Recommended Practice for Repair, Testing, and Setting Gas Lift Valves

API RECOMMENDED PRACTICE 11V7
SECOND EDITION, JUNE 1999

American Petroleum Institute

Helping You Get The Job Done Right.℠

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Upstream Segment

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Recommended Practice for Repair, Testing and Setting Gas Lift Valves

1 Scope

Recommended Practice 11V7 applies to repair, testing, and setting gas lift valves and reverse flow (check) valves. This is a recommended practice to present guidelines related to the repair and reuse of valves; these practices are intended to serve both repair shops and operators. API RP 11V7 refers to test procedures used in API Specification 11V1 and Recommended Practice 11V2. Portions of these procedures are included in the appendices of this document.

The injection gas pressure operated (IPO) bellows valve is one example of a commonly repaired valve; the spring loaded production pressure operated (PPO) valve is also covered. Other valves, including bellows charged valves in production pressure operated service should be repaired according to the guidelines, however specialty valves are best repaired at the original manufacturer's shop.

2 References

API

Spec 11V1	*Gas Lift Valves, Orifices, Reverse Flow Valves and Dummy Valves*
RP 11V2	*Gas Lift Valve Performance*

NACE[1]

MR-01-75	*Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Service*

3 Abbreviations

The following abbreviations are used in this recommended practice:

Pvo: Test rack opening pressure at 60°F.

P_{VOT}: Test rack opening pressure at specified temperature (T).

IPO: Injection pressure operated gas lift valve.

PPO: Production pressure operated gas lift valve.

4 Gas Lift Valve Designation and Construction

4.1 VALVE DESIGNATION

The code for designation of particular gas lift valves is presented in API Spec 11V1. The designation code identifies a valve as wireline or tubing retrievable, injection gas, spring or combination closing force, type of valve—production pressure operated or gas injection pressure operated, size, etc. This basic designation code should apply to rebuilt as well as new valves.

The rebuilder must permanently mark or etch the valve with date (MO/YR), Pvo, port size, and their name, symbol, or trademark for valve identification The valve should be marked using a low stress stamp or etching.

4.2 DESIGN

The gas lift valves and reverse flow (check) valves that are rebuilt according to this Recommended Practice should adhere to API Spec 11V1, as applied to component interchangeability, dimensional tolerance of components, packing diameters of wireline retrievable devices, and methods of attachment to provide leak free connections.

Component parts should be selected to permit interchangeability within one type or model line. Dimensions and dimensional tolerances of the components of the valves to be rebuilt should not prevent proper operation of the assembled device.

4.3 MATERIAL REQUIREMENTS

The material guidelines for metals and elastomers of the valves to be rebuilt are found in API Spec 11V1.

For the initial valve installation in an H_2S environment, new equipment is recommended and should comply with NACE MR-01-75. Subsequent replacement equipment should be rebuilt from valves whose components comply with the NACE specification. For example, the operator can use valves which come from the original completion and specify the components to maintain NACE compliance.

Since alloy specifications in used (exchanged) valves cannot be determined without extensive metallurgical testing, all metals should be assumed to be standard alloys of stainless steel or monel. Replacement parts should be made of standard alloys equivalent to those provided by the original manufacturer or as agreed between the repair shop and user.

Seats and stems are easily replaced and materials for these components can be specified.

4.4 EQUIPMENT REPAIR TERMINOLOGY

4.4.1 Rebuilt to Original Equipment Specification

The terms implying restoration to "original (new) equipment specifications" shall be applied to used equipment only when the replacement components match the original manufacturer's specifications. These specifications should be available to the operator (purchaser). The term shall not be applied to valve brands and models that have been discontinued. The intent is to prevent use of the terminology when specifications are not available for comparison.

[1]NACE International, 1440 South Creek Drive, P.O. Box 218340, Houston, Texas 77218-8340.

4.4.2 Repaired Equipment per API Recommended Practice 11V7

All equipment restored according to this Recommended Practice can be referred to as "repaired equipment per API RP 11V7." All repair facilities should have readily available written procedures for inspection, disassembly, reassembly, and testing of gas lift equipment.

