AEROSPACE RECOMMENDED PRACTICE

ARP4946™	REV. A
Issued 2000-10 Revised 2021-08 Superseding ARP4946	

(R) Recommended Design and Test Requirements for Hydraulic Check Valves

RATIONALE

ARP4946 has been updated to Revision A for the following reasons:

- It has been rewritten to a new format including the title change.
- It incorporates technical and editorial changes.
- The references have been updated.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides recommendations for the design and test requirements for a spring-loaded, normally-closed hydraulic check valve.

The check valve is intended for use in a civil or military aircraft hydraulic system with a rated system pressure up to 5000 psi (34500 kPa).

1.1 Purpose

The recommended requirements contained in this document are compiled for inclusion in a Procurement Specification for a spring-loaded, normally-closed hydraulic check valve.

NOTE: The recommended requirements in this ARP should be reviewed by the Purchaser or the Contractor and only those requirements that are applicable for a specific application should be incorporated in the Procurement Specification.

1.2 Classification

The check valve types covered by this ARP are:

- The line-mounted type - a valve with standard fitting ends
- The cartridge type - a cylindrical valve with O-ring glands for mounting in a manifold, for example
- The insert type - a cylindrical valve with an expansion pin to seal and lock in a cylindrical cavity

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP24	Determination of Hydraulic Pressure Drop
ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
ARP1383	Aerospace - Impulse Testing of Hydraulic Components
ARP4386	Terminology and Definitions for Aerospace Fluid Power, Actuation and Control Technologies
AS478	Identification Marking Methods
AS683	Installation Procedure and Torques for Fluid Connections
AS4059	Aerospace Fluid Power - Contamination Classification for Hydraulic Fluids
AS4941	Aerospace - General Requirements for Commercial Aircraft Hydraulic Components
AS5148	Assembly, Installation, and Torque for Flareless and Straight Thread Fluid Fittings and Tube Assemblies

AS5440 Hydraulic Systems, Military Aircraft, Design and Installation Requirements for

AS8775 Hydraulic System Components, Aircraft and Missiles, General Specification for

2.1.2 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

MIL-STD-130 Identification Marking of U.S. Military Property

MIL-STD-810 Environmental Test Methods and Engineering Guidelines

2.2 Definitions

Refer to ARP4386 for the fluid power terms that are used in this ARP.

CHECK VALVE: This is a valve that allows the free flow of hydraulic fluid in one direction only and prevents flow in the opposite direction.

INLET PORT: This is the port where hydraulic fluid can flow through the check valve.

OUTLET PORT: This is the port where hydraulic fluid is prevented from flowing through the check valve.

RATED FLOW: This is the maximum operating flow that is supplied to the check valve.

RATED SYSTEM PRESSURE: This is the nominal steady-state pressure that is applied to the check valve.

NOTES:

1. Rated System Pressure is equivalent to the Design Operating Pressure (DOP) for civil aircraft and Working Pressure (P_w) for military aircraft.

2. All pressures referred to in this document are gauge pressures.

RETURN PRESSURE: This is the pressure caused by the resistance to flow in the return line or by a pre-charged reservoir, or both.

ENDURANCE TEST: This is the test that is intended to determine if the check valve will operate satisfactorily throughout its design lifetime.

PRESSURE IMPULSE TEST: This is the test that is intended to determine the fatigue characteristics of the check valve pressure vessel to determine if it will maintain its strength throughout its operational lifetime.

PURCHASER or CONTRACTOR: This is the organization that is responsible for producing the Procurement Specification for the check valve.

NOTE: The Purchaser or Contractor is typically an aircraft manufacturer, a modification center, a system supplier (for hydraulic or braking systems, for example), or an equipment supplier (for use in a manifold or an actuator, for example).

SUPPLIER: This is the manufacturer of the check valve who is responsible for its design, production, and qualification.

PROCUREMENT SPECIFICATION: This is the document that includes the following:

a. Specific performance and technical criteria

b. Acceptance and qualification test requirements

c. Reliability requirements

d. Quality requirements

e. Packaging requirements

3. RECOMMENDED REQUIREMENTS

3.1 General

The check valve that is intended to be used in civil aircraft hydraulic systems should conform to the general hydraulic components' requirements of AS4941 as applicable.

The check valve that is intended to be used in military aircraft hydraulic systems should conform to the general hydraulic components' requirements of AS8775 as applicable.

The check valve should meet all the requirements when it is installed or operated as defined by the applicable Procurement Specification.

