

Specification for Gas Lift Equipment

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CONTENTS

	Page
1 SCOPE	1
1.1 Purpose.....	1
1.2 Applications	1
2 REFERENCES	1
2.1 General.....	1
2.2 Requirements	1
3 ABBREVIATIONS AND DEFINITIONS	1
4 GAS LIFT VALVES, REVERSE FLOW (CHECK) VALVES, ORIFICE VALVES AND DUMMY VALVES	2
4.1 Gas Lift Valve Designation.....	2
4.2 Design	3
4.3 Material Requirements.....	3
4.4 Testing.....	6
4.5 Marking.....	7
5 WIRE LINE RETRIEVABLE VALVE MANDRELS	7
5.1 General Requirements.....	7
5.2 Testing.....	12
APPENDIX A—QUALITY CONTROL	17
APPENDIX B—TEST PROCEDURES FOR GAS LIFT VALVES AND REVERSE FLOW VALVES	19
APPENDIX C—BELLOWS ATTACHMENT METHODS	31
APPENDIX D—HEAT TREATING EQUIPMENT QUALIFICATION	33
APPENDIX E—MARKING REQUIREMENTS FOR API MONOGRAM LICENSEES	37
 Figures	
1—Examples of Wireline Retrievable Valve	4
2—Examples of Tubing Retrievable Valve	4
3	4
4—Typical Injection Pressure Operated Spring Loaded Valve	5
5—Typical Injection Pressure Operated Gas Charged Valve	5
6—Typical Pilot Operated Gas Charged Valve	5
7—Without Guard/Deflector or Orienting Sleeve	12
8—Without Guard/Deflector With Orienting Sleeve	13
9—With Guard/Deflector without Orienting Sleeve	13
10—With Guard/Deflector with Orienting Sleeve	14
11—Fluid Passage from Casing at Undercut	14
12—Fluid Passage from Casing at Undercut. Exit thru Snorkel.....	15
13—Fluid Passage from Tubing at Undercut. Exit thru Snorkel.....	15
14—Fluid Passage from Tubing thru Top of Pocket Exit thru Snorkel.....	16
15—Typical Sleeve Tester	21
16—Typical Encapsulated Tester	21
17—Typical Gas Lift Valve Probe Test Fixture	21
18—Typical Vertical Valve Insertion Test Stand.....	22
19—Typical Stem and Seat Leakage Testers.....	22
20—Typical Stem and Seat Leakage.....	23
21—Stem Travel (Inch) Typical Data from Probe Test.....	26

22—Stem Travel (Inch) Determining Valve Load Rate (psig/inch).....	26
23—Thermocouple Locations	35

Tables

1—Nominal Polish Bore Diameters for Wireline Retrievable Valve Mandrels	3
2—Valve Service Classifications.....	6
3—Mandrel Service Classifications	8
4—Nominal Polish Bore Diameters for Wireline Retrievable Valve Mandrels	8
5—API 11V1 Part Number	12
6—Tubing Size	14
7—Material/Service	14
8—Drift Size	15
9—Minimum Test Pressure	15

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This specification shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution. This edition of API Specification 11V1 supersedes the first edition dated July 1, 1994 and includes items approved by letter ballot through February, 1995.

Specification for Gas Lift Equipment

1 Scope

1.1 PURPOSE

This specification was formulated to provide gas lift valves, reverse flow (check) valves, orifice valves, dummy valves and wireline retrievable valve mandrels (WRVM) that are consistently manufactured to a predictable level of quality. Technical content provides requirements for design, materials, tests and inspecting, welding, marking, storing and shipping. This specification is intended as a quality based specification and does not assure dimensional interchangeability between manufacturers.

1.2 APPLICATIONS

1.2.1 Equipment

This specification is for gas lift valves, reverse flow (check) valves, orifice valves, dummy valves and the WRVM's used as a receiver for these valves or other devices used to enhance oil well production or treat oil or gas wells. This specification is compiled such that the requirements for gas lift valves and WRVM's are in separate sections and unless indicated do not overlap requirements.

1.2.2 Service Classification

1.2.2.1 Valve Service Class

For gas lift valve class of service conditions refer to 4.3.3.

1.2.2.2 WRVM Service Class

For WRVM class of service conditions refer to 5.1.1.2.

