

Engineering Procedure

SAEP-1132

31 August, 2002

Instruction for Using
the Relief Valve Test Stand

Document Responsibility: Inspection Dept.

Saudi Aramco DeskTop Standards

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1 Scope

This procedure defines the requirements for a RV Test Stand used for testing Saudi Aramco RV's, and instructions for it's use.

- 1.1 The test stand shall have a volume large enough to provide reliable RV adjustment and pressure testing at the specified CDTP, Cold Differential Test Pressure (i.e.; the pressure at which the RV is adjusted to open on the test stand) set pressure, and leak testing.
- 1.2 For gas service, a test stand must be able to cause a sharp pop of the RV for the test to be valid. Simple opening and passing of air or nitrogen is not acceptable. The gas service test stand design described in this Procedure is intended to provide a sharp pop action with minimum altering of the blowdown ring adjustment. However, the blowdown ring may be adjusted to assist in achieving a valid pop action for the test. Upon these occasions it is essential that the blowdown ring be returned to it's original operating position upon completion of the test.
- 1.3 The RV test stand is designed to provide sufficient capacity to adequately verify the pressure at which the RV pops without damaging the valve trim. Insufficient volume, poor pressure control, inaccurate gauges or contaminated test media may cause unreliable testing and/or additional maintenance. Test stand design is intended to produce a pop action, because a pre-simmer action is not the true opening pressure of a gas service RV, by manufacturer's definition. This pre-simmer test method can result in a 10-15% difference in the actual popping pressure. RV manufacturers have recommended that "lift restrictors" be used for testing even with the Saudi Aramco test stand. Contact Operations Inspection Division, Dhahran for details of fabricating and use of lift restrictors.
- 1.4 It is not the purpose of a Saudi Aramco test stand to adjust blowdown for boiler valves because the test stand volume is too low. Blowdown adjustments shall be made with an approved RV IN-PLACE Procedure. See [SAEP-319](#) Section 10.

2 Test Stand Vessel Design

ASME, API, and Manufacturers recognize that a RV test stand must be adequately sized to ensure RV action is consistent with the set pressure and tolerances required for reliable RV performance. Saudi Aramco minimum design requirements are as follows:

- 2.1 RV test stand vessel design for GAS service.
 - 2.1.1 The test vessel shall be designed and fabricated to meet ASME SEC VIII D1 and [SAES-D-001](#) requirements. The vessel design pressure shall minimally be 1.1 times the highest RV set pressure to be tested. A Saudi
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Aramco equipment number shall be assigned. As built drawings, Safety Instruction Sheet, and Design Data Form shall be entered into the SAO drawing system by the User. Final approval by CSD and the Inspection Department shall be required.

- 2.1.2 The minimum volume shall be five (5) cubic feet and the minimum shell diameter shall be twelve (12) inches. The test nozzle size and test flange orifice shall be at least two (2) inches in diameter. The test nozzle may be designed with a multi-fit flange that shall secure RVs by bolting or a securing system having sufficient strength for the highest pressure and weight of RV to be tested.
- 2.1.3 Test vessels may have more test nozzles than the illustrated example in Figure I. Auxiliary flanged test nozzles may be included for future service. Threaded connection RVs shall be tested using full bore thread-o-let mounting adapters. Auxiliary piping for test gauges, shall not be less than 0.75" diameter. Test nozzle block valves shall be full bore, and seal tightly. Ball valves are preferred.
- 2.1.4 The Test Drum shall be protected against over pressure by a permanent RV mounted on the vessel and set at the design pressure of the drum. This RV shall be capacity rated to relieve the flow rate of the pressure source, and meet [SAES-J-600](#), [SAEP-318](#), and [SAEP-319](#) requirements.
- 2.1.5 Design of fabricated test vessels and reservoirs should include end flanges to permit coating the internal surface for corrosion prevention. The coating will prevent the formation of scale and rust which can damage the seating surface of the RV during testing.
- 2.1.6 The test drums shall be included in routine Equipment Inspection Schedules per [SAEP-20](#).
- 2.2 RV test stand vessel design for LIQUID service.
 - 2.2.1 A liquid service RV test drum shall be designed and fabricated to meet ASME SEC VIII D1 and [SAES-D-001](#) requirements. A Saudi Aramco equipment number shall be assigned. Safety Instruction Sheets, as built drawings and the Design Data Form shall be entered into the SAO drawing system by the User. The drum may be designed using piping Codes when the drum diameter is less than six inches, in accordance to the Scope of ASME SEC VIII D1.
 - 2.2.2 A minimum of two liters of liquid media volume should be provided.

