

MATERIAL AND EQUIPMENT STANDARD

FOR

PRESSURE STORAGE VESSELS AND SPHERES

(FOR LPG)

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0. INTRODUCTION

Storage Tanks are broad and contain variable types and usages of paramount importance, therefore, a group of Material Standards are prepared to cover the subject. This group includes the following standards:

STANDARD CODE	STANDARD TITLE
IPS-M-ME-100	"Atmospheric Above Ground Welded Steel Storage Tanks"
IPS-M-ME-110	"Large Welded Low Pressure Storage Tanks"
IPS-M-ME-120	"Aviation Turbine Fuel Storage Tanks"
IPS-M-ME-130	"Pressure Storage Spheres (For LPG)"

The requirements given in this Standard Supplement those of ASME pressure vessels code section VIII Division 1, 1989 edition.

For ease of reference, the clause or section numbring of ASME for items supplemented, is given at the begining of each paragraph.

For the purpose of this Standard specification, the following definitions shall hold:

- Sub. (Substitution)** : The ASME Standard clause is substituted by a new clause.
- Del. (Deletion)** : The ASME Standard clause is deleted without any replacement.
- Add. (Addition)** : A new clause with a new number is added.
- Mod. (Modification)** : Part of the ASME Standard clause is modified, and/or a new description and/or condition is added to that clause.

1. SCOPE

1.1 This Material and Equipment Standard covers the minimum requirements for pressure storage vessels and spheres(for LPG).

Pressure storage, in this Standard, means storage spheres with design pressure above 100 kPa (1 bar) gage. The requirements of this specification apply to both refrigerated and non refrigerated LPG pressure storage spheres.

1.2 For pressure storage spheres intended for storage of Liquefied natural gas (LNG) reference shall be made to NFC 59A "Standard for production, storage and handling of liquefied natural gas".

1.3 This material and equipment standard gives general requirements to be met by a vendor when submitting quotations for and when supplying the material to be incorporated into the pressure storage spheres.

1.4 Furthermore, the terms and conditions laid down in the inquiry and the purchase order and any attachments thereto shall apply.

1.5 It should be noted that when only the design of pressure storage spheres are involved, the requirements of Iranian Petroleum Engineering Standard for pressure storage spheres (IPS-E-ME- 130) shall be met.

2. SOURCES AND REFERENCES

2.1 Sources

In preparation of this Standard, in addition to the Referenced Codes and Standards mentioned in 2.2, the following standards and publications have also been considered:

BSI (BRITISH STANDARDS INSTITUTION)

BS 5500 "Fusion Welded Pressure Vessels, 1989"

NIOC (NATIONAL IRANIAN OIL COMPANY)

SP-41-3 "Pressure Vessels"
Eng. Std.

2.2 References

Throughout this Standard the following standards and codes 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:

API (AMERICAN PETROLEUM INSTITUTE)

API 2510 "Design and Construction of Liquefied Petroleum Gas (LPG) Installations, April 1989"
API 2508 "Design and Construction of Ethane and Ethylene Installations, Nov. 1985"

NACE (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)

MR-01-75 "Standard Material Requirements, Sulfide Stress Cracking Resistant , Metallic Materials for Oil Field Equipment"

AWS (AMERICAN WELDING SOCIETY)**IPS (IRANIAN PETROLEUM STANDARDS)**

E-ME-130	"Engineering Standard for Pressure Storage Spheres"
C-ME-130	"Construction Standard for Pressure Storage Spheres"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

Section VIII Division I or 2	"Boiler and Pressure Vessel"
Section II	"Boiler and Pressure Vessel, Material Specifications"
Section IX	"Boiler and Pressure Vessel, Welding and Brazing Qualifications"

ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE)

B.1.1	"Unified Inch Screw Threads"
B.16.9	"Factory Made Wrought Steel Butt Welding Fittings"

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

A-578	"Specification for Straight Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special applications"
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NFC (NFPA) (NATIONAL FIRE CODES "NATIONAL FIRE PROTECTION ASSOCIATION")

59 A	"Standard for Production, Storage and Handling of Liquefied Natural Gas (LNG)"
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3. UNITS

International System of Units (SI) in accordance with IPS-E-GN-100 shall be used.