2 References

2.1 GENERAL

This specification includes by reference, either in total or in part, the latest edition of other API, industry and government standards listed below.

2.2 REQUIREMENTS

Specific requirements, as outlined in the text, of other standards included by reference in this specification are essential to quality.

API

- 5CT *Casing, Tubing, and Drill Pipe*
- 5B *Threading, Gaging, and thread inspection of Casing, Tubing and Line Pipe threads*

ASME

Boiler and Pressure Vessel Code, Section V, "Non-

destructive Examination", Section VIII, "Rules for Construction of Pressure Vessels", Section IX, "Welding and Brazing Qualification"

ASME/ANSI

Std. B 1.20.1-1983 (R1992) Pipe Threads, General Purpose

Std. B 1.20.5-1991 Gaging for Dryseal Pipe Threads

ASTM

- A370 *Mechanical Testing of Steel Products*
- D-1415 *Test Method for Rubber Property—International Hardness*
- D-2240 *Test Method for Rubber Property—Durometer Hardness*
- E10 *Brinell Hardness of Metallic Materials*
- E18 *Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*
- E94 *Guides for Radiographic Testing*
- E140 *Standard Hardness Conversion Tables for Metals*
- E165 *Practice for Liquid Penetrant Inspection Method*
- E709 *Practice for Magnetic Particle Examination Military Standards*
- H-6875 *Heat Treatment of Steels—Aircraft Practice Process*
- 413C *Visual Inspection Guide for Elastomeric O-Rings*
- 105E *Sampling Procedures and Tables for Inspection By Attributes*
- 120 *Gage Inspection*

NACE

MR-01-75 *Sulfide Stress Cracking Resistant Metallic Material for Oil Field Equipment*

SAE

AS-568A *Aerospace Size Standards for O-Rings*

SNT

TC.1A *Personnel Qualification and Certification Nondestructive Testing*

3 Abbreviations and Definitions

ABBREVIATIONS

- API American Petroleum Institute
- AQL Acceptable Quality Level as defined in MIL-STD-105E
- ASME American Society of Mechanical Engineers
- ASTM American Society for Testing and Materials
- AWS American Welding Society

HAZ	Heat Affected Zone
HTS	Heat Treatment Specification
MIL-STD	Military Standard, U.S.A.
MSC	Mandrel Service Classification
NACE	National Association of Corrosion Engineers
NDE	Non Destructive Examination
PQR	Procedure Qualification Record
Ra	Microinch Roughness Average
SAE	Society of Automotive Engineers
SNT	Society for Non-Destructive Testing
WPQ	Welder/Welding Operator Performance Qualification
WPS	Welding Procedure Specification
WRVM	Wireline Retrieval Valve Mandrel

DEFINITIONS

3.1 coating: Internal and/or external application of a material for corrosion protection, paraffin control, etc.

3.2 class 1 or standard service: This class of equipment shall be designed for use in wells which do not exhibit the detrimental effects caused by stress corrosion cracking.

3.3 class 2 or stress corrosion cracking service: This class of equipment shall be designed for use in wells where corrosive agents could be expected to cause stress corrosion cracking. Class 2 equipment shall be manufactured from materials which are resistant to stress corrosion cracking in accordance with NACE Std MR-01-75, latest revision.

3.4 date of manufacture: The date of manufacturer's final acceptance of finished equipment.

3.5 deflector or discriminator: A section designed into WRVM's that will allow passage of sidepocket devices but will prevent entry of through tubing equipment of larger diameter.

3.6 end connections: Threads integral to the mandrel, male or female, used to connect the mandrel to the tubing string.

3.7 external test pressure: The differential pressure between applied external pressure and internal atmospheric pressure at which a mandrel is tested for collapse resistance during manufacturing or design verification testing.

3.8 heat (cast lot): Material originating from a final melt. For remelted alloys, a heat shall be defined as the raw material originating from a single remelted ingot.

3.9 high range valves: Valves intended to operate in the P_{vCT} pressure range from 1200 psi [8274 kPa] and above.

3.10 internal test pressure: The differential pressure between applied internal pressure and external atmospheric pressure at which a mandrel is tested for burst resistance during manufacturing.