4.4.3 Cleaned and Reset

All equipment that is only cleaned and the (test rack) opening pressure reset shall be referred to as "cleaned and reset." Equipment in this category will not be stamped as is specified in 4.1 and will not be considered repaired equipment.

5 Recommended Dismantling and Reassembly of Used Gas Lift Valves

5.1 GENERAL

The valves to be repaired according to this Recommended Practice will have an opening pressure (Pvo) check for bellows condition, be cleaned in solvent, and have components inspected visually for replacement or repair.

All valves that are to be rebuilt must be completely disassembled and cleaned in a solvent bath. This should be done regardless of the results of the initial check of the test rack opening pressure (Pvo). The following minimum procedures should be followed at disassembly:

5.2 DISMANTLE PROCEDURE

5.2.1 Use a donut or encapsulated tester (see Appendix B) to determine the "as received" test rack opening pressure for comparison with the opening pressure (Pvo) stamped on the valve. If depressured or abnormally pressured, the valve may need a bellows replacement or the fault may be a leaky tail plug gasket or seal. The valve should be identified on the shop form (Figure 2) and separated for special handling so the rebuild technician will carefully check for bellows leakage during the hydrostatic aging test.

At this point a preliminary check can be made on the stem-seat seal by observing if the valve will hold pressure for a short inspection period of 5 seconds. The stem and seat will be inspected later in the disassembly.

5.2.2 Remove the reverse flow (check) valve housing if not removed prior to the opening pressure (Pvo) test. Examine for damage and replace dart or other components if required to pass pressure test (7.3).

5.2.3 Remove tail plug (look for looseness or damage if valve Pvo was abnormal) and depressure valve, but leave valve core installed to prevent loss of dampening fluid and/or entry of cleaning solvent. Remove seat housing, snap ring, seat, and bellows housing. Discard tail plug gasket, other copper gaskets, O-rings, snap rings, and packing.

5.2.4 This item is an additional procedure for dismantling spring loaded valves:

Use the manufacturer's instructions to remove the spring housing and to relax the spring tension (no tension). Separate the spring assembly from the bellows assembly for cleaning and visual inspection.

Visually inspect the spring and components and reject any spring showing a fracture or crack. Inspect the tension rod for damage to threads or to one of the lock nuts.

5.2.5 Clean the bellows subassembly with solvent and brush to remove debris. Use caution so as not to damage the bellows. Discard bellows that are deformed, smashed, or otherwise damaged and changed from their permanent set.

5.2.6 Examine stem for damage and replace if necessary. Inspect seat and replace if necessary. Stem/seat components to be relapped should be kept together. The ball on the stem should be approximately one-sixteenth ($^1/_{16}$) inch larger than the square edged seat. Designs other than the square edged seat should retain the original manufacturer's dimensions.

Note: If stem must be removed from bellows, use caution to prevent torque on bellows.

5.2.7 Wash all parts in solvent or other cleaning agent. Visually inspect all parts for fluid cutting, thread damage, cracks, or abrasion. Reject any damaged parts.

5.2.8 All threads should be cleaned in solvent and brushed to remove debris. Inspect for torn or galled threads. Reject if damaged.

5.2.9 At this point, the valve is ready for reassembly with new O-rings snap rings, and gaskets. Lubricate all O-rings prior to assembly with lubricant specified by O-ring manufacturer.

5.3 REASSEMBLY PROCEDURE

5.3.1 The repair shop should have a written reassembly procedure.

5.3.2 Use new copper gaskets, O-rings, snap rings. Use light lubricant on all threads before assembly.

5.3.3 This item is an additional procedure for spring loaded valves:

Apply light lubricant to the threads on the rod tensioner, and to the spring plus components. Assemble the spring and components using the written reassembly procedure for spring valves. Join the spring assembly to the bellows assembly.

If needed, use manufacturer's instructions to adjust stem-to-seat dimension, and proceed to join to seat assembly.

5.3.4 Install new/reconditioned seat and mated stem back into bellows assembly using thread locking compound on threads. Avoid torque on the bellows.

5.3.5 Secure bellows assembly, bellows housing and seat housing. Remove and discard old valve core. Install new valve core, with a minimum 2,000 psig pressure rating.