The check valve should not be sensitive to spatial orientation.

If the check valve contains nonmetallic parts other than static seals, it should conform to all the functional and performance requirements specified herein after being immersed in the applicable hydraulic fluid (see 3.5.5) for 72 hours at the maximum operating hydraulic fluid temperature specified in 3.4.2. If the thermal relief valve contains no nonmetallic parts other than static seals, then the required period for being immersed in the applicable hydraulic fluid should be reduced to 24 hours.

3.2 Functional Requirements

The check valve should allow free flow of hydraulic fluid in one direction only and prevent flow in the opposite direction.

3.3 Performance Requirements

3.3.1 Cracking Pressure

The Procurement Specification should specify the minimum and maximum cracking pressure for the check valve.

NOTE: Typically, the cracking pressure is not less than 2 psi (14 kPa) and not greater than 8 psi (55 kPa).

3.3.2 Rated Flow

The Procurement Specification should specify the rated flow for the check valve.

3.3.3 Internal Leakage

The Procurement Specification should specify the internal leakage for the following range of pressures applied to the outlet port over the specified ambient and the hydraulic fluid temperature range:

a. At low pressure (for example, 5 psi (35 kPa))

NOTE: The internal leakage rate requirement is typically 30 drops maximum over 30 minutes.

b. At the nominal system return pressure (for example, 1000 psi (6900 kPa))

NOTE: The internal leakage rate requirement is typically zero (i.e., insufficient to form a drop).

c. At the rated system pressure

NOTE: The internal leakage rate requirement is typically zero (i.e., insufficient to form a drop).

3.3.4 External Leakage

There should be no external leakage allowed under any combination of environments specified herein.

NOTE: Any evidence of wetness sufficient to form a drop should be considered leakage.

3.3.5 Pressure Drop

The Procurement Specification should specify the maximum pressure drop through the check valve at:

- The rated flow rate
- The specified ambient and hydraulic fluid temperatures

3.4 Operating Temperature

3.4.1 Ambient Temperature

The Procurement Specification should specify the ambient temperature range, including the minimum and maximum operating and survival (non-operating) temperatures.

3.4.2 Hydraulic Fluid Temperature

The Procurement Specification should specify the hydraulic fluid temperature range, including the minimum and maximum operating and survival (non-operating) temperatures.

3.5 Construction

3.5.1 Materials

AS4941 or AS8775, as applicable, should be used for guidance in the selection of the check valve materials. The Procurement Specification should list any prohibited materials.

3.5.2 Corrosion Resistance

The corrosion protection features of the check valve should be per AS4941 or AS8775, as applicable.

3.5.3 Electro-Conductive Bonding

If there is a requirement for electro-conductive bonding, the Procurement Specification should state the electrical resistance requirement between any point on the mounting facilities and specified points on the check valve.

NOTE: A typical electrical resistance requirement is not to exceed 25 milliohms.

3.5.4 Seals

If seals are used in the check valve, AS4941 or AS5440, as applicable, should be used for guidance in the design of the seal glands and the seal materials.

3.5.5 Hydraulic Fluid

The Procurement Specification should specify the hydraulic fluid(s) to be used for the check valve application.

3.5.5.1 Hydraulic Fluid Contamination

The Procurement Specification should state the hydraulic fluid contamination limits per AS4059 for:

a. Aircraft at new build

b. In-service (typical and maximum)

3.6 Physical Requirements

3.6.1 Mounting Requirements

3.6.1.1 Line-Mounted Check Valve

The Procurement Specification should define the type and size of the hydraulic fluid ports' fittings and the overall space envelope.

NOTES:

1. It is recommended that the inlet port and outlet port be different sizes or be male/female to prevent the check valve from being installed incorrectly.

2. There should be a means of holding the check valve when tightening the tube connectors during its installation.

3.6.1.2 Cartridge or Insert Type Check Valve

The Procurement Specification should specify the dimensions of the check valve to enable it to be installed in the component or the manifold, including any surface finish requirements and geometrical (e.g., flatness) requirements.

3.7 Strength

3.7.1 Rated System Pressure

The Procurement Specification should state the rated system pressure for the check valve.

NOTE: Depending on the application, the rated system pressure will be generated by:

a. The hydraulic system pumps.

or

b. A hydraulic sub-system that regulates the pressure from the hydraulic power generation system to a lower value, for example, a brake control system.

or

c. The thermal effects at the point of the actuation of a thermal relief valve for an accumulator that is used to provide stored energy (for example, a brake accumulator if the check valve is used in a brake control system application).