3.11 job lot: a group or quantity of a piece part, subassembly or assembly which is grouped or processed together during the manufacturing process.

3.12 low range valves: Valves intended to operate in the P_{vCT} pressure range from 400 psi [2758 kPa] to 800 psi [5516 kPa].

3.13 manufacturer: As used in this text shall be the gas lift equipment manufacturer unless otherwise specified.

3.14 mid range valves: Valves intended to operate in the P_{vCT} pressure range from 800 psi [5516 kPa] to 1200 psi [8274 kPa].

3.15 orienting sleeve: A section designed into WRVM's that acts together with certain wireline tools to aid in radial and vertical alignment of tools used to install and remove sidepocket equipment.

3.16 painting: External application of paint for cosmetic purposes.

3.17 tensile load (pounds-force) [newton]: The load carrying capability in pounds of load in tension that may be applied to a WRVM as defined by the manufacturer.

3.18 test pressure: The maximum differential pressure between applied pressure and atmospheric pressure during the process of equipment acceptance or design verification testing.

3.19 traceability, job lot: The ability for individual components to be identified as originating from a job lot which identifies the included heat(s).

3.20 wireline: Equipment and techniques used to perform various operations in a well using a long, continuous length of solid or stranded wire and appropriate spooling equipment at the surface and weight and specialized tools attached to the well end of the wire. See "Wireline Operations and Procedures", API book 5, Vocational Training Series, 1983.

3.21 wireline retrievable valve mandrel (WRVM): A gas lift valve mandrel that provides access to the gas lift valve or other sidepocket device by wireline methods.

3.22 yield strength: The stress level measured at room temperature, expressed in pounds per square inch of loaded area, at which material plastically deforms and will not return to its original dimensions when the load is released. All yield strengths discussed in this standard shall be considered as being the 0.2% yield offset strength per ASTM A370.

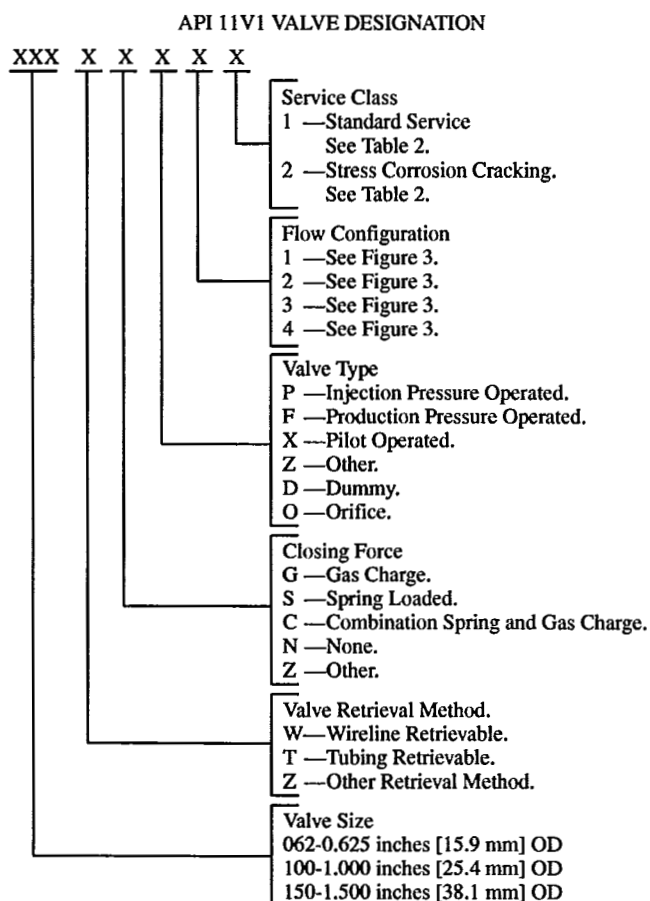
4 Gas Lift Valves, Reverse Flow (Check) Valves, Orifice Valves and Dummy Valves

4.1 GAS LIFT VALVE DESIGNATION

4.1.1 WIRELINE RETRIEVABLE valves (Fig. 1) are run and retrieved by wireline and are set in a receiving "pocket"

inside a WRVM. TUBING RETRIEVABLE valves (Fig. 2) are mounted on the outside of the tubing on a tubing retrievable valve mandrel and are retrieved by pulling the tubing. The reverse flow valve for a TUBING RETRIEVABLE valve may or may not be an integral part of the gas lift valve. Gas lift valves are described in 4.1.2 API Valve Designation.