5.3.6 Reassemble the reverse flow (check) valve housing with new or reconditioned components.

5.4 BELLOWS REPLACEMENT

5.4.1 Bellows replacement for each and every reconditioned valve is not a recommended practice. However, the bellows should be changed when a failure is identified.

5.4.2 If bellows replacement is needed, the bellows should be identical to the original manufacturer's equipment and the attachment methods should be equivalent to the original manufacturer's procedure. An option is replacement of the complete bellows assembly with a unit from the original equipment supplier.

5.4.3 If the bellows attachment is to be made using silver solder brazing, electric induction heating is the preferred method for soldering.

5.4.4 After attachment, the bellows should be leak checked according to the repair shop's written procedures to assure a leak free connection at each end of the bellows.

5.4.5 Before replacement of the valve core, add dampening fluid to bellows according to the manufacturer's written specifications, if available, or according to the repair shop's written procedures. The valve should be stored in a vertical or a near-vertical inclined position to aid fluid movement to the lower section of the bellows.

5.4.6 The bellows needs to be stabilized and set (aged); the procedures of B.3 should be followed.

6 Inspection and Reassembly Data

6.1 SOURCE OF REPLACEMENT PARTS—TERMINOLOGY

Equipment components that are manufactured by the original supplier or licensed, authorized agent can be referred to as original parts. The valve components are assumed to be original and are called "Reused" in Figure 3, the form "Reassembly and Test Data—All Valves." These components should be identical to those used in a new valve assembly.

Equipment components that are manufactured by other than the original manufacturer (or authorized agent) should be referred to as "Replaced." These parts should have equivalent physical properties to the original part and should match dimensionally.

Equipment components from the valve that are reworked, machined, lapped, or otherwise modified dimensionally should be referred to as "Reworked" parts.

6.2 INSPECTION DATA

Upon specific agreement between the operator and the valve repair shop, the valves and mandrels can be inspected with the process beginning at the well and continuing through to the opening pressure (Pvo) check and disassembly.

At the well, tags (Figure 1) should be provided by the operator to the workover (or wireline) contractor to attach to each valve as it is removed. The operator's representative should mark the tag after visually inspecting the valves.

At the repair shop the inspection procedure continues. The information on each tag can be transferred to the inspection report form (Figure 2). The other information on the valve condition can be added. This inspection process and the data required can be enhanced by both the repair shop and the operator.

The Pvot test rack opening pressure at ambient conditions, and ambient shop temperature should be listed, valve disassembly can begin according to 5.2. Report condition of components on form (Figure 2).

6.3 REASSEMBLY DATA

The source of replacement parts and description related to the source are given in 6.1.

A tag (Figure 3) should be attached, and the reassembly technician should identify sources of parts, according to 6.1. The reassembly procedure of 5.3 should be followed. This tag can also be used to record the data obtained during testing.

7 Testing Rebuilt Valves

7.1 GENERAL

All rebuilt valves shall be tested according to API Spec 11V1, section 4.4.1 (Appendix A in this Recommended Practice) with repair shop's written procedures substituted for "manufacturer's written specifications."

7.2 VALVE CORE

Test the valve core. First, nitrogen charge the valve to a minimum of 1,000 psi. Bubble check the valve core by placing a few drops of leak check (soapy water) around it and looking for bubbles. If leaks occur, depressure bellows, remove and discard the valve core. Replace the valve core and recheck for leaks.

7.3 REVERSE FLOW (CHECK) VALVE

The reverse flow (check) valve should be air pressure tested according to Appendix A. If the check fails the test, the

elastomers should be replaced or metal seals lapped and the check should be retested.

7.4 VALVE LEAKAGE TEST

Test to be performed is identical to the Valve Leakage Test specified in API Spec 11V1. However, if leaks exceed the allowable 35 std ft/day rate, the stem and seat may be lapped together (and retained as a matched set) until leak is less than the allowed rate. Air or nitrogen should be used in testing valves and the stem and seat should be clean and dry.

7.5 HYDROSTATIC AGING TESTS

Hydrostatic aging tests to stabilize the bellows should be according to Appendix B. The repair shop should have a written procedure for the bellows stabilization method.

