Verification of Double Block-and-Bleed Valves in Hydrocarbon Measurement Applications

API RECOMMENDED PRACTICE 25XX

FIRST EDITION, MM YYYY

Contents

Introduction

This recommended practice describes verifying proper sealing of double block-and-bleed (DBB) type valves or valving configurations in measurement applications. While this recommended practice is focused on DBB type valves in flow measurement applications, the guidance herein can be applied to verifying DBB valve sealing in non-measurement applications. Seal verification should be performed in accordance with applicable manufacturer's recommendations and operating company procedures.

Some specifications make a distinction between double block and bleed and double isolation and bleed, depending on the number and location of pressure sources. For the purpose of this recommended practice, the term double block and bleed is used as applicable to any valve or valving configuration with a cavity, from which pressure can be bled, between both process connections.

While a small differential of 1 psi can be sufficient for verifying that a valve is leak-free with instrumentation, the recommendations and practices within this document have greater requirements to ensure that uncertainty is minimized. These enhanced criteria are intended to account for potential measurement inaccuracies, environmental variables, and operational risks, thereby ensuring a higher level of confidence in valve integrity and therefore system reliability.

1 Scope

The purpose of the document is to provide guidance on verifying double block-and-bleed (DBB) type valves or valve manifolds are leak-free in applications with fluids in liquid or supercritical phase.

These valves are commonly used to ensure a no-flow condition in piping through which unintended flow would cause flow measurement error. (e.g., DBB valves installed between flow meter(s) and the prover, including the divert valve).

2 Normative References

No documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

3 Terms, Definitions, Abbreviations, and Acronyms

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply. Terms of more general use can be found in the API *MPMS* Chapter 1 Online Terms and Definitions Database.

3.1.1 Atmospherically stable liquid

A liquid that remains in a liquid phase (does not boil or flash) at atmospheric conditions.

3.1.2 Atmospherically unstable liquid

A liquid that does not remain in an entirely liquid phase (boils or flashes) at atmospheric conditions.

3.1.3 Block and bleed valve

a high integrity valve with double seals and provision for determining if either seal leaks

3.1.4 Double block-and-bleed (DBB) valve

A valve with two or more independent seating surfaces where each seating surface independently provides a seal against pressure from both directions, with a means of venting/bleeding or monitoring the cavity between the seating surfaces.

3.2 Abbreviations and Acronyms

DBB double block-and-bleed

psi pounds per square inch

4 Typical Valve Types and Valving Configurations for Double Block-and-Bleed.

4.1 Double Block-and-Bleed (DBB)

The DBB feature of the valve, or valving configurations, provides the ability to segregate two pressure sources and to bleed, vent, or monitor pressure in the void between the two sealing elements (blocks). The bleed can be in the valve body between two seats of a DBB valve as shown in Figure 1. A bleed can also be connected to the piping between two valves, collectively referred to herein as a DBB valving configuration as shown in Figure 2.