4.1.2 API Valve Designation



For example, if Figure 4 is a 1.5 inch [38.1 mm] OD tubing retrievable valve for standard service the designation would be:

150 T S P 1 1

If Figure 5 is a 1.5 inch [38.1 mm] OD wireline retrievable valve for stress corrosion cracking service the designation would be:

150 W G P 1 2

If Figure 6 is a 1.5 inch [38.1 mm] OD tubing retrievable valve for standard service the designation would be:

150 T G X 1 1

4.2 DESIGN

4.2.1 General

Gas lift valves, orifice valves, reverse flow valves and dummy valves designed and manufactured in accordance with this specification shall be constructed of materials in compliance with 4.3 of this specification.

4.2.2 Interchangeability

Components and sub-assemblies of each type, model and size shall be designed, manufactured and identified to provide interchangeability within the product line of any one manufacturer. Stem and seats lapped to form matched pairs are considered as a single component under this section.

4.2.3 Dimensions

Dimensional tolerance of components or subassemblies shall be such that cumulative tolerances will not preclude proper operation described in the testing requirements of 4.4 of this Specification.

4.2.4 Packing

The diameters of the external packing on all WIRELINE RETRIEVABLE valve types (4.1.2) shall be designed using the polish bore dimensions in Table 1. Material requirements for the packing are not addressed by this specification.

4.2.5 Attachment

TUBING RETRIEVABLE gas lift valves and reverse flow valves shall be connected to the mandrel using National Pipe Thread (NPT) connections according to ASME/ANSI standard B1.20.1-83 or ASME/ANSI standard B1.20.5-78.

Table 1—Nominal Polish Bore Diameters for Wireline Retrievable Valve Mandrels

In Inches		
Nominal Valve OD	Upper Seal	Lower Seal
1	1.027 ± 0.005	1.027 ± 0.005
1 1/2	1.558 ± 0.005	1.496 ± 0.005
In Millimeters		
Nominal Valve OD	Upper Seal	Lower Seal
1	26.086 ± 0.127	26.086 ± 0.127
1 1/2	39.573 ± 0.127	37.984 ± 0.127

4.3 MATERIAL REQUIREMENTS

4.3.1 Certification

Components shall be traceable to heat(s) or other material manufacturer's report or supplier certification report, except for the following components where a certificate of compliance to the manufacturer's written specification is required:

- bellows
- copper gaskets



Documents

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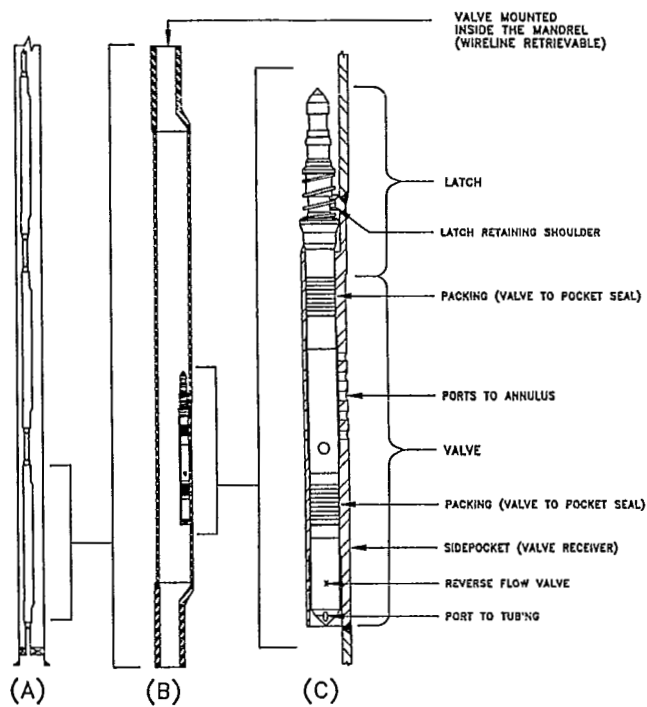


