the air pressure test. **(Add)**

7.3.11 On completion of all tests the entire storage tank must be free from leaks to the satisfaction of the owner inspector. **(Add)**

7.5.4 Local deviations

a) Deviations (peaking) at vertical weld joints shall not exceed 10 mm. Peaking at vertical weld Joint shall be determined using a horizontal sweep board 1m long. The sweep board shall be made to the nominal radius of the tank. **(Mod)**

b) Deviation (banding) at horizontal weld joints shall not exceed 10 mm. Banding at horizontal weld joint shall be determined using a straight edge vertical sweep board 1 m long. **(Mod)**

7.5.5.4 Unless otherwise specified, foundations for tanks will be constructed to the specified levels, profiles and tolerances. **(Add)**

7.5.5.5. For tank, to have a shell which is truly circular and free from buckles and flat spots, the foundation shall remain level as the tank shell is erected. For this reason the foundation shall be checked, not only at the commencement of operations, but several times during the various stages of tank erection. The measurements shall be stated in a report. This final report shall be handed to the owner for maintenance purposes. **(Add)**

7.6 Protection of Shell during Erection

The erection manufacturer shall employ suitable methods for the protection of the shell during erection which have been agreed with the owner. When required by the owner, full details of these methods shall be made available for his approval. **(Add)**

SECTION 8. METHODS OF INSPECTING JOINTS

8.1.2.2

a. Storage tank shell vertical, horizontal and T-joints shall be inspected by radiography method. The extent and location of radiography shall be as specified in table 2 of this Standard. **(Mod)**

e. Butt welds around the periphery of an insert plate shall be radiographed over the whole of their length. **(Mod)**

TABLE 2 - EXTENT OF RADIOGRAPHY PER TANK

THINNER PLATE THICKNESS	VERTICAL WELDS AND T-JOINTS	HORIZONTAL SEAMS	ANNULAR BOTTOM BUTT WELDS*
OVER 25 mm	10% OF TOTAL SEAM LENGTH PLUS ALL T-JUNCTIONS **	2% OF SEAM LENGTH	-
OVER 13 mm UP TO AND INCLUDING 25 mm	10% OF TOTAL LENGTH, AT LEAST HALF OF THE RADIOGRAPHS TO INCLUDE T-JUNCTIONS	2% OF SEAM LENGTH	-
UP TO AND INCLUDING 13 mm	1% OF TOTAL VERTICAL SEAM LENGTH	1% OF SEAM LENGTH	-
ANNULAR PLATES OVER 10 mm	-	-	ALL JOINTS
ANNULAR PLATES OVER 8 mm UP TO AND INCLUDING 10 mm	-	-	HALF THE NUMBER OF JOINTS
ANNULAR PLATES UP TO AND INCLUDING 8 mm	-	-	A QUARTER OF THE NO. OF JOINT, WITH A MIN. OF 4 RADIOGRAPHS

*** The length to be radiographed shall consist of that length from the outside of the annular plate to a point 250 mm inside the tank.**

**** 50% of radioghraphs with film horizontal and 50% of radiographs with film vertical.**

Note: welds part to be radiographed will be selected by the owner's representative. (Mod)

8.1.2.3 Storage tank shell horizontal joints shall be inspected by radiography method. The extent and location of radiography shall be as specified in table 2 of this standard. **(Mod)**

8.1.2.10 Annular plate butt joints shall be radiographed as specified in table 2 of this standard. If for any reason, radiography is not possible, the joints may be magnetic particle tested from the topside after completion of the root pass and again after completion of the full weld. **(Add)**

8.1.5 Acceptance levels for radiographic examination shall be in accordance with table 3 of this standard. **(Mod)**

TABLE 3- ACCEPTANCE LEVELS FOR RADIOGRAPHIC EXAMINATION

DEFECT TYPE	**PERMITTED MAXIMUM**
CRACK	NOT PERMITTED
LACK OF FUSION	NOT PERMITTED
INCOMPLETE PENETRATION	NOT PERMITTED
ISOLATED PORES	Ø<t/4
UNIFORMLY DISTRIBUTED OR LOCALIZED POROSITY	2% BY AREA * (AS SEEN IN A RADIOGRAPH)
LINEAR POROSITY	LINEAR POROSITY IN VERTICAL WELDS PARALLEL TO THE AXIS OF THE WELD MAY INDICATE LACK OF FUSION OR LACK OF PENETRATION AND THEREFORE IS NOT PERMITTED.
WORMHOLES, ISOLATED	LENGTH < 6 mm
WORMHOLES, ALIGNED	AS LINEAR POROSITY
INDIVIDUAL SLAG INCLUSIONS PARALLEL TO MAJOR WELD AXIS **NOTE:** INCLUSIONS TO BE SEPARATED ON THE MAJOR AXIS BY A DISTANCE EQUAL TO OR GREATER THAN THE LENGTH OF THE LONGER INCLUSION AND THE SUM OF THE LENGTHS OF THE INCLUSIONS SHALL NOT EXCEED THE TOTAL WELD LENGTH BEING EXAMINED.	LENGTH < t