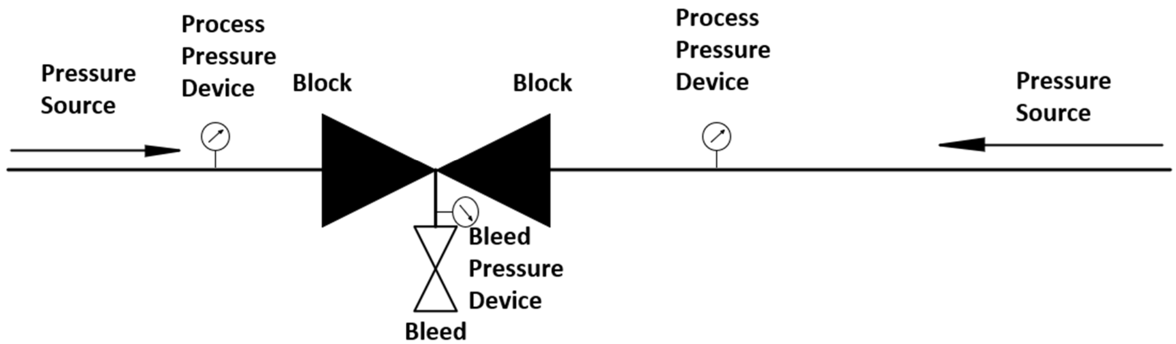


Figure 1—Double Block and Bleed Single Valve—Type B

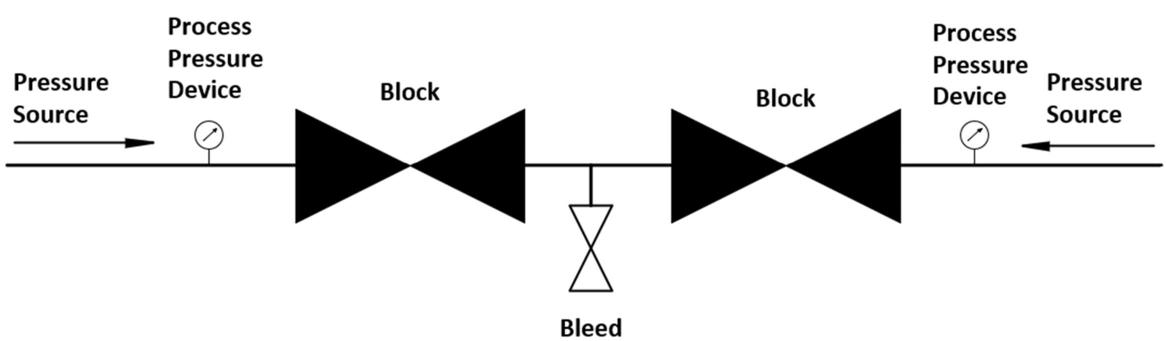
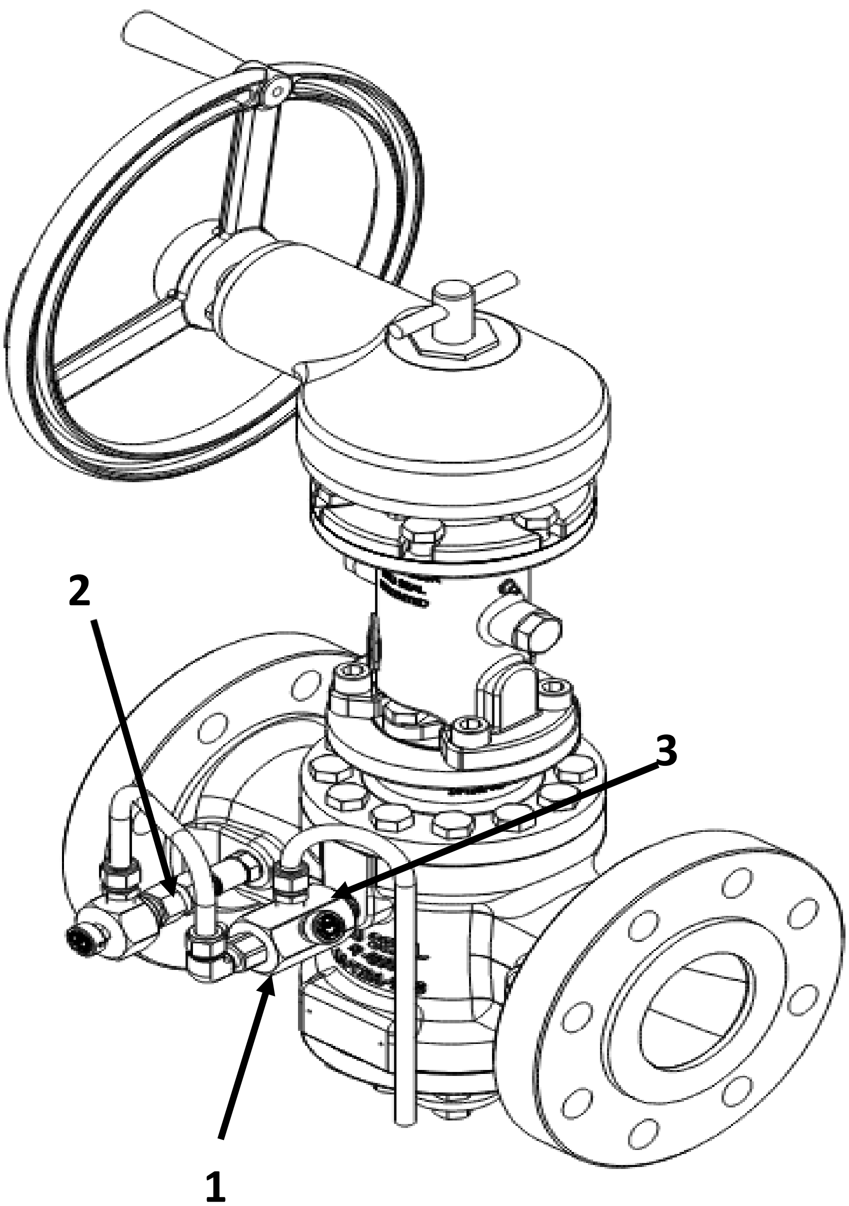