Figure 1—Examples of Wireline Retrievable Valve

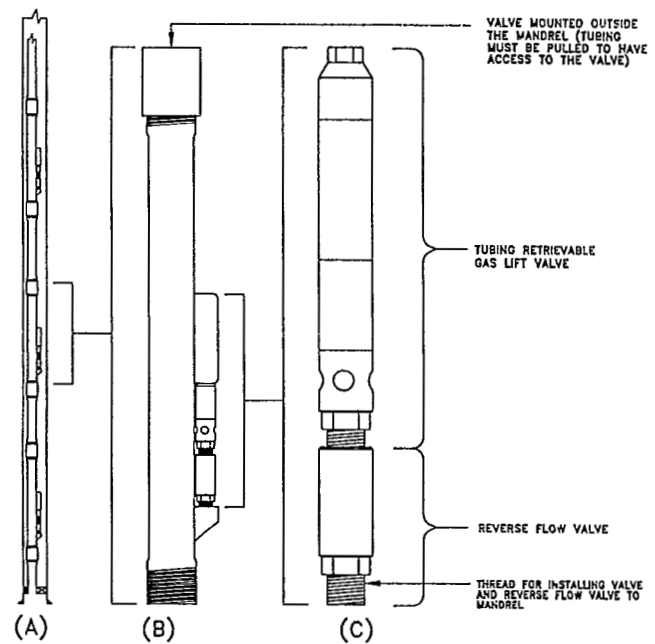


Figure 2—Examples of Tubing Retrievable Valve

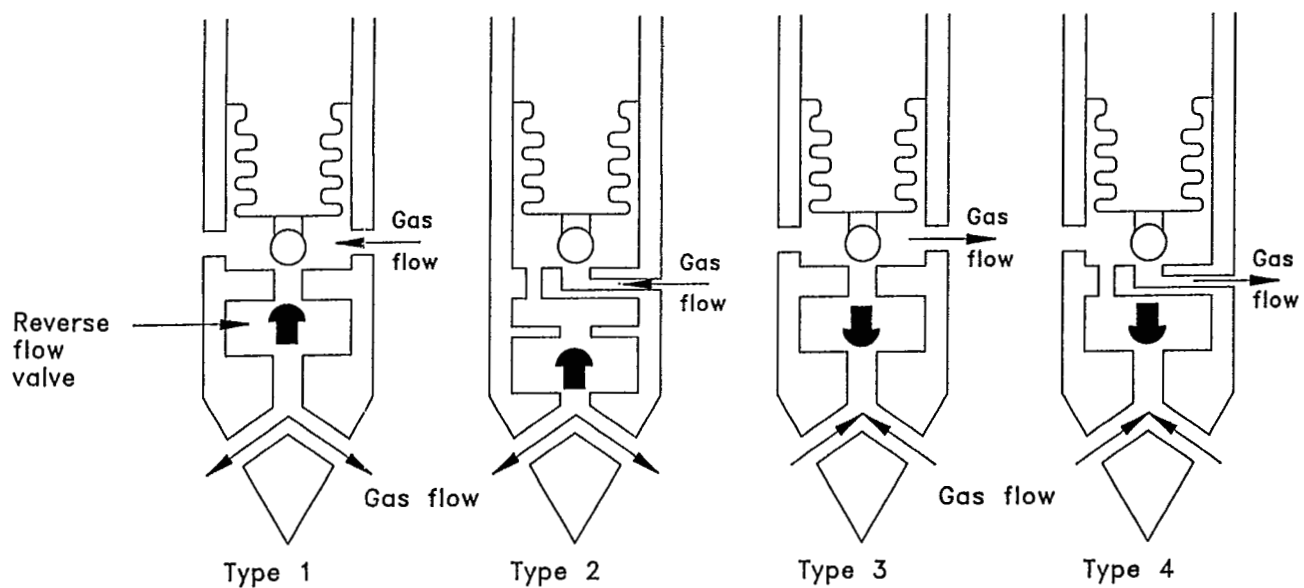


Figure 3

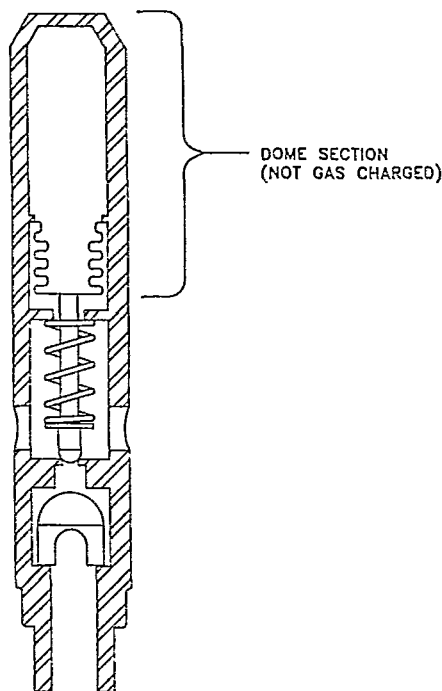


Figure 4—Typical Injection Pressure Operated Spring Loaded Valve

Note: The case of a combination spring and gas charged closing force valve the valve will also have a gas charge.

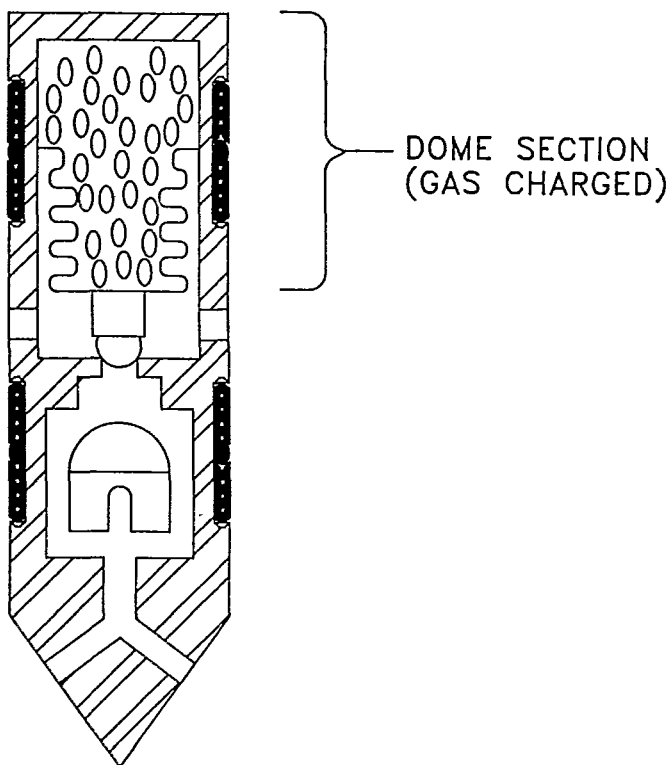