*** Area to be considered should be the length of the weld affected by porosity multiplied by the maximum width of the weld locally.**

Note: In this table the following symbols are used:

Ø is a defect diameter (in mm)

t is the thickness of thinner plate being joined (in mm) **(Mod)**

SECTION 9. WELDING PROCEDURE AND WELDER QUALIFICATIONS

9.2.1.1.1 Manufacturer shall submit for purchaser's approval prior to material supply his weld preparation procedure including details of beveled plates to be supplied. **(Add)**

9.2.1.1.2 All welding procedures submitted shall be identified with the specific item and purchase order numbers. **(Add)**

9.2.1.1.3 The manufacturer shall show on a drawing the applicable welding procedure and nondestructive tests required. **(Add)**

APPENDICES

APPENDIX C

EXTERNAL FLOATING ROOFS

C.3 Design

C.3.1 General

All floating roofs shall be designed so that the vapor spaces are minimum. **(Mod)**

C.3.2 Joints

The variations in the gap between the shell and the periphery of the roof on completion of erection of roof shall not exceed ±13 mm from the nominal gap. **(Mod)**

C.3.3 Decks

C.3.3.7 At any elevation of the roof other than that at which it was erected, this difference in gap shall not exceed 50 mm unless some other value has been agreed upon for a particular seal design. **(Add)**

C.3.3.8 Unless otherwise specified, double deck floating roof shall be provided for storage tanks over 84m diameter and for smaller tanks when required by the Purchaser. **(Add)**

C.3.7 Ladders

If the tank diameter is equal to or greater than the height, a rolling type roof ladder with self-leveling treads shall be furnished having a minimum angle of 30 degree from the vertical. If the tank diameter is less than the tank height, it shall have a vertical roof ladder. **(Mod)**

C.3.8 Roof drains

a) The design and use of roof drains shall be as follows:

Floating roofs shall be provided with articulated (swivel) pipe or proper flexible hose drains. The inlet for these drains shall have a swing type check valve to prevent product from flowing on to the roof if the pipe or hose drain fails.

b) Emergency drains shall not be installed in pontoon type roofs, as the oil level in the tank is always higher than the rain water level on the center deck of the roof. The minimum size of the roof drains shall be DN 65 for tanks up to and including 20m, DN 100 for tanks over 20m and DN 150 for tanks of 60m or more in diameter.

c) In areas with excessive rainfall in short periods, e.g. the tropics, it is recommended to install two roof drains. Under normal circumstances tanks shall be operated with open roof drains. **(Mod)**

C.3.9 Vents

a) Automatic bleeder vent

Each roof shall be equipped with a bleeder vent, designed to open automatically when the roof lowers to 75 mm its lowest operating position or lower leg setting, and to close automatically when the roof raises more than 75 mm above its lowest position.

b) Rim seal vent

When flexible steel shoe type seals are employed the roof shall be equipped with a vent or vents between the roof rim and the seal shoe. These vents shall release excess air of non condensable

vapors entering the tank through the filling line. **(Mod)**

C.3.10 Supporting legs

C.3.10.1 Floating roof supports shall be adjustable to two following position:

a) The lower position shall permit the roof to go 1m above the tank bottom without interference with any internal accessories or roof seal mechanism.

b) The upper position (for cleaning and maintenance) shall provide for a clearance of 2m between the lowest portion of the roof and the tank bottom. **(Mod)**

C.3.10.10 Floating roof supports shall be made of carbon steel pipe, schedule 80 minimum thickness. Legs shall be provided with a 50 mm × 25 mm notch at the bottom to provide drainage. **(Add)**

C.3.10.11 The length of the leg support sleeves shall be such that any opening will be above the liquid level when the deck is deflected by the 250 mm rainfall or punctured center deck condition. In no case shall the height of the support for single deck pontoon roofs be less than the tank diameter divided by 60. **(Add)**

C.3.12 Centering and antirotation devices

Floating roofs shall be designed for elastic stability against “gross out of plane” buckling and “local” buckling of the outer pontoon due to the radial load imposed by deflection of the center deck. The radial load shall be determined from the 250 mm rainfall loading condition as specified in 3.2.6, or punctured center desk loading condition whichever governs.