7.6 VALVE STEM TRAVEL TEST

The assembled gas lift valve should be tested for stem travel. This test purpose is to discover grossly mismatched parts that might prevent or restrict stem movement. This test does not check stem movement caused by gas or liquid pressure—only a probe test can determine that movement.

The valve should be nitrogen charged to a minimum of 500 psig. The stem should be moved by a stem lifter (head lifter) and measurement made of the stem travel. For reference, the following table gives the stem travel of a fully open valve with a ball stem $^{1}/_{16}$-inch larger than the square edged seat (orifice):

Port size, inches	Stem travel, inches
0.1250	0.04
0.1875	0.07
0.2500	0.10
0.3125	0.11
0.3750	0.14
0.4375	0.19
0.5000	0.22

The tested valve stem travel should be listed on the report form, Figure 3. Other geometries (other than the square edged seat) should have stem travel recorded and compared to the manufacturer's written specifications.

8 Valve Pressure Setting

Set the valve pressure using Appendix A. The repair shop should have a written procedure for both the valve pressure setting method and the bellows stabilization method.

If the rebuilt valve fails the shelf life pressure requirement, the valve should be disassembled and reassembled according to the procedure of 5.3. If failure occurs again, a new bellows should be installed.

9 Operator's Use

The operator can use the reporting forms to develop a history of valve failure causes. This can also serve to substantiate valve life and frequency of workovers or wireline jobs for "suspected" valve failures.

A. Front of Tag

OPERATOR
WELL NAME & NO.
FIELD
DATE

Meas depth _____ Valve _____ Of _____ (Top to bottom)

Order pulled _____

Mfg _____ Model _____

Size (OD) _____ PVO (TROP) _____

Clean _____ Fouled _____ Damaged _____
Gas inlet ports plugged with:
Sand _____ Scale _____
Rust _____ Paraffin _____
Mud _____ Cement _____

B. Back of Tag

Gas outlet plugged with:
Sand _____ Scale _____
Rust _____ Paraffin _____
Mud _____ Cement _____

Valve body condition:
OK _____ Smashed _____ Cut _____ Bent _____

Top Packing: Condition _____
Bot Packing: Condition _____
Latch: Condition _____
Comments: _____

Tag filled out by _____
Service company _____

Figure 1—Tag for Wellsite Data

Operator _____

Well name and no. _____

Field _____

Date removed from well _____

Date inspected/tested _____

Meas depth _____ Valve _____ Of _____ (Top to bottom)

Order pulled _____

Mfg _____ Model _____

Size _____ Port Size _____

Clean _____ Fouled _____ Damaged _____

Gas inlet ports plugged with:

- Sand _____ Scale _____
- Rust _____ Paraffin _____
- Mud _____ Cement _____

Gas outlet plugged with:

- Sand _____ Scale _____
- Rust _____ Paraffin _____
- Mud _____ Cement _____

Valve body condition:

OK _____ Smashed _____ Cut _____ Bent _____

Top Packing: Condition _____

Bot Packing: Condition _____

Latch: Condition _____

Original P_{VOT} _____ PSIG at temp = _____ °F

Test P_{VOT} _____ PSIG at ambient temp _____ °F

Seat/Stem:

- Cut out _____
- Ball damage _____
- Seat deformed _____

Bellows:

- Convolutions plugged _____ Cut _____
- Smashed _____ Cracked _____
- Abrasion _____
- Weld failure _____

Check:

- Plugged _____ Cut _____
- Elastometer failed _____
- Spring failed _____
- Dart condition _____

Comments: _____

Form filled out by _____

Service/valve repair company _____

Figure 2—Shop Form

Operator _____

Well name and no. _____

Field _____

Date removed from well _____

Date inspected/tested _____

Order pulled								
Meas depth								
Mfg								
Model								
Valve size, inches								
Port size, inches								
General condition:	1. Clean			2. Damaged			3. Plugged	
List for each valve								
Ports plugged with:	1. Sand	2. Scale		3. Rust	4. Paraffin		5. Mud	6. Cement
Gas inlet ports								
Gas outlet ports								
Valve body condition:	1. OK		2. Smashed		3. Cut		4. Bent	
List for each valve								
Wireline packing and latch condition:		1. OK		2. Cut		3. Damaged		4. Missing
Top packing:								
Bot packing:								
Latch:								
Pvo Check								
Original Pvo, PSIG								
Temp, deg F								
Test P_{VOT}, PSIG								
Ambient temp, deg F								
Seat/Stem:	1. Cut out			2. Ball damage			3. Seat deformed	
List for each valve								
Bellows convolutions:	1. Plugged	2. Cut		3. Smashed	4. Cracked		5. Abrasion	6. Weld
List for each valve								
Check:	1. Plugged	2. Cut		3. Elastometer failed		4. Spring failed		5. Dart condition
List for each valve								