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- 2.2.3 The Test Drum shall be protected against over pressure by a permanent RV mounted on the drum that is capacity rated to relieve the flow rate of the pressure source, and meets [SAES-J-600](#) requirements.
 - 2.2.4 The liquid test stand drum test nozzle orifice shall not be less than 0.75" diameter. The test nozzle may be designed with a multi fit flange that shall secure RVs by bolting or a securing system of sufficient strength for the highest pressure and weight of RV to be tested.
 - 2.2.5 An internal coating is not required providing the liquid test media is noncorrosive and the vessel remains filled with the media.
 - 2.2.6 The test media liquid should be opaque and noncorrosive, i.e.: a mix of water and solvent oil creates a white liquid which is non-foaming and is safely disposable as well as non-toxic.
- 2.3 Test Stand Pressure Gauges
- 2.3.1 The test gauges shall have a range of 1.25 to 2.0 times the RV CDTP set pressure.
 - 2.3.2 Gauges shall have scale markings in the same measurement units as those of the RV set pressure shown on the Saudi Aramco Form [3099A-ENG](#). Conversions between units shall not be made. The gauge scale definition shall be adequate to determine the pressure tolerances.
 - 2.3.3 All gauges must have evidence of calibration within three months. Calibrate if the gauge appears to be functioning improperly. New gauges shall be calibrated before use.
 - 2.3.4 Gauge calibration procedures shall be included or referenced in the QA document, as required in [SAEP-319](#). The procedure shall include calibration stickers and a calibration log for scheduling to assure the task is followed and the responsibility is defined.
- 2.4 Additional Requirements
- 2.4.1 Test stand control valve configuration and/or regulators shall be designed for the necessary control needed for leak testing and low set pressures.
 - 2.4.2 A Vacuum pump shall be included in the Test Facility where vacuum type breather valves are maintained.
 - 2.4.3 Adapter plates and special fixtures shall be readily available for mounting and testing the various types of RVs being maintained.
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- 2.4.4 Figure IV illustrates an acceptable stand and method for testing Tank breather valves in the RV Shop.
- 2.4.5 The pilot of Pilot RVs may be adjusted using the gas test stand or a specialized pilot test stand, similar to Figure III of this Procedure. The requirements for gas test drum fabrication shall apply.
- 2.4.6 Noise suppression shall be used when necessary to maintain safe working conditions, as required by Industrial Hygiene measurement of sound levels. Exhaust piping, mufflers or hose shall be large enough to prevent back pressure rise, and shall be vented to a safe location. Noise suppression may be by vertical upward venting, venting to a large insulated baffle chamber, or any other method acceptable to OID and Saudi Aramco Loss Prevention.

3 Improving Test Stand Performance

Several options to improve the testing capability of the RV Shop are suggested in this section to acknowledge the limitations and problems associated with testing relief valves. Other options can be developed, and they should be discussed with OID/ID for approval and to help inform other Saudi Aramco RV Shops.

- 3.1 Use a lift restrictor to limit the disk travel when momentum forces cause hammering damage to the disk. Dresser Consolidated recommends 1900 Series valves with orifice sizes D and greater be tested with lift restrictors. Crosby also state that their valves should be tested with lift restrictors. Contact OID/ID, Dhahran for fabrication and adjustment details.
- 3.2 Avoid testing with incorrect test equipment. Contact OID or Dhahran Shops, Planning and Coordinating Unit, Dhahran, if assistance is needed in locating a RV Shop with a larger capacity or specialized test equipment.
- 3.3 Steam boiler safety valves shall not have the blowdown adjusted on a test bench.