For preventation of “gross out of plane” bucking the following relationship shall be satisfied:

a) For fully stiffened pontoons:

$$P < 3.784 \times 10^{-3} \frac{EIx}{R^3}$$

b) For partially stiffened pontoons:

$$P < 2.526 \times 10^{-4} \frac{EIx}{R^3}$$

Where:

P= Design radial inward load, Newton per millimeter

E= Modules of elasticity, kPa.

I_X= Moment of inertia of full pontoon cross section with respect to horizontal axis through its centroid, mm^4.

R= Mean radius of pontoon ring, mm

c) The radially unsupported width of partially stiffened plates shall not exceed 3meters **(Mod)**

C.3.13 Peripheral seals

a) Moving part pins shall be 18/8 stainless steel. Also if the hanger mechanism is in the vapor space below the seal, stainless steel shunts 50 mm wide × 0.6 mm thick × 400 mm long shall be provided between the shoe and roof above the seal area. At least one shunt shall be provided for each hanger.

b) Toroidal type seals shall be equipped with a weather shield.

c) Roof seals shall contact the shell above the liquid level for at least 90% of circumference. The maximum permissible gap between the primary seal and the tank shell is 6 mm.

d) If liquid filled tube seals are required, the seal shall be sectionalized i.e. discontinuous, in order to prevent the complete loss of sealing in the event of leakage. **(Mod)**

C.3.16 Floating roofs are to be provided with the mountings listed in Fig. 5. In the case of double deck roofs, manholes, in addition to pontoon manholes shall be spaced on distances not exceeding 30 m. **(Add)**

C.3.17 Adequate means shall be provided to prevent electrical charge on the floating roof causing sparking in or above the seal. In the case of liquid filled tube seals a galvanized steel weather shield shall be provided which shall also permit the discharge of static or lightning induced electrical charges from the roofs, to the shell without causing sparking. **(Add)**

C.4 Fabrication, Erection, Welding, Inspection, and Testing

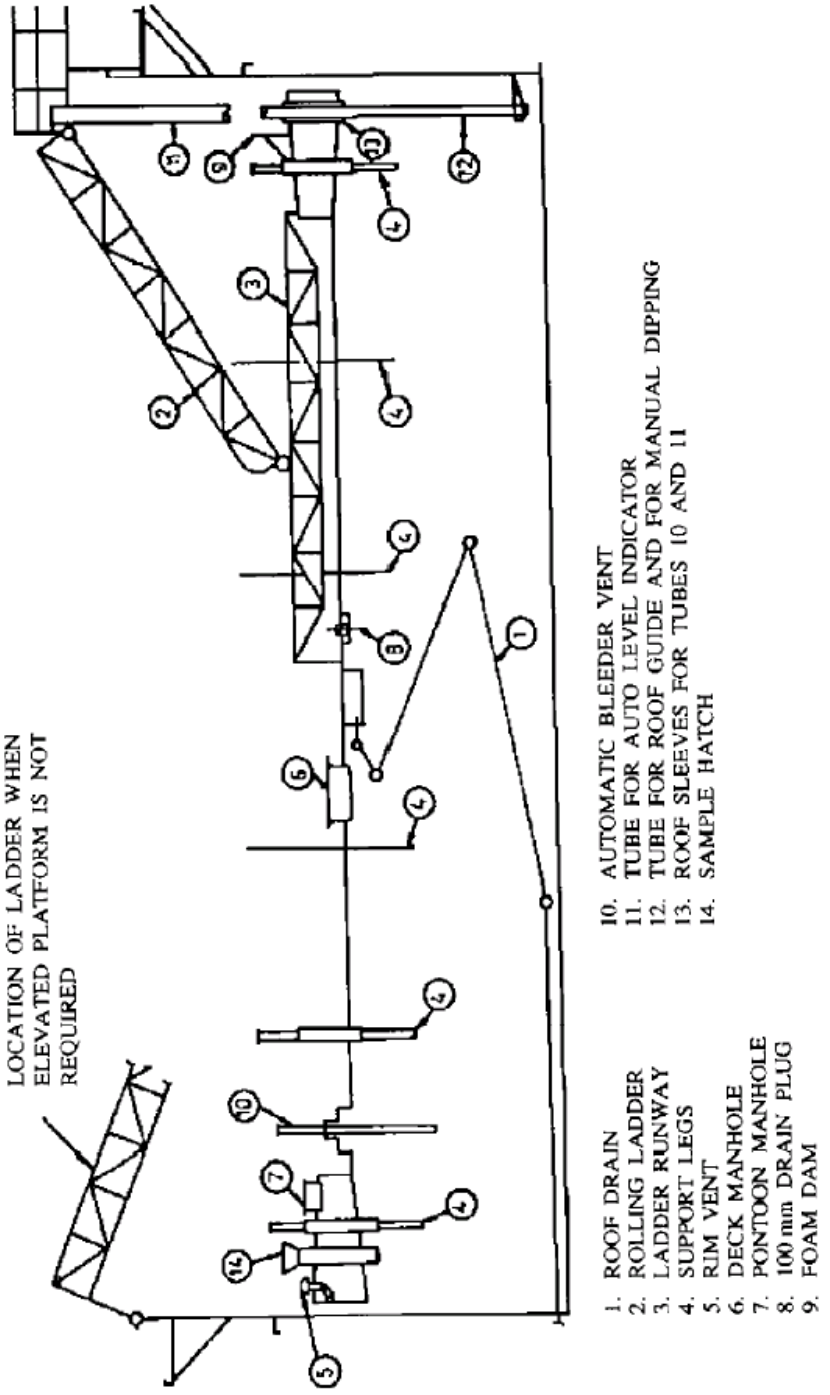
C.4.1:

a) The center deck plate, pontoon bottom plate and rim plate welded joints shall be tested by spraying with a penetrating oil, such as light gas oil, on the bottom side and inspecting visually on the top side and inside of rim plates.

Either of the methods of test specified in (b) or (c) below, shall be applicable;

b) The fillet welds connecting the bulk heads between pontoon to the inner and outer rim plates and to the pontoon bottom shall be examined for leaks using penetrating oil prior to the installation of the pontoon top plates. When continuously welded, the welds connecting the pontoon top plates shall be inspected visually for pinholes or defective welding;

c) Alternatively, when the compartments are completely welded, each completely welded compartment of pontoon roof shall be individually tested with an air pressure of 0.7kPa (7 mbar) gage, a soapy water solution being applied to all welded joints under pressure which have not been previously tested with penetrating oil. **(Mod)**



TYPICAL MOUNTINGS FOR FLOATING ROOFS
Fig. 5

C.4.3.1 The roof drain of the floating roof storage tanks shall be installed prior to the hydraulic test on the tank and during this test the drain shall be examined to ensure that it is not leaking due to external pressure. **(Add)**

C.4.3.2 The roof shall be given a floatation test while the tank is being filled with water and emptied. During this test, the upper side of the lower deck and all pontoon compartments shall be examined for leaks. Rainwater shall be prevented from entering the pontoon compartments during this test. **(Add)**

C.4.3.3 The sealing mechanism shall be checked to ensure proper functioning over the full height of the shell. **(Add)**

C.4.5 Roof drains together with any flexible coupling incorporated with them shall be subjected to a hydrostatic test pressure of 3.5kPa (3.5Bar) gage. The tank shall be empty during this test. To ensure freedom from internal obstructions. The drain piping should be flushed through before testing. **(Mod)**

APPENDIX L

API STANDARD 650 STORAGE TANK – DATA SHEETS

TABLE L-1—INDEX OF DECISIONS OR ACTIONS WHICH MAY BE REQUIRED OF THE PURCHASER

This checklist shows the standard requirements of IPS as purchaser for those items which are indicated by bullet (●) in API std. 650