Comments: _____

_____

_____

Form filled out by _____

Service/valve repair company _____

Figure 2A—Shop Form—All Valves

Operator _____

Well name and no. _____

Field _____

Date _____

Total number of valves _____

Valve number								
Meas depth								
Mfg								
Model								

Source of valve parts (List source for each item)	1. Reused		2. Replaced			3. Reworked		
Spring								
Bellows								
Stem								
Seat								
Check								

Test rack opening pressure								
Pvo, PSIG								
@ deg F								
Hydrostatic test								
@PSIG								
Dimensions and stem travel								
Valve size, inches								
Port size, inches								
Stem travel, inches								

Form filled out by _____

Service/valve repair company _____

Figure 3—Reassembly and Test Data—All Valves

APPENDIX A—EXCERPTS FROM API SPEC 11V1, TESTING

A.1 Testing

A.1.1 PRODUCTION RUN TEST

All valves shall successfully complete the following requirements:

A.1.1.1 Bellows Assembly Test

Each bellows assembly shall be tested in accordance with the manufacturer's written specifications to assure bellows integrity is in accordance with 4.4.1.5 and B.3.1 and B.3.2 in Appendix B of this specification.

A.1.1.2 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.

A.1.1.3 Stem-Seat Leakage Test

Each gas lift valve shall be tested for leakage across the stem and seat in accordance with B.4 in Appendix B and the manufacturer's written specifications. The leak shall not exceed 35 std ft^3/day (1 std m^3/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 B.4.3 in Appendix B.)

A.1.1.4 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 ft^3/day (1 std m^3/day) with a 100 psi (689 kPa) ± 10% differential pressure across the reverse flow valve.

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

A.1.1.5 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.

APPENDIX B—EXCERPTS FROM API SPEC 11V1—TEST PROCEDURES FOR GAS LIFT VALVES AND REVERSE FLOW VALVES

B.1 General

B.1.1 This is a mandatory appendix as applied to API RP 11V7, *Recommended Practice for Repair, Testing and Setting Gas Lift Valves.*

B.2 Apparatus

B.2.1 TEST RACK

This is the equipment used to set the opening and/or closing pressure of either a pressure charged or a spring loaded valve as specified by the manufacturer. There are two general types in use: the "sleeve" tester (Figure 15) and the "encapsulated" tester (Figure 16).

B.2.2 WATER BATH

This is a water-filled container where several gas lift valves are immersed in the water to bring them to some predetermined controlled temperature. Since most gas lift installation designs calculate the gas lift valve set pressure at 60°F (15.5°C), the temperature of the water bath is usually controlled to 60°F (15.5°C). If the water temperature is other than 60°F (15.5°C), then the pressure used for setting the gas lift valve must be corrected for the temperature of the water bath. This device is absolutely essential for pressure charged gas lift valves. It is not needed for spring loaded valves as they are essentially insensitive to temperature.

B.2.3 PRESSURE CHAMBER OR AGER

This device is a water filled chamber capable of at least 5,000 psig [34.474MPa (ga)]. The gas lift valves are inserted into the chamber and subjected to a predetermined external pressure for some predetermined length of time and number of cycles.

B.2.4 PROBE

This device is a micrometer to measure the stem travel as pressure is applied to the bellows. Figure 17 is a sketch of one such device. The rod of the probe is insulated electrically from the valve. A continuity tester determines when the rod touches the valve stem.

B.3 Valve Setting and Bellows Stabilization

B.3.1 PRESSURE CHARGED GAS LIFT VALVES

B.3.1.1 Remove the tail plugs, charge the dome to a pressure required by the repair shop's written specifications. Put the valves in the water bath for a minimum of 15 minutes.