4 Test Stand Operation

- 4.1 A test stand operating procedure shall be prepared and included in the RV Shop QA Manual. The procedure shall include safety requirements such as eye and ear protection, safe tool operation, and installation of air compressor filters. Refer to the testing requirements of [SAEP-319](#), and RV manufacturer repair manuals to prepare a complete procedure.
 - 4.2 A Certified RV Technician, as defined by [SAEP-1134](#), shall operate the Test Stand or be present.
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- 4.3 RVs in liquid service shall be tested with liquids only, however, they may be LEAK tested with gases (air or nitrogen).
 - 4.4 RV's in vapor, air, gas, or a combination of liquid and gas service shall only be tested with air.
 - 4.5 RVs in boiler steam service may have the initial pop pressure set in the Test Shop using air, but the final pressure and blow-down setting shall be made with steam, on the boiler using an approved In-place Procedure, as defined in [SAEP-319](#) Section 10.
 - 4.6 The following is an example instruction for testing a gas service spring actuated RV on the typical RV Test Stand illustrated in Figure I of this SAEP.
 - 4.6.1 Before using the RV test stand eliminate loose particles in the system by air blowing. This is done by closing valves V4 and V5, open valve V2 and V6, and to alternately open and close valve V1 until no particles are visually seen. Close test nozzle valve (V2) after flushing.
 - 4.6.2 Testing begins with mounting the RV to the test nozzle flange.
 - 4.6.3 Attach noise suppression line to RV outlet.
 - 4.6.4 Open test nozzle valve (V2) and close the bleed valve.
 - 4.6.5 Open the pressure gauge valve for the appropriate pressure range, refer to para. 2.3.1. Close all other pressure gauge isolation valves.
 - 4.6.6 Increase pressure in test drum to 90% of cold differential test pressure (CDTP) by opening valve V1. WARN Shop personnel of high noise level test.
 - 4.6.7 Close valve V1 and use small bypass valve V8 to increase pressure smoothly and continuously until the RV pops or CDTP tolerance is reached; BUT NEVER HIGHER THAN 10% OVER THE CDTP.
 - 4.6.8 Close valve V8 and record pop pressure/results. Compare to allowable tolerances, shown in Table 1 of this Procedure.
 - 4.6.9 Based on test results and Work Order, either disassemble, accept, rework or readjust the RV. Perform a final verification test. Proceed with the leak testing; see Section 5 for a representative procedure.
 - 4.6.10 Remove the RV when testing is completed by first closing test nozzle valve (V2).
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- 4.6.11 Reduce stand pressure to 75% of the CDTP of the next valve.
- 4.6.12 Open bleed valve on test nozzle valve (V2) outlet and release pressure under tested RV.
- 4.6.13 Remove tested relief valve and install next valve to be tested. Go to operation 4.6.1 for next test.
- 4.6.14 After ALL testing is complete, shut in the test stand by blowing down the drum through valve V6. After verifying there is no pressure in the drum, close the test gauge valve that was in use.
- 4.6.15 While the test stand is not in use, close valves V1, V2, V4, V5 and V8. Open valve V6 or designate one valve that remains open when the test stand is not in use.

5 Seat Leakage Testing

- 5.1 Leak testing is mandatory, and is conducted as required in [SAEP-319](#). Leakage is measured through the seat to disk seal while the RV is at 90% of CDTP. The test is conducted on the RV test stand.
- 5.2 The seat leakage test shall be conducted in accordance with API STD 527.
- 5.3 Attach the special flange and water bubbler (it shall be designed with a rupture seal that will vent full flow in the event the RV should open), as per Figure II, and seal all other RV body outlets or vents.
- 5.4 Hold 90% of CDTP for the required test period as follows:
 - One minute for 0.5" to 2" RV inlet size
 - Two minutes for 2.5" to 4" RV inlet size
 - Five minutes for all other larger inlets sizes
- 5.5 Compare BUBBLES PER MINUTE leakage rate to the acceptance criteria, as follows:
 - Appendix Table II for RV's with CDTP up to 1000 psig.
 - Appendix Table III for RV's with CDTP over 1000 psig.
- 5.6 When the RV body can not be sealed for the API STD 527 test method (such as an open bonnet RV design) then use the Half Gasket Dam Leak Test Method.

- 5.6.1 Cover the lower half of the outlet flange with a half gasket or a fabricated device that allows the body cavity to be partially filled with water.
 - 5.6.2 Fill the body cavity with water to cover the seating joint.
 - 5.6.3 Raise the test bench pressure to 90% of the CDTP set pressure and look for evidence of bubbling from the seating joint. Use a mirror to observe the activity; NEVER LOOK DIRECTLY INTO A RV OUTLET WHILE IT IS UNDER PRESSURE. No bubbles are acceptable with this method.
- 5.7 For small screwed RVs, attach an elbow on the outlet, and fill the body cavity and the elbow with water.