Figure 2—Double Block-and-Bleed — Valving Configuration – Type A

4.2 Common Valves used for DBB

Figures 3 and 4 show examples of DBB valves. DBB valves can be fitted with thermal relief to prevent unintentional pressure buildup in the cavity due to temperature increases when the valve is closed. The examples below are for reference only as DBB valves and valving configurations can vary. Refer to the manufacturer for valve specific drawings.



Key

1) bleed port with valve
2) differential thermal relief system
3) connection point for bleeding, venting, or monitoring pressure

Figure 3 - Typical 2-way DBB Process Valve

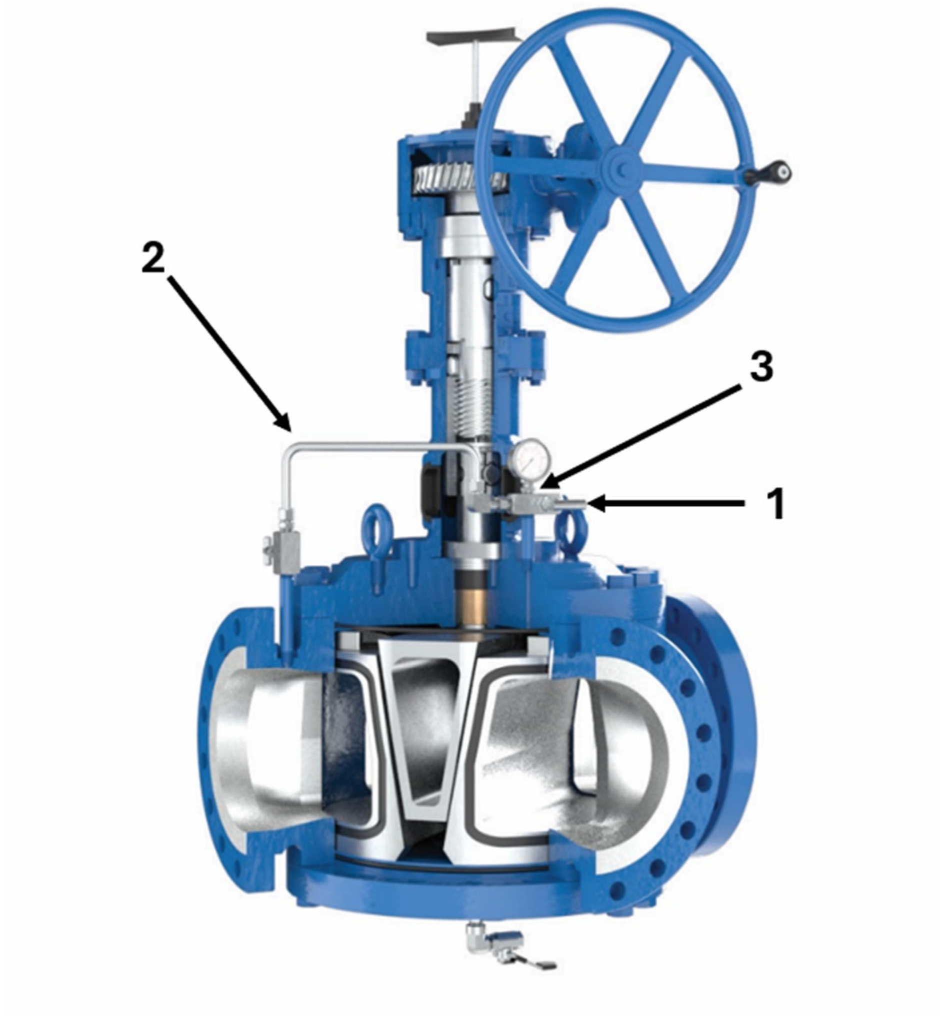


Figure 4—Typical 4-Way DBB Process Valve

Key

1) bleed port with valve
2) differential thermal relief
3) connection point for bleeding, venting, or monitoring pressure

5 Methods for Verification of DBB Valve Seal Integrity

DBB valves and valving configurations are used to prevent unintended flow in piping, which could lead to flow measurement errors. For example, DBB valves and 4-way valves are used for liquid meter proving to help ensure accurate meter factor determination.

DBB valves and valving configurations can be verified as leak-free using either the atmospheric verification method or the pressure-instrumentation verification method. The atmospheric verification method is performed by closing the DBB valve and bleeding the process fluid between the double block to containment at atmospheric conditions in a controlled manner. The pressure verification method uses pressure instrumentation (e.g., static pressure or differential-pressure devices). Because the design of 4-way valves causes the seating surfaces to differ for forward and reverse flow, 4-way valve sealing integrity shall be verified in both directions.

The method and torque used to close the valve before verification should match those used during normal operation.

5.1 Atmospheric Seal Verification Method

The atmospheric seal verification method should only be performed with atmospherically stable liquids. To avoid valve seal damage, the process operating pressure should not exceed the valve manufacturer's specified maximum seal differential pressure.