Whenever reference is made to API, ASME or any other standard, equivalent SI Unit System for dimensions, fasteners and flanges shall be substituted.

For pipe size, the international nomenclature "diameter nominal" written as DN 15,25,32,40, etc. has been used in accordance with ISO 6708, 1980, ANSI / ASME B16.5, 1981 and ANSI / ASME B 31.3, 1983 (see Appendix D). Also for pipe flanges, pressure temperature ratings "pressure nominal" written as PN 20,50,68, etc. has been used in accordance with the said standards (see Appendix E).

4. GENERAL REQUIREMENTS**4.1 Quotation (Add)**

Refer to Appendix A of this Standard for general information to be submitted in the quotation.

4.2 Secrecy (Add)

Refer to Appendix B of this Standard for secrecy requirements.

5. DESIGN

5.1 Design of pressure storage spheres shall be in accordance with ASME section VIII division 1.

Where justified, pressure storage spheres may be designed according to division 2 of ASME section VIII.

The requirements of Iranian Petroleum Engineering Standard for pressure storage spheres (IPS-E-ME-130) shall be also met. The followings shall be considered as supplementary:

5.2 (UG-16 Add)

Any part for which no drawing have been prepared shall be designed by vendor on the basis of the above mentioned standards.

5.3 (UG 54c Add)

The pressure retaining parts of sphere and their support columns shall be designed to be filled with water.

6. MATERIAL

6.1 Material selection for pressure storage spheres shall meet the requirements of section II of the ASME boiler and pressure vessel code.

Requirements of API 2510 for pressure storage of LPG spheres and requirements of API 2508 for pressure storage of refrigerated liquefied ethane and ethylene shall be met. The followings shall be considered as supplementary.

6.2 (UG-4 Add)

Low melting point materials of construction such as aluminum and brass, shall not be used for LPG storage spheres.

6.3 (UG-4 Add)

low ductility materials such as cast iron, semi steel, malleable iron and cast aluminum shall not be used in any pressure retaining accessory parts.

6.4 (UG-4 Add)

Mill certificates for the following materials shall be submitted for purchaser's approval.

6.4.1 Shell plates and reinforcing pads.

6.4.2 Forging materials such as flanges, nozzle/manhole necks.

6.4.3 Support columns and bracings.

6.4.4 Pipes and fittings for nozzle necks.

6.4.5 Welded attachments to pressure retaining parts.

6.4.6 Bolts and nuts for pressure retaining parts

6.5 (UG 4 Add)

Pressure retaining materials to be welded shall have the following chemical composition.

Carbon Equivalent (CeQ): $CeQ \leq 0.41 \%$

Where: $CeQ = C + Mn/6$

6.6 (UG-4 Add)

Material for pressure retaining parts specified for use in H₂S service, where defined in para. 1.3 of NACE standard MR-01-75, shall be selected in accordance with the said standard.

6.7 (UG-4 Add)

Materials of non pressure retaining parts to be welded directly to pressure retaining parts shall be of the same quality material as the pressure retaining parts.

6.8 (UG-8 Add)

Flange for sphere nozzles and connections shall be a minimum of PN 20 (150#) flange class (see Appendix H). All fittings shall have a minimum nominal diameter of DN 20 (¾") (see Appendix D).

6.9 (UG-12 Add)

The internal bolts and nuts including U bolts shall be of TP- 405 or 410 stainless steel.

6.10 (UG-8 Add)

Where connections are made to external piping, the material and all other requirements for nozzles, flanges, bolting, gasketing and pipe shall be met as specified in that piping class.

6.11 (UG-11 Add)

Manholes and blanked off nozzles shall have gaskets conforming to the piping specification for lines connecting to the storage nozzles, unless otherwise specified.

6.12 (UG-9 Add)

Vendor shall supply all welding rods required to fabricate the pressure storage.

6.13 (UG-4 Add)

Materials equivalent to ASTM standard may be used with the prior approval of the purchaser.