Raise the test bench pressure to 90% of the CDTP set pressure and look for evidence of bubbling at the open elbow. NEVER LOOK DIRECTLY INTO the elbow WHILE IT IS UNDER PRESSURE. No bubbles are acceptable with this method.

6 Specialty RV Testing Devices

- 6.1 Specialized RV testing Devices, such as direct spring assist units, shall be approved by ASME, the Inspection Department, CSD, and concurred with by Loss Prevention prior to using the equipment.
- 6.2 A direct spring assist device should incorporate precise, accurate and repeatable pressure recording, as a minimum.
- 6.3 An approved written Operating Procedure shall be developed by the User's Engineering Unit that includes calibration details, limitations, Operator training, and tolerance requirements. Approval shall be required by the Manager of the Inspection Department, Process & Control Systems Department, and concurrence from Loss Prevention.

7 Applicable Documents

The requirements contained in the following documents apply to the extent specified in this procedure.

- 7.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

[SAEP-20](#)

Equipment Inspection Schedule

[SAEP-318](#) *Pressure Relief Valve Program Authorization for
Installation, Deletion and Changes*

[SAEP-319](#) *Pressure Relief Valves - Routine Test, Inspection,
Quality Assurance & Regulation*

[SAEP-1134](#) *Relief Valve Technician Certification*

Saudi Aramco Engineering Standards

[SAES-D-001](#) *Design Criteria for Pressure Vessels*

[SAES-J-600](#) *Pressure Relief Devices*

Saudi Aramco Form and Data Sheet

[3099A-ENG](#) *Relief Valve Authorization*

7.2 Industry Codes and Standards

American Petroleum Institute

API STD 527 *Seat Tightness of Pressure Relief Valves*

American Society of Mechanical Engineers

ASME SEC VIII D1 *Rules for Construction of Pressure Vessels*

Revision Summary

31 August, 2002 Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with editorial changes.



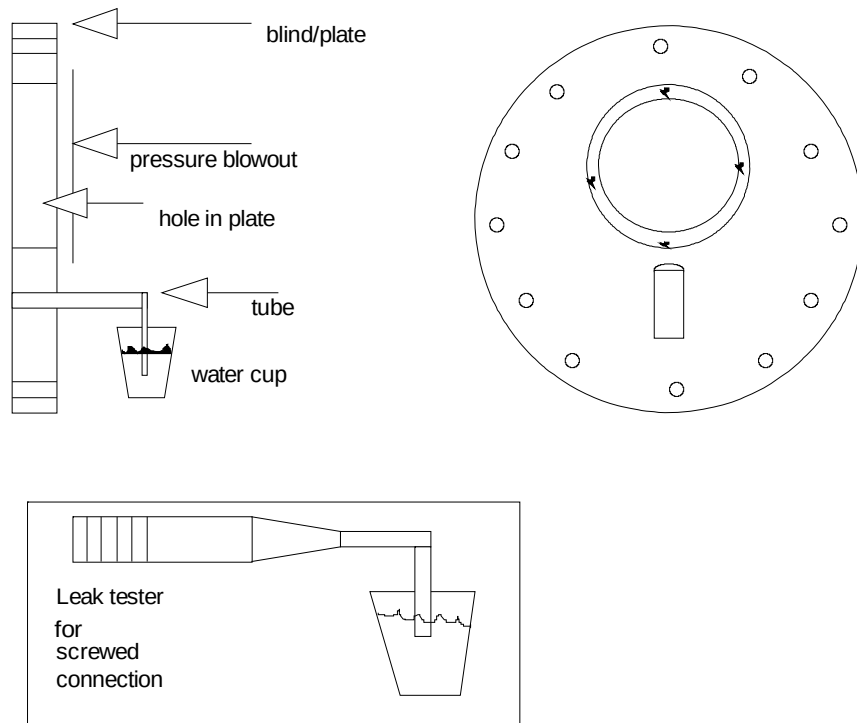


Figure II – API STD 527 Test Apparatus for RV Metal to Metal Seat Leak Testing

Attach the blind/plate to the RV outlet and seal all other body ports so that the only available gas exit from a seat leak is through the water trap.

Use the half gasket leak test method if body ports can not be sealed. With this method, the outlet is partially covered or an elbow is attached to permit filling of the body cavity with water. Leaking seats will cause bubbles in water. With this method NO LEAKAGE IS PERMITTED.