B.3.1.2 Remove a valve from the water bath and insert it in the tester.

CAUTION: Do not hold the valve by the dome as that will heat the dome and cause incorrect set pressure. Apply gas pressure to open the valve (test rack opening pressure). If it takes longer than 30 seconds to measure the opening pressure, remove the valve from the tester and return it to the water bath for at least 15 minutes and repeat B.3.1.2.

B.3.1.3 Install tail plugs and put all valves in the pressure chamber or ager. Bring the pressure of the changer up to a gauge reading of 5,000 psig ± 100 psi [34.474 MPa (ga) ± 689 kPa] and hold for a minimum of 15 minutes. Release the pressure and cycle the pressure to 5,000 psig ± 100 psi [34.474 MPa (ga) ± 689 kPa] a minimum of three times without pausing more than one minute between cycles.

B.3.1.4 Remove the valves from the chamber and return them to the water bath for a minimum of 15 minutes.

B.3.1.5 Remove a valve from the water bath, install it in the tester, and check the opening pressure. If the opening pressure has changed 5 psi (34.5 kPa) or more, repeat B.3.1.3 through B.3.1.5 until the pressure does not change 5 psi (34.5 kPa) or more.

B.3.2 SPRING LOADED GAS LIFT VALVES

B.3.2.1 Put the valve in the tester and measure the opening pressure (or closing pressure). Adjust the spring compression (tension), and check the opening pressure (or closing pressure). Continue until the pressure required by the manufacturer's written specification is achieved.

B.3.2.2 Put the valves in the pressure chamber, bring the pressure on the chamber up to a gauge reading of 5,000 psig ± 100 psi [34.474 MPa (ga) ± 689 kPa] and hold for a minimum of 15 minutes. Release the pressure and cycle the pressure to 5,000 psig ± 100 psi [34.474 MPa (ga) ± 689 kPa] a minimum of three times without pausing more than one minute between cycles.

B.3.2.3 Remove the valves from the pressure chamber. Check the opening pressure (or closing pressure). If the pressure has changed 5 psi (34.5 kPa) or more, repeat B.3.2.2 and B.3.2.3 until the pressure does not change 5 psi (34.5 kPa) or more.

B.4 Valve Leakage Test

B.4.1 The test rack for this test shall have provisions for measuring low gas flow rates on the downstream side of the

Previous page is blank

gas lift valve. Figure 19 and Figure 20 are sketches of two such devices.

B.4.2 This test is conducted at ambient temperatures.

B.4.3 Measure the test rack opening pressure (P_{VOT}) at ambient temperature and calculate P_{VCT}.

$$P_{VCT} = P_{VOT}(1 - Ap/Ab)$$

where

P_{VCT} = closing pressure of the valve at valve temperature when th injection gas pressure and the production pressure are equal at the instant the valve closes in a test rack, psig [kPa (ga)],

P_{VOT} = valve opening pressure in test rack at valve temperature, psig [kPa (ga)],

Ap = effective pressure area of valve stem and seat contact, in.^{2} (or mm^2),

Ab = effective area of the bellows, in.^{2} (or mm^2).

B.4.4 No visible oil, grease, water or other lubricating or sealing material shall be allowed on the stem and/or seat.

B.4.5 Install the valve in the fixture, open the valve with gas pressure above P_{VOT}, and then reduce the gas pressure to a value greater than P_{VCT}.

B.4.6 Direct the downstream side for flow measurement.

B.4.7 If the flow rate is greater than 35 std ft^3/day (1 std m^3/day), the stem and seat shall be rejected.