6.14 (UG-12 Add)

Bolting for pressure parts shall be as follows:

6.14.1 Stud bolts shall be threaded full length, be semi finished and conform to ANSI class 2A dimensions, and shall have semi finished nuts conforming to ANSI heavy nuts having class 2B dimensions.

6.14.2 Bolting shall normally be used in accordance with ANSI B1.1, unified screw threads. Nominal size 25 mm and smaller shall be of the coarse thread series, nominal size 28 mm bolts and larger shall be of the 8 thread series.

6.14.3 Nuts shall be double chamfered.

6.15 Butt welding fittings shall be seamless, of the same thickness and schedule of the piping, and conform to ANSI B.16.9.

6.16 Socket welding fittings DN 50 (2") or smaller in dia. size, such as ells, tees, and couplings, shall be of forged steel and shall have a working pressure of at least 20.7 MPa (3000 Psi).

6.17 Slip on flanges should be avoided. If they are used, they shall be welded both inside and outside.

7. FABRICATION

7.1 (UG-75 Add)

Works including welding shall be done, as much as possible, at shop to minimize field assembling work. Adjacent pieces, to be assembled at site, shall be shop fitted, and the match shall be marked to ensure proper site fit up.

7.2 (UG-79 Add)

Shell plates shall be formed with accurate dimensions so that they are easily assembled at site. All nozzles and manholes shall be prefabricated and welded to the shell plates concerned at shop.

7.3 (UG-79 Add)

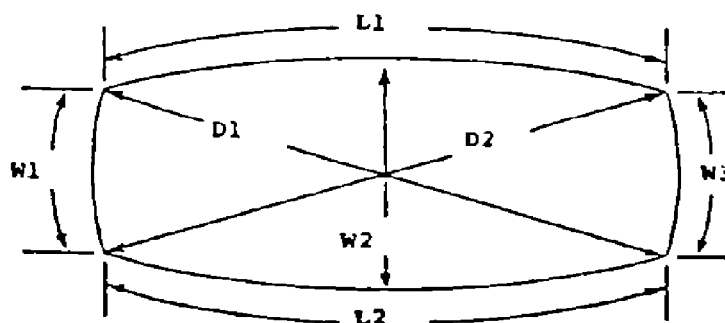
shop fabrication tolerances for the prefabricated sections such as shell plates, support columns, nozzles etc. shall be as follows:

7.3.1 The shell plate thickness after forming shall not be less than the required design thickness by the amount of 0.25 mm or 6% of the design thickness, whichever is smaller.

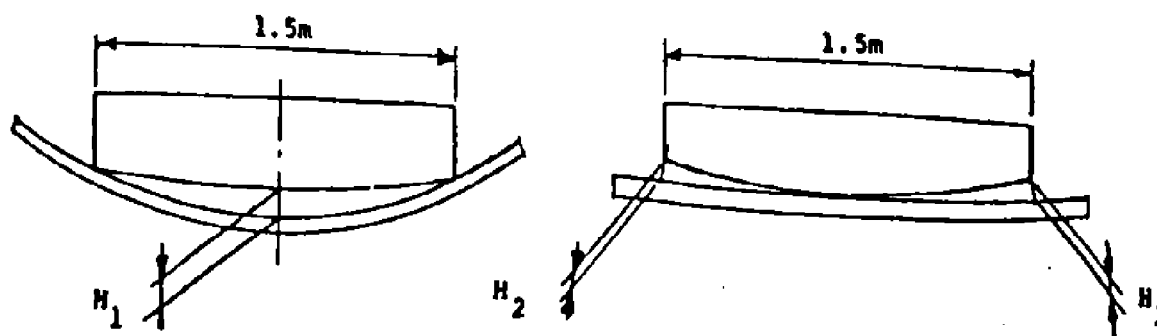
7.3.2 Allowable tolerance for arc length shall be in accordance with Table 1 below:

**TABLE 1 - TOLERANCES FOR ARC LENGTH
OF SHELL PLATE**

MEASURING PORTION	ALLOWABLE TOLERANCES
W1, W2, W3	±1. 5mm
L1, L2	±1. 5mm
D1, D2	< 3. 9mm



7.3.3 The inner surface of formed shell plate shall not deviate more than 3 mm from the specified curvature over a span of 1.5 meter. see Fig. 1 below:



H1, H2, H3 = 3 mm

**PERMISSIBLE DEVIATIONS OF INNER SURFACE
OF FORMED SHELL PLATES**

Fig. 1

7.3.4 Projection, location and inclination tolerances for flange of nozzles and manholes shall be as shown in Table 2 below:

TABLE 2 - TOLERANCES OF NOZZLES AND MANHOLES

	CONNECTED TO PIPING	NOT CONNECTED TO PIPING
PROJECTION	±10 mm	±25 mm
LOCATION	±15 mm	±25 mm
INCLINATION	±0.5°	±1°

7.3.5 Shop fabrication tolerances for the prefabricated sections other than the above, such as length and bolt circle diameter of support columns etc. shall be submitted for purchaser's approval.

7.4 (UG-82c Add)

The inner edge of manholes and nozzles shall conform to the sphere inside radius and be smooth without sharp edge.

7.5 (UG-46 Add)

All reinforcing pads shall be provided with a 6 mm NPT telltale hole which shall be left open.

7.6 (UG-85 Add)

All flange facing and threaded connections shall be protected against oxidation during heat treatment.

7.7 (UG-75 Add)

Fabricator shall submit for purchaser's approval the following drawings and documents within the time specified and before start of fabrication.

7.7.1 All shop fabrication drawings.

7.7.2 A general arrangement drawing for each storage vessel or sphere. This drawing shall be to scale and shall show the position of all mountings and accessories required, with reference to the relevant detail drawing (s).

7.7.3 Static calculations for all members of the storage vessel/sphere for which the sizes are not shown on the reference drawings.

7.7.4 Marking diagram.

7.7.5 In the event that only departure from the reference drawing is proposed with regard to the material to be incorporated, detail drawings showing the proposed changes shall be submitted for approval.

7.7.6 Detail specification or drawings of any auxiliary materials to be supplied such as pressure and vacuum relieving devices shall be also submitted for approval.

7.7.7 Four number of copies for each drawing for approval shall be submitted. A separate set of drawings for each requisition is required.

7.8 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 practical, 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.

8. ERECTION AND PREPARATION FOR SITE ERECTION

8.1 Field erection of pressure storage spheres shall be in accordance with Iranian Petroleum Construction Standard IPS-C-ME-130 "General Requirements for Construction and Field Erection of Pressure Storage Spheres". The following shall be considered as supplementary.

8.2 spheres supports shall be fire proofed. The fireproofing encasement shall not, however, cover any portion of the supports at points where they are welded to the shell of the sphere.

9. WELDING

9.1 Qualification for welding procedures, welders and welding operators shall be in accordance with the requirements of ASME code section IX.

9.2 Welding on pressure storage sphere shall be in accordance with subsection "B" part UW of the ASME pressure vessel code section VIII division I.

9.3 (UW-12 Add)

Use of Table UW-12 column C of ASME sec. VIII div. 1 regarding joint efficiency is not permitted.

9.4 (UW-28a Mod)

Fabricator shall submit to the purchaser his welding procedure specification and welders qualification test records for approval prior to start of fabrication.

9.5 (UW-28 Add)

All welding procedures submitted shall be identified with the specific item and purchase order numbers.

9.6 (UW-26 Add)

Fabricator shall submit for purchaser's approval prior to material supply, his weld preparation procedure including details of beveled plates to be supplied. This shall also conform to ASME section VIII division I.

9.7 (UW-26 Add)

Fabricator shall show on a drawing the applicable welding procedure and non destructive tests required.

9.8 (UW-37 Add)

Tack welds shall be made with the same type of electrode that is used for depositing the root pass.

9.9 (UW-35 Add)

Full penetration welding with full fusion shall be required for all pressure retaining parts including non pressure retaining parts to be welded to pressure retaining parts. All nozzles and manholes shall be attached to the shell by full penetration welds. Fillet welding is acceptable for the outside circle of reinforcing plates.