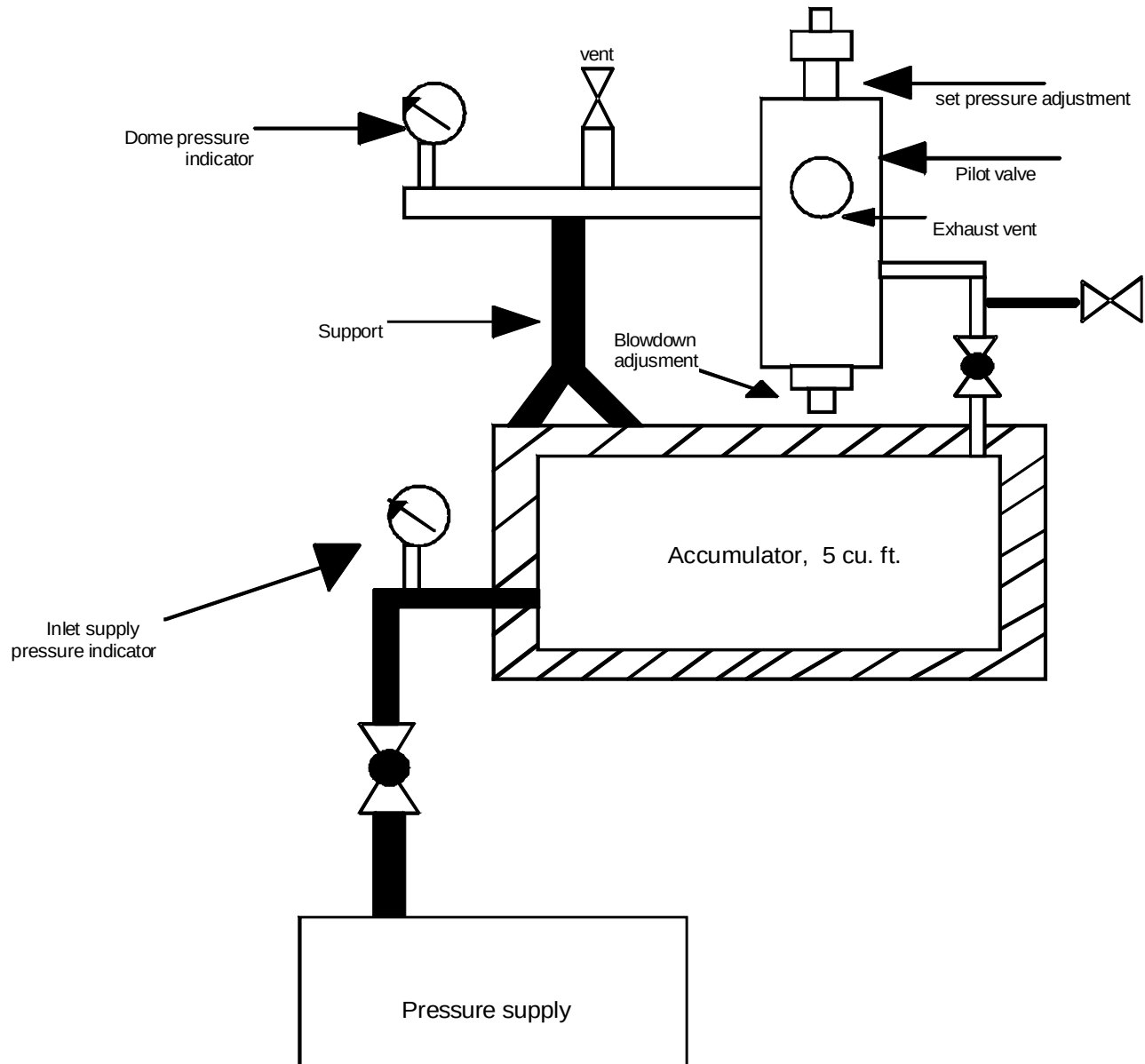


Figure III – Test Apparatus for Pilot RV Adjustment and Testing

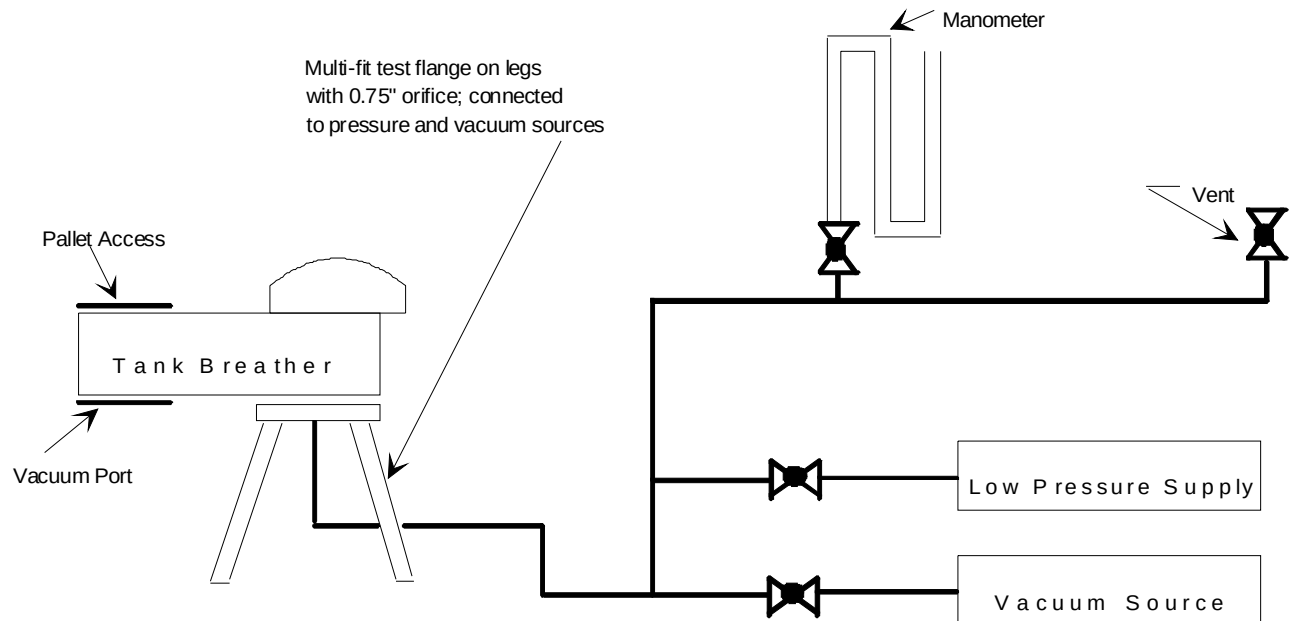


Figure IV – Test Apparatus for Tank Breather Adjustment and Testing

Mount breather on test flange after disassembly, cleaning and repairs are complete.

1. Replace all soft goods, and restore seating surfaces.
2. Pallets should be checked for free movement before testing.
3. Verify that weighted pallets have not been altered. Apply the correct pressure, and verify pressure when pallets opens.
4. Isolate pressure source, and apply vacuum. Verify vacuum pressure when pallet lifts.

Table I – Tolerances for Set Pressures of Pilot/Safety Relief Valves

(In English Units to Conform to ASME Code Requirements)

Set Pressure (CDTP)	POP Pressure OK if
0 to 100 psi (0-690 kPa)	± 2 psig (14 kPa)
101 to 110 psi (696-758 kPa)	± 3 psig (21 kPa)