Figure 5—Typical Injection Pressure Operated Gas Charged Valve

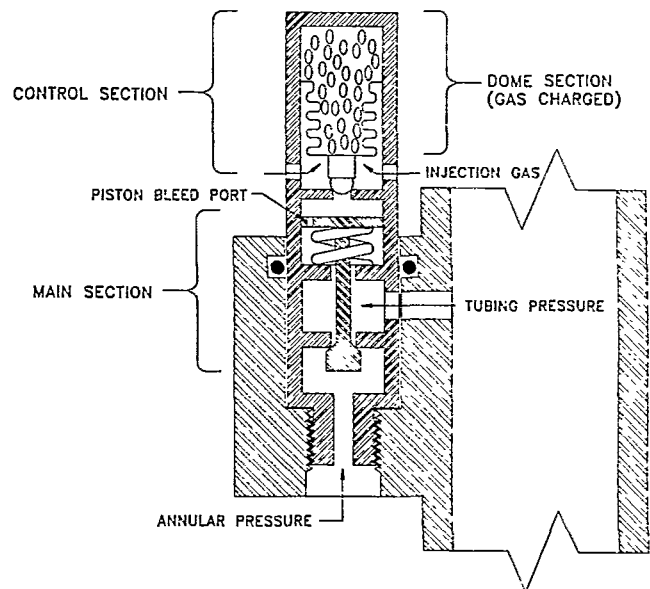


Figure 6—Typical Pilot Operated Gas Charged Valve

- core valves
- carbide balls and seats
- ceramic balls and seats
- snap rings
- brazing and solder material
- elastomeric materials
- plastic or polymeric materials
- pulsation dampening fluids
- common hardware items such as nuts, bolts, shear pins, set screws, fittings, and shear screws.