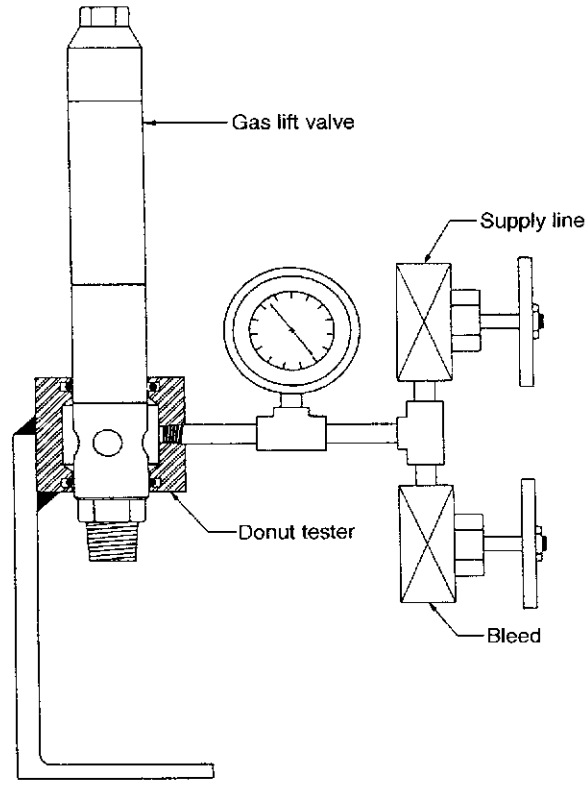

Figure 15—Typical Sleeve Tester

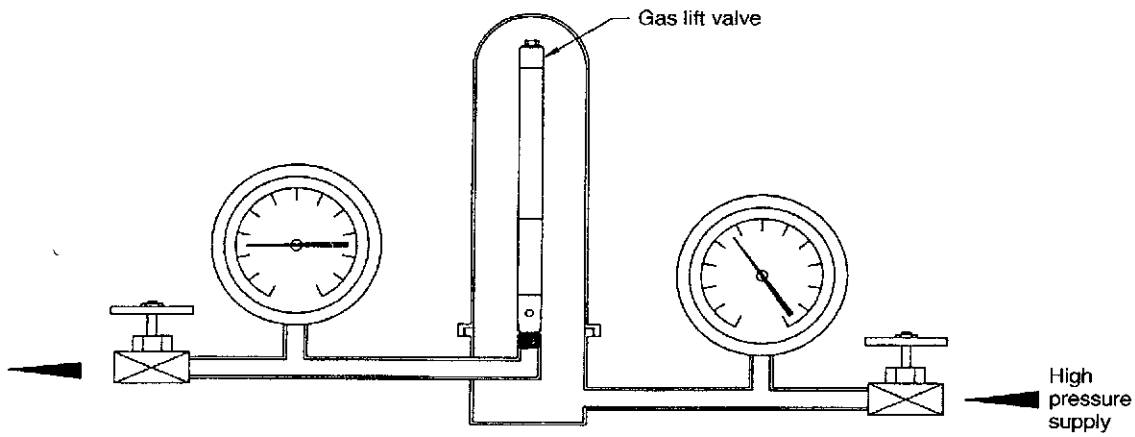

Figure 16—Typical Encapsulated Tester

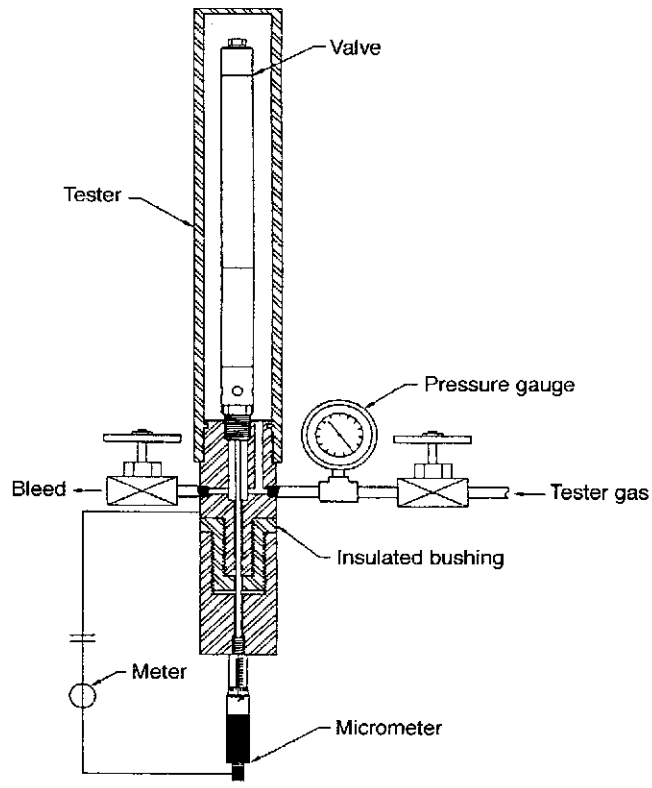

Figure 17—Typical Gas Lift Valve Probe Test Fixture