Before starting the verification, the user should ensure the bleed port and associated tubing are free of obstructions (e.g., paraffin, debris, ice). This is done by partially opening the bleed port valve with the process valve open or partially open to confirm flow through the bleed port. Close the bleed port valve immediately after this check.

With the process valve in the closed position, the bleed port valve should be slowly opened to confirm that flow or drips from the cavity have stopped. The time to stop dripping may vary based on valve-cavity size and bleed-line configuration. A valve is considered leak-free if no drips are observed for one minute.

If drips or leakage continue with the process valve closed, the likely causes may include atmospherically unstable liquids, valve sealing issues (e.g., torque setting, travel limits, seal damage, debris), or system thermal effects. Further evaluation may be completed using the pressure-instrumentation verification method described in Section 5.2 or possible causes per Section 5.3.

5.2 Pressure Instrumentation Seal Verification Method

The pressure-instrumentation method can be used for both atmospherically stable and unstable liquids. This method requires instrumentation attached to the valve cavity, bleed port, or associated piping. All instruments shall be rated for the process fluid and pressure.

This method may be performed manually or automatically using fixed values that meet Table 1 requirements.

Instruments that can be used include:

- A single pressure gauge, switch, or transmitter sensing cavity pressure after bleeding the cavity to a reduced pressure (typically atmospheric).
- Two pressure gauges or transmitters: one measuring process pressure and the other measuring valve-cavity pressure.
- A differential-pressure gauge or transmitter measuring the differential between process and cavity pressure.
- A differential-pressure switch sensing differential pressure between the process and cavity.

5.2.1 Manual Pressure Instrumentation Seal Verification Method

When manually monitoring using pressure gauges, digital gauges are recommended, while analog gauges of adequate resolution (e.g., resolution with a minimum of half that of the value(s) to be measured during verification, or better) are permissible.