S: to be specified Y: Yes N: No I: As per IPS

Reference Paragraph	Decision	Reference Paragraph	Decision	Reference Paragraph	Decision	Reference Paragraph	Decision
Foreword	S	5.2.3 (a, b, c)	I	5.8.11.3	Y	8.1.2.7	Y
1.1.2	I	5.2.4	Y	5.9.3.3	Y	8.1.4	Y
1.1.3	I	5.2.6.1	Y	5.9.6.1 (Note)	Y	8.1.6	Y
1.1.5	S	5.3.1.1	S	5.9.7.1 (*t*, d)	Y	8.1.7.2	Y
1.1.6	S	5.3.2.1	I	5.9.7.2 ($t_{uniform}$, t_{actual})	Y	8.1.8.2	Y
1.1.12	S	5.3.2.3	S	5.9.7.7	Y	8.3.2.5	Y
Table 1-1 (App. C, E, G, I, L, O, P, V, W)	S	5.3.2.6	S	5.10.2.2	Y	8.6.3	Y
1.1.16	S	5.3.3	S	5.10.2.4	Y	8.6.10	Y
1.1.19	Y	5.3.4	Y	5.10.2.6	Y	8.6.11	Y
1.1.23	S	5.3.5	S	5.10.2.7	Y	9.2.1.1	Y
1.1.30	Y	5.4.1	Y	5.10.2.8	Y	10.1.1 (e, f, g, j, k)	Y
1.3.2	Y	5.4.4	Y	5.10.3.1	Y	Figure 10-1 (Note)	Y
1.3.3	Y	5.4.5	Y	5.10.4.1	I	10.3 (Note)	Y
1.4	Y	5.6.1.1 (Notes 1, 3)	Y	5.10.4.4	Y	A.1.1	Y
4.1.1.4	Y	5.6.1.2	Y	5.10.4.5	Y	A.1.2	Y
4.1.2	Y	Tables 5-2a and 5-2b (Notes a, b)	S	5.10.5	Y	A.3.4	Y
4.1.3	Y	5.6.3.2 (*H*, *G*, *CA*)	Y	5.10.6	Y	A.4.1 (*G*, *CA*)	Y
4.1.5 (b)	Y	5.6.4.1	S	5.12.5	S	A.6	Y
4.2.1.3	I	5.6.4.6 (H)	Y	5.12.6	Y	A.8.2	Y
4.2.6	Y	5.7.1.4	Y	5.12.10	Y	A.9.2	Y
Table 4-1 (Note 1)	Y	5.7.1.8	S	6.1.1.1	Y	B.3.3	Y
Table 4-2 (Note C)	Y	Figure 5-7A (Note 7)	Y	6.1.2 (Note)	I	B.3.4	Y
4.2.8.4	S	Figure 5-7B (Note 6)	Y	6.1.3	I	B.4.4.1	Y
4.2.9.1	Y	Figure 5-8 (Note 4)	Y	6.2.1	Y	C.1	Y
4.2.10.3	I	5.7.2.2	Y	6.2.3	Y	C.3.1.1	Y
4.4.1 (h)	S	5.7.2.3 (b)	Y	6.2.4	Y	C.3.1.2	Y
4.4.2	Y	Tables 5-6a and 5-6b (Note c)	Y	7.1.1	Y	C.3.1.5	Y
4.6.1	Y	Tables 5-8a and 5-8b (Note d)	Y	7.1.4	Y	C.3.3.2	Y
4.6.2	Y	Tables 5-9a and 5-9b (Note c)	Y	7.2.1.1	Y	C.3.4.1 (b)	S
4.7	Y	Figure 5-12 (Note 4)	Y	7.2.1.7	Y	C.3.4.2	Y
4.9.1.1	Y	5.7.3.4	Y	7.2.3.3	Y	C.3.5	S
4.9.1.4	Y	5.7.4.5	S	7.2.4.1	Y	C.3.7	Y
4.9.1.5	S	5.7.5.2	Y	7.2.4.3	S	C.3.8.1 (1, 3)	Y
4.9.2	Y	5.7.6.1.a	Y	7.3.1.3	S	C.3.8.2	Y
4.9.3.1	Y	5.7.6.1.b	S	7.3.2.1	Y	C.3.8.3	Y
5.1.3.6.1	S	5.7.6.2	S	7.3.2.3	Y	C.3.10.1	Y
5.1.3.8	S	5.7.6.3	S	7.3.5, 1	Y	C.3.10.3 (b)	Y
5.1.5.3 (b)	I	5.7.7.1	Y	7.3.6.2 (2, 3, 4, 5, 7)	Y	C.3.10.4	Y
5.1.5.4.1	Y	5.7.8.1	I	7.3.6.3	S	C.3.10.8	Y
5.1.5.5	Y	5.8.2	Y	7.3.6.5 (Note)	S	C.3.10.9	Y
5.1.5.8 (b)	Y	5.8.5.3	Y	7.3.7.2	S	C.3.12.3	Y
5.1.5.9 (e)	I	5.8.5.4	Y	7.4.1	Y	C.3.13.2	Y
5.2.1 (a, b, e, g, h, i, k.1)	Y	5.8.7	Y	7.4.4	Y	C.3.13.3	Y
5.2.2	Y	5.8.11.2	Y	7.5.1	Y		
C.3.13.5 (Primary, Secondary Seal)	Y	H.4.2.2.2	Y	M.4.2 (c)	Y		
C.3.14.1 (1)	Y	H.4.2.3.2	Y	N.2.1	S		