3.7.2 Proof Pressure

The check valve should be designed to ensure that it can withstand the application of proof pressure at the higher of the specified maximum rated ambient or the hydraulic fluid temperatures for 2 minutes minimum as follows:

- To the inlet port with the outlet port capped
- To the outlet port with the inlet port open

The check valve should not sustain any deformation that would prevent it from performing its intended function.

There should be no external leakage for both tests and no internal leakage when pressure is applied to the outlet port.

NOTE: For production, the proof pressure should be applied at room temperature for 2 minutes for both cases.

The Procurement Specification should specify the factor to be applied to the rated system pressure for the proof pressure.

NOTE: Typically the proof pressure factor is 1.5 x the rated system pressure.

3.7.3 Ultimate (Burst) Pressure

The check valve should be designed to ensure that it can withstand the ultimate (burst) pressure being applied simultaneously applied to both ports at the higher of the specified maximum rated ambient or the hydraulic fluid temperatures for 2 minutes minimum. There should be no evidence of external leakage, failure, or rupture. Permanent deformation of the check valve is permitted, but it is not required to operate after being subjected to ultimate (burst) pressure.

The Procurement Specification should specify the factor to be applied for the ultimate (burst) pressure.

NOTE: Typically the ultimate (burst) pressure factor is 2.0 x the rated system pressure for civil aircraft applications and 2.5 x the rated system pressure for military aircraft applications.

3.7.4 Fatigue (Pressure Impulse)

Unless otherwise specified in the Procurement Specification, the check valve should be designed to withstand, without any evidence of cracks:

- 750000 pressure impulse cycles with the pressure applied to the inlet port and the outlet port simultaneously.
- 750000 pressure impulse cycles with the pressure applied to the outlet port with the inlet port open to atmosphere.

The test pressure should be stated in the Procurement Specification (for example, the rated system pressure or 1.5 x the rated system pressure) and the minimum pressure should be 100 psi (690 kPa).

The Procurement Specification should define any additional requirements including:

- Details of predicted pressure transients.
- Any functional/performance requirements to be met after the impulse test.

3.7.5 Surge Flow

The check valve should meet all requirements after being subjected to 25 surge flows.

The Procurement Specification should specify the required surge flow rate.

3.7.6 Operational Shocks

The check valve should be designed to withstand the operational shock levels per AS4941 or AS8775 as applicable.

The Procurement Specification should provide the specific requirements for the operational shocks test procedure (test category, levels, etc.).

3.7.7 Vibration

The check valve should be designed to withstand the vibration levels per AS4941 or AS8775 as applicable.

The Procurement Specification should define:

- The test procedure, the applicable category, and the levels for normal operation
- Any specific vibration requirements to cater for top-level aircraft failure cases (for example, sustained engine imbalance, nosewheel imbalance, etc.)

3.7.8 Acceleration Forces

The check valve should be designed to withstand the steady-state acceleration forces levels per MIL-STD-810.

3.7.9 Handling Loads

The check valve should be designed to withstand the effects of mishandling the unit (for example, dropping it) per MIL-STD-810.

3.7.10 Maximum Wrenching Torque

If the check valve is a line-mounted type, then it should withstand 250% of the maximum wrench torque required for making the tubing connection, as specified in the Procurement Specification, without any permanent deformation of the check valve (in particular the area around the connection ports).

3.7.11 Flexural Strength

If flexural strength is required by the Procurement Specification, then it should withstand flexing without any detrimental effects when tested per ARP1185 or as specified in the Procurement Specification.

NOTE: This is only applicable to line-mounted check valves.

3.8 Weight

The Supplier and or Contractor should agree the maximum guaranteed drip-dry weight of the check valve, which should be stated in the Procurement Specification.

3.9 Environmental Requirements

Unless otherwise specified, the Procurement Specification for the line-mounted check valve should specify the environmental requirements listed below per AS4941 or AS8775 as applicable:

a. Humidity

b. Fluids Susceptibility

c. Fungus Resistance/Fungus

d. Salt Spray/Salt Fog

e. Sand and Dust

f. Waterproofness

g. Icing

3.10 Operational and Safety Requirements

3.10.1 Reliability

The Procurement Specification should specify the required reliability targets for the application of the check valve.