4.3.2 Metals

Metallic components supplied under this specification shall comply with the manufacturer's written specifications. Except for items listed in 4.4, manufacturer's specifications shall define:

- a. Chemical composition limits
- b. Heat treatment conditions
- c. Mechanical property limits
 1. Tensile strength
 2. Yield strength
 3. Elongation
 4. Hardness

4.3.3 Service Classification

Equipment manufactured in accordance with this specification shall conform to one or more of the following classes of service:

4.3.3.1 Class 1. Standard Service



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This class of equipment shall be designed for use in wells which do not exhibit the detrimental effects caused by stress corrosion cracking. Metals such as stainless steels and monel are in general use and are considered acceptable for standard service.

4.3.3.2 Class 2. Stress Corrosion Cracking Service

This class of equipment shall be designed for use in wells where corrosive agents could be expected to cause stress corrosion cracking. Class 2 equipment shall be manufactured from materials which are resistant to stress corrosion cracking in accordance with NACE Std MR-01-75, latest revision.

Table 2—Valve Service Classifications

Classifications	Characteristics
Class 1—Standard Service	Non Sour Service
Class 2—Stress Corrosion Cracking	Stress Corrosion Cracking ¹

¹Per NACE MR-01-75

4.3.4 Elastomeric Materials

Each elastomeric component shall comply with the manufacturer's written specifications. Manufacturers providing equipment to this specification shall be responsible for the following.

4.3.4.1 Tolerances

The tolerances of O-rings shall be in compliance with SAE AS 568A, latest revision. Other packing elements shall meet dimensional tolerances of the manufacturer's written specifications. Sampling procedures for inspection, and the basis for acceptance or rejection of a batch lot, shall be in accordance with MIL STD 105D, latest revision, General Inspection Level II at a 2.5 AQL for O-rings and at a 1.5 AQL for other packing elements.

4.3.4.2 Hardness

The durometer hardness of O-rings shall be measured in accordance with ASTM D-2240 or D-1415, latest revision. The preferred method is to conduct the hardness test on a test specimen from each batch and cure cycle rather than testing individual seals. In the event such tests are to be conducted on individual seals, sampling procedures for inspection, and the basis for acceptance or rejection of a batch lot, shall be in accordance with those cited in 4.3.4.1 above for O-rings or other packing elements respectively.

4.3.4.3 Visual Inspection

O-rings shall be visually inspected in accordance with MIL STD 413C, latest revision. Other packing elements

shall be visually inspected according to the manufacturer's written inspection procedures and includes such items as lip damage, flashing, breaks, cracks, or other visible damage. Sampling procedures for inspection, and the basis for acceptance or rejection of a batch lot, shall be in accordance with those cited in 4.3.4.1 above for O-rings or other packing elements respectively.

4.3.4.4 Handling and Storage

Many of the elastomeric materials used for O-rings or other packing elements require special handling and storage procedures. Manufacturer's written specifications shall include handling and storage requirements including shelf life appropriate for each specific compound.

4.3.5 Other Materials

Non-metals other than elastomers shall comply with the manufacturer's written specifications.

4.3.6 Traceability

Traceability requirements shall be documented by the manufacturer and shall be sufficient to ensure that all piece parts are manufactured from materials that satisfy the manufacturer's written specifications. Traceability of piece parts is required only until the parts are used in subassemblies or assemblies. The traceability of subassemblies or assemblies is not required by this specification.

4.3.7 Bellows Attachment

The method and materials used for attachment of the bellows shall be as defined in the manufacturer's written specifications.

Some of the methods of bellows attachment are listed in Appendix C.

4.4 TESTING

4.4.1 Production Run Test

All valves shall successfully complete the following requirements.

4.4.1.1 Bellows Assembly Test

Each bellows assembly shall be tested in accordance with the manufacturer's written specifications to assure bellows integrity in accordance with 4.4.1.5 and B3.1 and B3.2 in Appendix B of this specification.

4.4.1.2 Valve Pressure Test

Each gas lift valve shall be set and pressure tested in accordance with the manufacturer's written specifications and tested in accordance with Section B3 in Appendix B.