9.10 (UW-16 Add)

All shell plate seams shall be clear from nozzles, clips and other external parts by a minimum of 50 mm.

9.11 (UW-33 Add)

Joints between plates in different thicknesses for shell plates shall be aligned at the inside surfaces.

9.12 (UW-39 Add)

Welding sequence shall be established in order to perform a deliberate welding to minimize welding stresses.

9.13 (UW-5 Add)

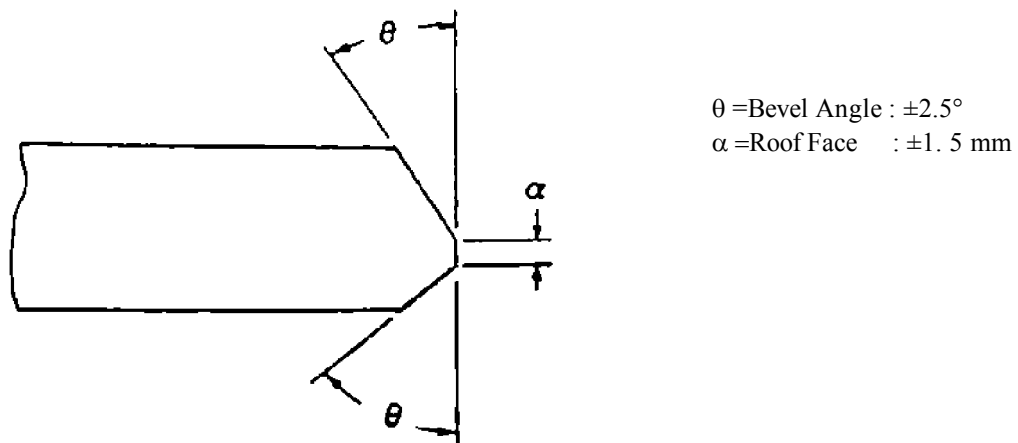
Welding electrode shall be of AWS approved quality or equivalent. Welding electrodes for use with carbon steels shall be "low hydrogen" type.

9.14 (UW-40 Add)

All welding shall be completed prior to final heat treatment.

9.15 (UW-37 Add)

Weld bevels shall be within the tolerances as shown in Fig. 2 below:



TOLERANCES OF WELD BEVELS

Fig. 2

9.16 (UW-9 Add)

All joints between shell plates shall be of double butt welded type with full penetration and complete fusion.

9.17 (UW-27 Add)

Single pass submerged arc welding through the full thickness of the material from one side only is not permitted.

9.18 (UW-31 Add)

Where more than one shell ring is required, longitudinal joints shall be staggered to allow at least 60° between longitudinal joints in adjacent sections. Where the orientation of shell connections will not permit this spacing to be maintained, fabricators drawings shall show proposed location of longitudinal seams for the purchaser's consideration and approval. Openings shall not be placed in weld seams insofar as it is practical and economical.

9.19 (UW-37 Add)

Tolerance for the groove angle shall be within $\pm 5^\circ$ and tolerance for the root opening shall be within ± 3 mm.

9.20 (UW-33 Add)

Misalignment of sphere shell plates at edges to be butt welded shall be as per applicable code, but it shall not exceed 3.2 mm for longitudinal joints and 4.8 mm for circumferential joints.

10. INSPECTION AND TEST

10.1 Shop inspection and testing of pressure storage spheres shall be performed in accordance with the requirements of ASME code section VIII division I and the following requirements.

10.2 (UG-90 Mod)

When the code symbols stamping is not required to the spheres, the items of inspection and testing are considered to be the same as the items of inspection and testing specified in the code to be performed by the manufacturer as the case of code symbol stamping required.

10.3 (UG-93 Add)

The material inspection shall be performed to confirm the material certificates or mill test reports of the materials as specified in para. 6.4 of this Standard.

10.4 (UG-93 Add)

Where wet H₂S service is specified, all plate materials to be used for pressure retaining parts shall be subjected to an ultrasonic examination. The method and acceptance standard of ultrasonic examination for the plates material to be used for the spheres shall be in accordance with ASTM standard A 578, acceptance (level 1).