(to be continued)

APPENDIX L (continued)

Reference Paragraph	Decision	Reference Paragraph	Decision	Reference Paragraph	Decision	Reference Paragraph	Decision
C.3.14.2	Y	H.4.3.3	Y	N.2.2	S		
C.3.14.4	Y	H.4.3.3.1	Y	N.2.4	S		
C.3.14.5	Y	H.4.3.4	Y	N.2.5	S		
C.3.14.6	Y	H.4.3.5	Y	N.2.6	S		
C.3.15.2	Y	H.4.4	Y	O.2.2	S		
C.3.15.3	Y	H.4.4.2	Y	O.2.6	S		
C.3.15.4 (a, e)	Y	H.4.4.4	Y	O.3.1.4	S		
E.1	S	H.4.6.1	Y	P.1	S		
E.3.1	S	H.4.6.2	Y	P.2.1	Y		
E.4.1	S	H.4.6.3	Y	P.2.2	Y		
E.4.2	S	H.4.6.5	Y	P.2.8.1	Y		
E.4.2.4	S	H.4.6.6	Y	P.2.8.2	Y		
E.4.4	S	H.4.6.7	Y	R.2	Y		
E.4.6.1	S	H.4.6.8	Y	S.1.2	Y		
E.4.6.2	S	H.4.6.9	Y	Table S-1a and S-1b (Notes 1, 2, 3, 5)	Y		
E.5.1.2	S	H.5.1.1	Y	S.2.1.2	Y		
E.6.1.3	S	H.5.1.4	Y	S.2.2	Y		
E.6.1.5	S	H.5.2.1	Y	S.3.1	Y		
E.6.1.6	S	H.5.2.2.1	Y	S.3.2 (*G, CA*)	Y		
E.6.2.1.2	S	H.5.2.2.3	Y	S.4.3.2	S		
E.7.2	S	H.5.3.1	Y	S.4.4.3	Y		
E.7.5	S	H.5.3.2	Y	S.4.5.1	Y		
F.5.1	Y	H.5.3.3	Y	Table S-2a and S-2b (Notes 2, 3)	Y		
F.7.4	Y	H.5.5.3	Y	Table S-3a and S-3b (Note 4)	Y		
G.1.3.2	S	H.5.6	Y	S.4.9.2	Y		
G.1.3.3	S	H.5.7	Y	S.4.10.2 (a, f)	S		
G.1.4.1	S	H.5.8	Y	S.4.10.3	Y		
G.1.4.2	S	H.5.9	Y	S.4.13	Y		
G.1.4.4	S	H.6.1	Y	S.6 (b)	Y		
G.2.1	S	H.6.2	Y	U.3.1	Y		
G.2.4	S	H.6.4 (Note)	Y	U.3.3	Y		
G.4.3	S	H.6.6	Y	U.3.5	Y		
G.5.3	S	H.6.6.1	Y	U.4.3	Y		
G.6.2	S	I.1.2	Y	Appendix V	Y		
G.7	S	I.1.3	Y	Appendix W	Y		
G.8.3	S	I.2 (e)	Y				
G.9	S	I.5.5	Y				
G.10.1.1	S	I.6.2	Y				
G.10.1.2	S	I.6.3	Y				
G.11.3	S	I.6.4	Y				
H.1.1	Y	I.7.1	Y				
H.1.2	Y	I.7.3.2 (CA)	Y				
H.1.3	Y	I.7.6	Y				
H.2.2 (f, g, h)	Y	J.1.2	Y				
H.3	Y	J.3.6.3	Y				
H.4.1.6	Y	J.3.7.1	Y				
H.4.1.7	Y	J.3.7.2	Y				
H.4.1.8	Y	J.3.8.2	Y				
H.4.1.9	Y	J.4.2.2	Y				
H.4.1.10	Y	Appendix L	Y				
H.4.2.1.1	Y	M.1.2 (Note)	S				
H.4.2.1.3	Y	M.2	Y				

APPENDIX Z (Add.)