4.4.1.3 Stem-Seat Leakage Test

Each gas lift valve shall be tested for leakage across the stem and seat in accordance with B4 in Appendix B and the manufacturer's written specifications. The leak shall not exceed 35 std cu ft/day [1 std cu m/day] when the downstream pressure on the valve is zero psig [0 kPa (ga)] and the upstream pressure on the valve is greater than P_{vcT} with the valve in the test fixture. (P_{vcT} is defined in B4.3 in Appendix B.)

4.4.1.4 Reverse Flow Valve Leakage Test

Reverse flow valves shall be tested with air, nitrogen, helium, or other compressed gas for leakage in accordance with the manufacturer's written specifications. The leak shall not exceed 35 std cu ft/day [1 std cu m/day] with a 100 psi [689 kPa] $\pm 10\%$ differential pressure across the reverse flow valve.

Note: For safety considerations, non-flammable gases such as the ones suggested should be used for all valve testing.

4.4.1.5 Shelf Test

Before delivery to the user each pressure charged valve shall be set with a minimum test rack opening pressure of 800 psig [5516 kPa (ga)] at the manufacturer's specified reference temperature, the test rack opening pressure recorded, and the valve then placed on the shelf for a minimum of 5 days. After 5 days on the shelf, the set pressure of each valve shall be checked at the manufacturer's reference temperature and any valve whose set pressure has changed more than one percent shall be rejected.

4.4.2 Valve Design Verification Tests

All valve designs must pass the test listed below in addition to the manufacturer's written specifications. A change in seat size is not considered a change in valve design for this section unless it also changes the calculated stem travel and bellows position from initial starting position to the mechanical stop by greater than 5%.

4.4.2.1 Production Run Tests

All tests under 4.4.1 of this specification are required as part of the valve design verification tests.

4.4.2.2 Probe Test

A probe test to determine the effective stem travel and valve load rate shall be made on a minimum of five gas lift valves of each bellows and/or dome configuration. The results shall be retained in accordance with B5 in Appendix B. The tests shall be conducted with P_{vcT} pressures ($\pm 5\%$) of 400 psig [2758 kPa (ga)], and 600 psig [4137 kPa (ga)], and 800 psig [5516 kPa (ga)] for low range valves; 800 psig [5516 kPa (ga)], 1000 psig [6895 kPa (ga)], and 1200 psig

[8274 kPa (ga)] for mid range valves; 1200 psig [8274 kPa (ga)], 1500 psig [10.34 MPa (ga)], and 1800 psig [12.41 MPa (ga)] for high range valves so long as the pressure does not exceed that recommended for the valve by the manufacturer. In case the P_{vcT} probe test pressure does exceed the valve manufacturer's recommended limit, the maximum test pressure will be the manufacturer's maximum recommended value as one of the test pressures. (P_{vcT} is defined in B4.3 in Appendix B.) Probe test procedure is described in B5 in Appendix B of this specification.

4.4.2.3 Valve Insertion Test

Valve insertion test shall be conducted on wireline retrievable valves. A minimum of 5 valves shall be tested in the vertical position. The set pressure of each of the 5 valves shall not change more than one percent after being set in the pocket for the valve design to be acceptable.

The valve insertion test procedure is described in B6 in Appendix B, of this specification.

4.4.2.4 Reverse Flow Valve Closure Test

A minimum of five reverse flow valves shall be tested with water in accordance with the manufacturer's specifications to establish the minimum flow rate for closure and the results shall be recorded. Form 3 of Appendix B is available as a convenient place to record the data.

4.5 MARKING

4.5.1 Assemblies

All complete assemblies furnished under this Specification shall be marked in accordance with NACE STD MR-01-75, latest revision as follows:

Manufacturer's name or trademark.

Spec 11V1.

Date of manufacture.

4.5.2 Parts

There is no requirement for marking individual parts.

4.5.3 Superseding of 4.5.1

This section shall be superseded by Appendix E of this specification when applicable.

5 Wire Line Retrievable Valve Mandrels

5.1 GENERAL REQUIREMENTS

5.1.1 Design Requirements

5.1.1.1 Pressure and Load

5.1.1.1.1 Some WRVM's, particularly those constructed with oval pipe, have a test pressure that is lower than the test