3.10.2 Endurance Life

Unless otherwise specified by the Purchaser or Contractor, the check valve should be designed to achieve an operating endurance life of 250000 cycles of flow through the check valve at the rated flow followed by the application of pressure in the no-flow direction for each cycle, without any degradation in operation.

If the specific application on the aircraft has additional requirements or the need for a scatter factor is required, then the different endurance cycles or numbers of cycles should be defined per the Procurement Specification.

3.10.3 Repeated Assembly

If the check valve is a line-mounted type, then it should withstand being assembled and re-assembled in a pipeline for eight successive times without damage.

3.10.4 Storage

The check valve should be constructed of materials that should not degrade during its lifetime.

The shelf life of the check valve should be specified by the Procurement Specification.

3.10.5 Safety

The Procurement Specification should specify the required safety objectives for the application of the check valve, including the failure rates for the following events:

a. External leakage.

b. Excessive internal leakage.

c. Jamming of the check valve internal components.

d. Failure to close when required.

e. Failure to open when required.

3.11 Marking

3.11.1 General

The Procurement Specification should specify the check valve identification markings (for example per AS478 or MIL-STD-130, as applicable).

3.11.2 Detail Marking Requirements

When possible, each check valve should have the following information:

a. The manufacturer’s part number, with a free place to add an amendment letter to the part number.

b. The manufacturer’s cage code.

c. The manufacturer's serial number or lot control number.

d. An arrow indicating the direction of free flow.

If there is sufficient space, then some or all of the following additional information should be provided:

a. Port identification letters, for example, “A” - inlet port; “B” - outlet port.

b. The operating hydraulic fluid.

c. The manufacturer’s name.

4. RECOMMENDED QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the Supplier:

a. Is responsible for the performance of all inspection requirements as specified herein.

b. May use his facilities or the services of any industrial laboratory that is satisfactory to the Purchaser or the Contractor.

The Purchaser or the Contractor should reserve the right to perform any of the inspections contained in this ARP or in the Procurement Specification, where such inspections are deemed necessary to ensure that the supplies and services conform to the stipulated requirements.

4.1.1 Physical Defect Inspection

All detail parts of the check valve should be subjected to non-destructive inspection before its assembly.

There should be no evidence of cracks or other injurious defects.

4.2 Classification of Tests

To demonstrate compliance of check valve with this ARP and the applicable Procurement Specification, two distinct test programs should be conducted, hereinafter referred to as follows:

a. Production Acceptance Tests (see Section 5).

b. Qualification Tests (see Section 6).

4.3 Test Stand Requirements

These should be per AS4941 or AS8775, as applicable.

NOTE: AS4941 contains tolerance requirements for steady-state test conditions, including temperature and pressure. However, if tighter tolerances are required, then they should be specified in the Procurement Specification.

4.3.1 Test Medium

The hydraulic fluid test medium should be the system hydraulic fluid as specified in 3.5.5.

4.3.2 Check Valve Axis Position

Unless otherwise specified herein, tests may be made with the check valve axis in either of the following positions:

a. Horizontal.

b. Vertical - The check valve should be positioned such that the outlet port is at the top, i.e., the force of gravity will act with the check valve checking action.

4.4 First Article Inspection

The First Article Inspection should consist of the examinations specified in 4.4.1 and the tests specified in Section 5.

4.4.1 First Article Samples

The Supplier should make available at least one check valve for review by the Purchaser's or the Contractor's quality organization. The sample(s) should be representative of the design and construction, workmanship, integral components and materials to be used during production.

4.4.2 First Article Inspection Report

If a first article inspection is required by the Procurement Specification, the Supplier's quality organization should submit to the Purchaser or the Contractor the following:

a. The results of the inspection.

b. The recommendation if the Qualification Test Program can commence or not.

4.4.3 Rejection

The failure of any check valve to successfully comply with any of the requirements of the First Article Inspection should be the cause for the rejection of that check valve.

5. RECOMMENDED PRODUCTION ACCEPTANCE TESTS

Each check valve submitted for delivery under a Procurement Contract should be subjected to the following acceptance test requirements:

a. A visual and dimensional examination (see 5.1).

b. A test program to determine product conformance to the functional and performance requirements of this ARP and the Procurement Specification. A recommended test program is detailed in 5.2.

The tests should comprise the following:

1. Proof pressure (see 5.2.2).
2. Internal leakage (see 5.2.3).
3. Cracking pressure (see 5.2.4).
4. Weight (see 5.2.5).
5. Electro-conductive bonding - if required (see 5.2.6).