PACKAGING

Z.1 When considering the following instructions, due regards shall be paid to handling facilities in transit and at the destination, and also to any special packaging instruction given in the purchase order.

Z.2 Structural materials and plates shall be treated as follows:

Z.2.1 To prevent damage in transit all roof plates shall be bundled by welded clips as shown in Appendix Z Fig. 6.

The maximum weight of single bundle shall not exceed approximately 1 ½ tons.

Bundling shall not take place until the paint is thoroughly dry.

Z.2.2 All shell and bottom plates shall be bundled as described under Z.2.1 above, except that maximum weight of a single bundle shall not exceed approximately 2tons.

Z.2.3 All structural members, such as roof framing, curb angles, wind girders, hand rails and stair threads, shall be bundled and secured by bolting or tack welding. To prevent the nuts from loosening during transit, either the threads must be damaged or the nuts spot welded to the bolts. The weight of a single bundle shall not exceed approximately one ton.

Z.2.4 All gusset plates, cleats, etc. shall be securely bundled by bolting, each bundle weighing approximately ¼ton.

Z.2.5 All small parts such as bolts, nuts, erection key plates, shim plates, wedges etc. shall be bagged and packed separately, and shall be enclosed in stout wooden cases. The minimum thickness of timber used for the cases shall be 22 mm. The total weight of each case shall not exceed approximately ½ton.

Z.3 Roof and shell manholes, nozzles, bottom sumps and clean outs, etc. may be shipped loose. Manhole and clean out cover shall be bolted on with gasket in position. Flange of nozzles, etc. shall be adequately protected to prevent damage in transit.

Roof vents, dip hatches and similar fittings shall be packed complete with gasket, etc. in stout wooden case, and shall be securely fixed there to prevent damage in transit.

Cases shall be made of timber not less than 22 mm thick strongly battened, and banded with tensioned steel strapping. The weight of any case shall not exceed ¼ton.

Z.4 All welding electrodes, rods, wires and fluxes shall be packed in such a manner as to keep them in first class condition during transport and storage.

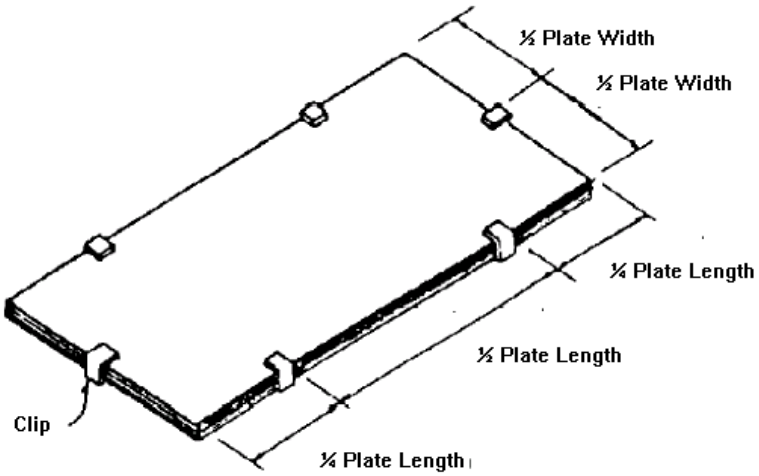
Welding electrodes shall be supplied in containers which give adequate protection against damage and moisture in transit and in storage on site.

The type of packing to be employed shall be specified by the electrode manufacturer.

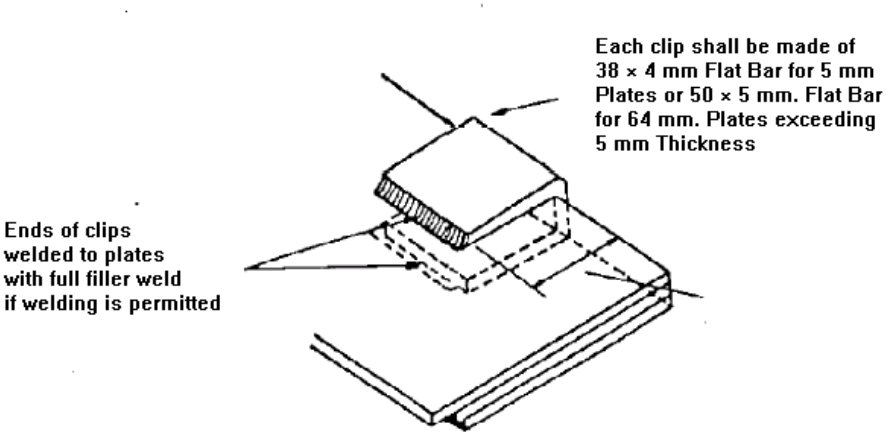
(to be continued)

APPENDIX Z (continued)

BUNDLING METHOD



Note 1: Use 6 numbers of clips for each bundle except where ½ plate length exceeds 4 m in that case use three clips on each side which is 8 clips per bundle.