Differential pressure transmitters or differential switches should be set greater than or equal to the values specified in Table 1. Because differential pressure switches are binary devices set at a single value, differential pressure switches are not recommended for applications with a process pressure range of greater than 2 to 1 (i.e., the ratio of maximum pressure to minimum pressure should be two or less). When pressure transmitters are used, pressure indicating transmitters are recommended.

Before manually performing the valve seal integrity verification by instrument, the user should verify that the instrument connection is free of any obstructions (e.g., paraffin, debris, ice). This can be accomplished by verifying that the process pressure and valve cavity pressure can be equalized at a value other than zero with the process valve open.

Once the absence of obstructions is verified, the block valve should be closed. Observe that the minimum differential pressure as specified in Table 1 is achieved, stabilized, and maintained within 10 % of the stabilized pressure for a minimum of one minute. In some cases, bleeding pressure at the bleed port to a closed or open system might be necessary to obtain adequate differential pressure. While performing this verification, it is possible that thermal effects from product types and environmental conditions can cause fluctuations in cavity pressure.

When monitoring cavity seal integrity using a single pressure device, observe that the minimum cavity pressure stabilizes and maintains atmospheric or equilibrium vapor pressure of the product within 10% for a minimum of one minute.

If the process valve in the closed position is found to equalize back to line pressure or not hold within the limits from Table 1, it's possible that there is a faulty check valve on the thermal relief or a non-sealing valve (e.g. torque or travel limit setting, seal damage, debris).

If the seal verification fails, the cause of the failure should be resolved using section 5.3 Troubleshooting Valve Seal Verification Failures (e.g., faulty instrumentation, torque or travel limit setting, seal damage, debris), prior to continuing the seal verification.

5.2.2 Remote Pressure Instrumentation Seal Verification Method

When pressure instrumentation is used for remote or continuous monitoring of DBB valve cavity pressure, the minimum differential pressure requirements shall be in accordance with Table 1 to verify seal integrity. Instruments and setpoints should be configured to ensure that the required differential pressure is achieved, stabilized, and maintained within the specified limits.

Interpreting cavity pressure behavior using remote monitoring alone may be challenging, as both thermal expansion in a sealed cavity and minor valve leakage can produce gradual pressure changes over time. Unlike manual verification, remote monitoring may not provide direct observation of bleed behavior or immediate correlation to operating actions.

To improve reliability of remote seal verification:

- Alarm thresholds and trip setpoints should be based on historical pressure behavior observed during successful manual pressure-instrumented seal verifications.
- Historical data should include expected pressure rise rates, stabilization levels, and normal variations due to ambient or process temperature changes.
- Setpoints should be configured to detect pressure trends or rates of change that deviate from established thermal expansion behavior and approach leakage characteristics.

Where cavity pressure behavior cannot be clearly attributed to thermal effects or leakage using remote monitoring alone, manual verification using pressure instrumentation in accordance with section 5.2 should be performed to confirm valve seal integrity.

Table 1—Minimum Pressure Differential for DBB Pressure Instrumentation Seal Verification Method

Instrumentation Seal Verification Method - Implementation	Operating Pressure ≤ 40 psi	Operating Pressure 40 ≤ 200 psi	Operating Pressure > 200 psi
Manually Monitoring Instrumentation – Minimum Differential Pressure	50 % of the current operating pressure	20 psi differential	10 % psi differential of the current operating pressure
Automated Seal Verification - Minimum Differential Pressure	50 % of the maximum operating pressure	20 psi differential	10 % psi differential of the maximum operating pressure

NOTE The automated process utilizes the system's maximum operating parameters for differential pressure requirements. This is due to the dynamic nature of operating pressure and the limitations in device programming, which prevent real-time adjustments to reflect these fluctuations.

5.3 Troubleshooting Valve Seal Verification Failures

If a valve fails seal verification using either the atmospheric or pressure-instrumented method, common causes include a faulty thermal-relief check valve, valve sealing issues, instrumentation problems, or process-related conditions. The troubleshooting guidance provided in this section identifies typical failure causes and describes common methods used to determine the cause of the failed verification and implement corrective actions.