10.5 (UG-103 Add)

The radiographic examination shall be carried out before postweld heat treatment, if any, except where the code specifies that the examination is to be performed after heat treatment.

10.6 Hardness test shall be made on the weld metal and heat affected zone for the following cases:

- a) When specified ultimate tensile strength of shell plate is 490 MPa and over.
- b) Where wet H₂S service is specified.

Hardness test shall be performed after postweld heat treatment where this is to be conducted.

10.7 (UW-46 Add)

All welding joints of pressure retaining parts and non pressure retaining parts shall be visually inspected to confirm that there are no injurious defects in the weldments.

10.8 (UG-100 e Add)

Weld joints of reinforcing pad for opening shall be leak tested by pneumatic pressure. The test shall be preferably performed at 98 kPa minimum using compressed air.

The test shall be carried out before postweld heat treatment where this is to be conducted.

10.9 (UG-96 a Mod)

After completion of prefabricated sphere sections, dimensional Inspection shall be made to assure that the tolerances are within the permissible ranges specified in the applicable code and in this Standard specification.

10.10 (UG-99 Add)

Water to be used for hydrostatic test shall be free of sediment and shall be clean and fresh.

Test pressure shall be kept for a minimum of 60 minutes before starting visual inspection.

The sphere having no abnormal deformation or leak of the test medium shall be accepted.

10.11 (UG-90 b Mod)

It shall be the responsibility of the fabricator to maintain adequate inspection in his own or his sub contractor's works to ensure that the requirements of the specified inspection and test are met.

Purchaser however reserves the right of access at all times to monitor or complement any such inspection.

11. SUPPLEMENTARY REQUIREMENTS (UG-120 Add)

11.1 Vendor shall send final issues of all drawings mentioned under 7.7 together with dispatch lists of materials to the purchaser, the same number of copies as stated in 7.7.7 is required.

11.2 All drawings etc. mentioned under 7.7 and 11.1 will, in every respect, be the property of purchaser who shall have the right to use and reuse them for any purpose whatsoever without any obligation to vendor.

11.3 Papers used for drawings and prints shall be suitable for the purpose, according to TAPPI T1 0404-36-87, Paper Grade Classification, or, as approved by the Company.

12. GUARANTEE (Add)

12.1 Reference is made to Appendix C of this Standard for guarantee requirements.

APPENDICES

APPENDIX A QUOTATION

A.1 The following information shall be submitted in the quotation:

A.1.1 Price.

A.1.2 Estimated total shipping weight of materials for each sphere with accessories.

A.1.3 Delivery time of the materials.

A.1.4 Steel grades offered.

A.1.5 Plate thicknesses.

A.1.6 Any deviations or exclusions from the stipulations referred to in this specifications if no deviations or exclusions are mentioned in the quotation, it will be deemed to be fully in compliance with said stipulations.

Vendor is free to offer as an alternative, before the purchase order is placed, deviations from the required standards, if these result in a reduction in costs.

A.1.7 The names of subcontractors, if any for the fabrication or any part thereof. Such subcontractors shall be subject to acceptance by purchaser.

A.2 Any purchase order will be subject to all terms, conditions, etc. forming part of the inquiry and any agreed amendments to it.

APPENDIX B
SECRECY

Vendor shall not disclose or issue to third parties without the written consent of purchaser any documents, etc. placed at his disposal by purchaser or any documents prepared by himself in connection with inquiries and purchase orders for purposes other than the preparation of a quotation or carrying out such purchase orders.

APPENDIX C

GUARANTEE

C.1 Vendor shall guarantee that the materials delivered to be incorporated into pressure storage sphere(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 sphere(s) are delivered.

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

C.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 spheres 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.

C.4 Remedying and repairing may be effected by purchaser without prior approval by vendor in cases where it would be unreasonable to demand that prior approval be obtained. In such cases vendor and purchaser shall agree which party shall bear the costs and expenses there of 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 sphere(s).

C.5 In no event will this guarantee cover defect 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 D

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 - D1

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 E

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 - E1

PN (1)	ANSI RATING CLASS (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)