Note 2: When welding is not permitted use other safe methods for bundling.

BUNDLING OF ROOF, SHELL AND BOTTOM PLATES

Fig. 6

APPENDIX ZV (Add.)

SHIPMENT

ZV.1 Plates and storage tank material shall be loaded in such a manner as to ensure delivery without damage.

ZV.2 Shipping marks shall be provided as follows:

ZV.2.1 Whenever possible, the shipping marks and any other desired particulars shall be stenciled on each bundle, case or package. Stenciled marks shall be at least 50 mm high. If stenciling cannot be applied, the information shall be suitably stamped on a metal label, securely attached to the package. Stamped symbols shall be at least 13 mm high.

ZV.2.2 If any confusion is likely to arise in reception, storing or distribution of the materials (e.g. in the case of purchase orders comprising materials for more than one tank), all parts shall have painted on them a further distinctive mark in addition to any erection or shipping marks. Such additional marking shall consist of a colored band or other mark as agreed with purchaser.

ZV.2.3 All identification marks shall be applied on at least two sides of each package.

ZV.3 Each package, case and bundle shall be accompanied with a packing list.

APPENDIX ZW (Add.)

GUARANTEE

ZW.1 Vendor shall guarantee that the materials delivered to be incorporated into storage tank(s) are in accordance with the purchase order and will be free from any defects in design, workmanship and material and that they will give proper service under the operating and design conditions as specified, for a period of 18 months, reckoned from the day on which the tanks are delivered.

ZW.2 The period of 18 months specified above shall be extended by any period(s) during which the tanks after delivery are out of action as a result of any defect covered by this guarantee.

ZW.3 In the event of defects covered by this guarantee, Purchaser shall notify vendor as soon as possible and Vendor shall without delay remedy or repair free of charge (cost of labor and transportation not excluded) the tank(s) having such defects, or authorize Purchaser to do so. In the latter event Vendor shall reimburse to Purchaser the actual out of pocket costs, excluding over heads and similar administrative costs.

ZW.4 Remedying and repairing may be affected by Purchaser without prior approval by Vendor in cases where it would be unreasonable to demand that prior approval be obtained. In such case Vendor and Purchaser shall agree which party shall bear the costs and expenses thereof or in what proportion these costs and expenses shall be divided between them. This guarantee shall remain in effect, provided the remedying and repairing do not result in any detriment to the tank.(s)

ZW.5 In no event will this guarantee cover defects due to normal wear and tear, disregard by Purchaser or his consignee of operating instructions, excessive over loading by Purchaser or his consignee or unsuitable operating conditions.

APPENDIX X

PIPE COMPONENTS – NOMINAL SIZE

The purpose of this Appendix is to present an equivalent identity for the piping components nominal size in Imperial System and SI System.

TABLE X

Nominal Size		Nominal Size		Nominal Size		Nominal Size	
DN (1)	NPS (2)	DN (1)	NPS (2)	DN (1)	NPS (2)	DN (1)	NPS (2)
15	½	100	4	500	20	1000	40
20	¾	125	5	600	24	1050	42
25	1	150	6	650	26	1100	44
32	1¼	200	8	700	28	1150	46
40	1½	250	10	750	30	1200	48
50	2	300	12	800	32	1300	52
65	2½	350	14	850	34	1400	56
80	3	400	16	900	36	1500	60
90	3½	450	18	950	38	1800	72

1) Diameter Nominal (DN), mm.

2) Nominal Pipe Size (NPS), Inch.

APPENDIX Y

PIPE FLANGES, PRESSURE – TEMPERATURE RATINGS

The purpose of this Appendix is to present an equivalent identity for the pipe flange nominal pressure temperature ratings in Imperial System and SI System.

TABLE Y

PN (1)	Equivalent (2)
20	150
50	300
68	400
100	600
150	900
250	1500
420	2500

1) Pressure Nominal (PN), bar gage.

2) Pounds per square inch gage, (psig).