5.3.1 Thermal Relief Check Valve Failure

Thermal relief system check valve seats can be damaged or accumulate debris, preventing the thermal relief check valve from seating/sealing closed. If company policy allows, and if safe to do so, the check valve can be evaluated by bypassing the thermal relief system. To do this, the valve should be visually identified or tagged before temporarily isolating the thermal relief piping from the process by closing the process connection valve downstream of the thermal relief check valve while leaving the bleed port open to verify the check valve is holding. If the observed leak or dripping stops, the process valve is then verified leak free, and the defective thermal relief component(s) should be repaired or replaced. If the observed leak or dripping continues, the section 5.2 Pressure Instrumentation Seal Verification Method can be used to verify if a non-sealing valve or atmospherically unstable liquid is the cause.

5.3.2 Thermal Expansion vs Valve Leakage During Instrumentation Verification

When using pressure instrumentation to verify DBB valve seal integrity, changes in cavity pressure can result from either thermal expansion in a properly sealed cavity or leakage across a valve seat. Correct interpretation of cavity pressure behavior is necessary for accurate verification.

5.3.2.1 Thermal Expansion Response

Thermal expansion in a sealed cavity produces a predictable pressure profile. Typical indicators include:

- A slow, incremental pressure increase that corresponds with an increase in ambient temperature, solar exposure, or process-side temperature.
- A pressure rise that remains well below process pressure, without trending toward full line pressure.
- Pressure stabilization once thermal conditions stabilize, reflecting a naturally sealed and volume-constrained cavity.

5.3.2.2 Leakage Response

Leakage into the valve cavity produces pressure behavior distinct from thermal expansion. Common indicators include:

- Rapid pressure rise after the block valve is closed, often approaching or equaling line pressure.

- Pressure increase observed during periods of stable temperature.

5.3.2.3 Instrument-Based Diagnostic Guidance

- If cavity pressure varies proportionally with temperature change, thermal expansion is the likely cause.
- If cavity pressure increases rapidly or approaches line pressure regardless of temperature conditions, valve leakage should be suspected.