111 to 150 psi (765-1034 kPa)	± 4 psig (28 kPa)
151 to 199 psi (1041-1372 kPa)	± 5 psig (35 kPa)
over 200 psi (1379 kPa) for every hundred psig	± 3 psig (21 kPa)

Steam Safety Valves

Set Pressure (CDTP)	POP Pressure OK if
0 to 70 psi (0-483 kPa)	± 2 psi (14 kPa)
71 to 300 psi (490-2068 kPa)	± 3%
301 to 1000 psi (2075-6895 kPa)	± 10 psi (70 kPa)
over 1000 psi (6902 kPa)	± 1%

- NOTES:**
1. NEVER CONDUCT A TEST HIGHER THAN 10% OVER THE CDTP.
 2. NEVER CONDUCT A TEST ABOVE THE TEST STAND MAWP.

**Table II – Leakage Rates for Pilot/Safety Relief Valves
with Set Pressures to 1000 psig (6895 kPa)**

Type of Valve	Manufacturer's Orifice Size	Standard Bubbles Per Min.	Standard Cubic Ft. Per 24 Hrs	Cubic Meters Per 24 Hrs.
Conven- tional	F & smaller	40	0.60	0.017
	G & larger	20	0.30	0.0085

**Table III – Maximum Seat Leakage Rate (Bubbles Per Minute)
for Set Pressure Over 1000 psig**