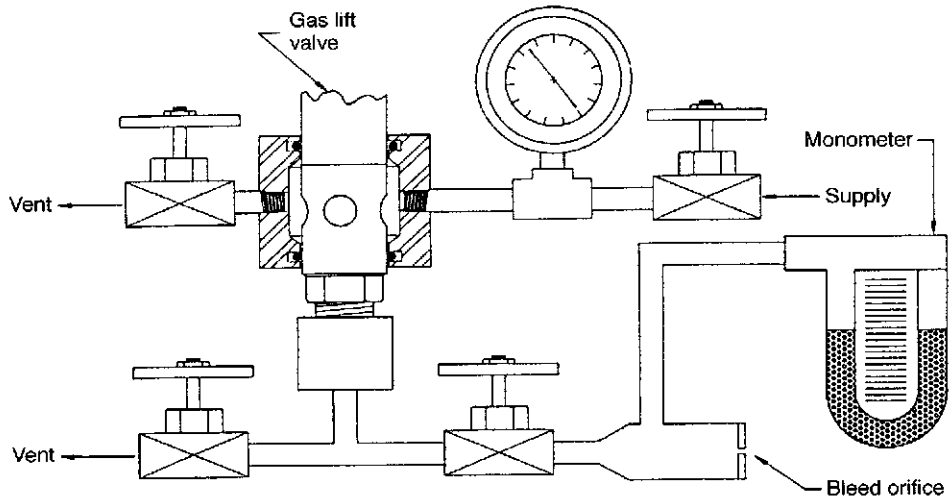

Figure 19—Typical Stem and Seat Leakage Testers

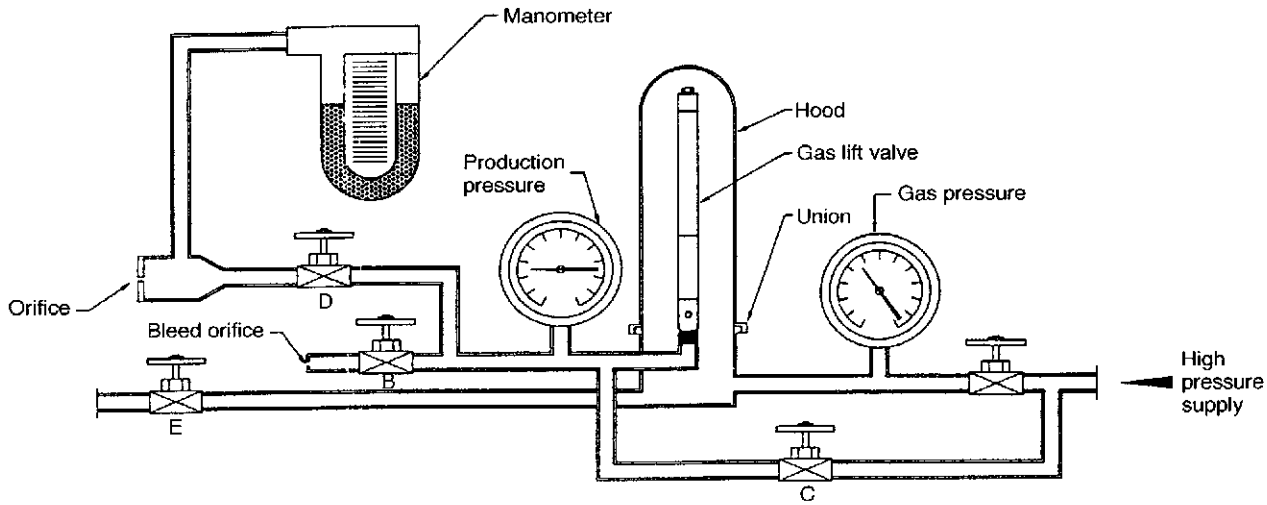

Figure 20—Typical Stem and Seat Leakage

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