5.3.3 General Seal Verification Failure Causes

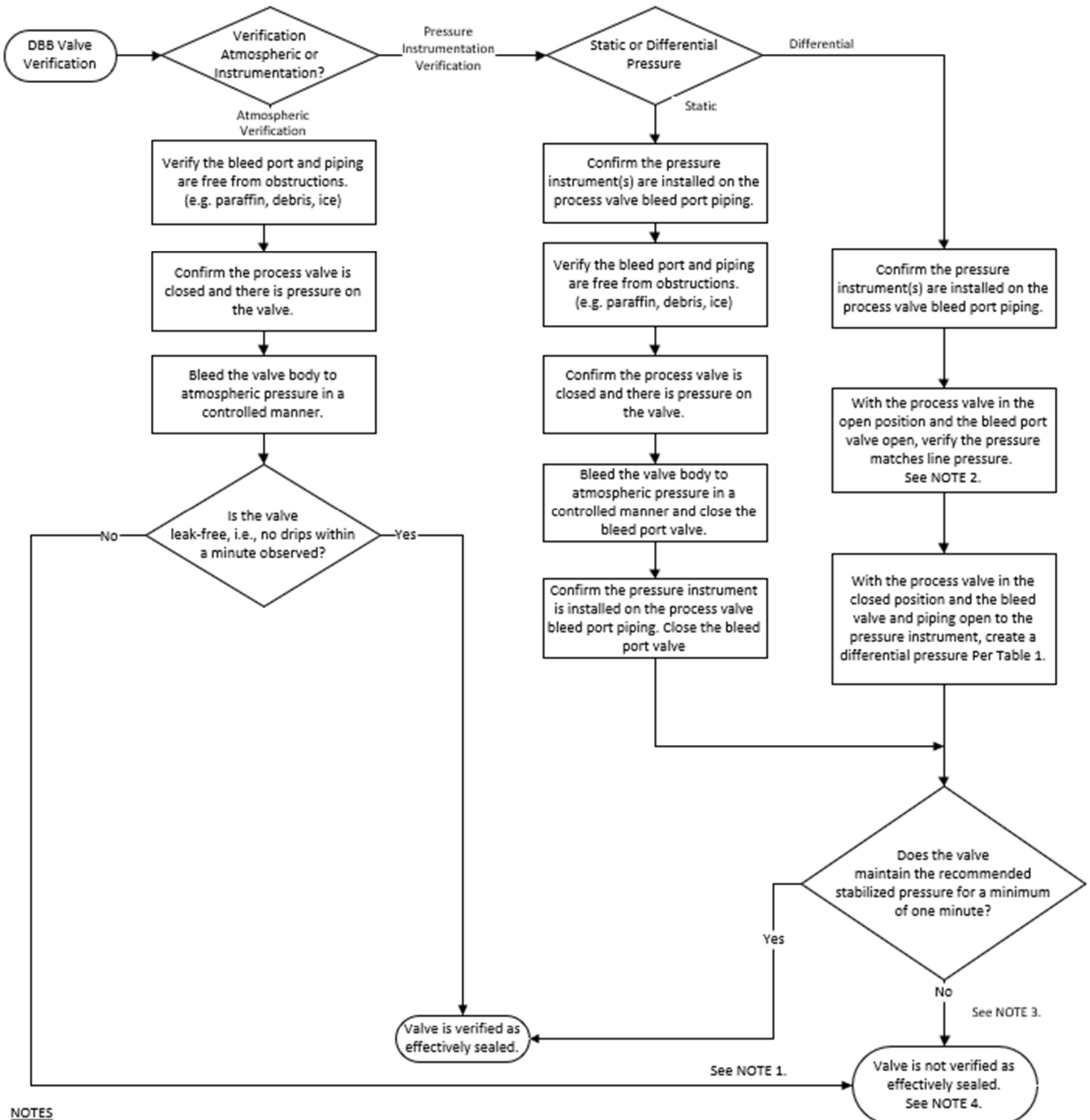
When the pressure behavior is inconclusive, the guidance in the following table should be used in addition to sections 5.3.1 and 5.3.2 to evaluate seat integrity, thermal relief check valve function, and potential mechanical obstruction.

Possible Valve Seal Verification Failure Cause	Troubleshooting Guidance
Valve operation did not fully close to provide seal.	• Ensure the valve was closed using the correct operating method and torque. • Verify actuator travel limits or hand-lever stop positions are properly set.
Mechanical obstruction(s)	• Inspect for debris, paraffin, ice, or other foreign material in the valve seat or cavity. • Confirm bleed ports, tubing, and instrumentation lines are free of obstructions.
Fluid or thermal conditions	• Determine whether thermal expansion is increasing cavity pressure.
Atmospheric pressure verification method is not suitable for fluid or operating conditions	• Confirm that the liquid is stable and not flashing in the cavity • If atmospheric verification fails, consider valve verification using the pressure instrumentation seal verification method (Section 5.2).
seal(s) or seat(s) damaged	• Evaluate for seal or seat damage by inspecting valve seats, seals, O-rings, or soft-seal components. Check for wear, cuts, swelling, deformation, or chemical degradation.

Table 2 – General Seal Verification Causes

6 DBB Verification Flowchart

Figure 5 summarizes DBB valve seal verification by the atmospheric seal verification method or seal verification by pressure instrumentation method, as described within this recommended practice.



NOTES

NOTE 1. If the fluid is believed to be an atmospherically unstable liquid or to validate the valve is leaking, consider the pressure instrumentation method.

NOTE 2. Periodic purging of the associated piping or tubing, to a closed system or atmosphere, might be required to remove any blockage by debris.

NOTE 3. Due to the operation of some systems, there may be a need to vent the bleed line to a closed system or atmosphere to achieve enough differential for a successful seal verification.

NOTE 4. For common valve seal verification causes of erroneous verification failures, refer to section 5.3.

Figure 5—DBB Verification Flow Chart

Bibliography

[1] API Recommended Practice 686, *Machinery Installation and Installation Design*
[2] API Specification 6D, *Specification for Valves*