5.1 Visual and Dimensional Examination

Before commencing the acceptance testing, each check valve should be inspected for quality of workmanship and to determine compliance with this document and the referenced Procurement Specification and drawings.

5.2 Acceptance Test Program

5.2.1 General

If the check valve is intended to be installed into another component (for example, in a manifold), then it should be installed in a representative test fixture.

The Procurement Specification should specify the hydraulic fluid maximum contamination limits per AS4059 in the test stand for these tests.

All tests should be conducted at ambient temperature.

5.2.2 Proof Pressure Test

Apply pressure per 3.7.2 to the inlet port and then to the outlet port for 2 minutes minimum with a maximum pressure rise rate of 25000 psi/min (172350 kPa/min) in each case. There should be:

- No external leakage
- No internal leakage when pressure is applied to the outlet port
- No permanent deformation of the check valve that would prevent it from performing its intended function after the completion of this test

5.2.3 Internal Leakage Test

These tests should be performed with the check valve held in the vertical position per 4.3.2.b. Pressures of 5 psi (35 kPa), 1000 psi (6900 kPa) and the applicable rated system pressure should be applied at the outlet port for 3 minutes each. The check valve poppet should be unseated between each pressure application. In each case, the leakage measurement period should consist of the last 2 minutes of the 3 minutes.

The rate of internal leakage should not exceed the amount specified in 3.3.3. There should be no external leakage throughout the pressure range other than a slight wetting at any seals that is insufficient to form a drop.

5.2.4 Cracking Pressure

Unless otherwise specified in the Procurement Specification, the cracking pressure is the pressure at which the poppet is unseated allowing flow equal to or exceeding 0.3 in^3/min (5 mL/min) through the check valve in the free-flow direction.

With the outlet port open, gradually increasing pressure should be applied at the inlet port beginning with zero. The cracking pressure should be observed and it should be between the minimum and maximum pressure requirements of 3.3.1.

5.2.5 Weight

The check valve should be drained of hydraulic fluid and then be weighed. The weight should not exceed the requirements of 3.8.

NOTE: This test should be only required for the first five production units including any allocated for qualification tests. This test should also be conducted on random production units at a frequency agreed between the Supplier and the Purchaser or Contractor.

5.2.6 Electro-Conductive Bonding

If required by the Procurement Specification, the electrical resistance at locations specified in the Procurement Specification on the check valve should be measured. The resistance should not exceed the requirements of 3.5.3.

5.3 Preparation for Shipment

After testing, the check valve should be prepared for delivery (including the installation of shipping caps, packaging, and marking) per AS4941 or AS8775, as applicable.

NOTE: When the shipping cap is removed, it may be wetted with oil. This should not be construed as a hydraulic fluid leakage failure.

5.3.1 Storage and Packing

The method of storage, packing, and marking should be per any specific requirements that are defined in the Procurement Specification.

6. RECOMMENDED QUALIFICATION TESTS

6.1 General

Qualification tests, to check whether the check valve design conforms to the recommended requirements in this ARP, should consist of the tests specified herein.

Before the commencement of any testing, a tolerance analysis should be performed by the Supplier that would validate the variations/tolerances that would be permitted on key performance affecting dimensions.

Table 1 provides the listing of the tests for a check valve, together with the proposal for the number and allocation of test check valves that the tests should be conducted on.

Table 1 - Qualification test program

Requirement	Test Paragraph	Test #1 Check Valve	Test #2 Check Valve	Test #3 Check Valve
Visual and Dimensional Examination	5.1	X		
Production Acceptance Tests	5.2	X	X(As applicable)	X
Pressure Drop	6.2	X		
Functional Tests	6.3			
Leakage	6.3.1	X		
Endurance Cycling	6.3.2	X		
Repeated Assembly	6.3.3	X		
Additional Functional Tests	6.3.4	X(If required)		
Environmental Tests	6.4			
Temperature Tests	6.4.1	X		
Humidity	6.4.2	X(If required)(1)		
Fluids Susceptibility	6.4.3	X(If required)(1)		
Fungus Resistance/Fungus	6.4.4	X(If required)(1)		
Salt Spray/Salt Fog	6.4.5	X(If required)(1)		
Sand and Dust	6.4.6	X(If required)(1)		
Waterproofness	6.4.7	X(If required)(1)		
Icing	6.4.8	X(If required)(1)		

Table 1 - Qualification test program (continued)

Requirement	Test Paragraph	Test #1 Check Valve	Test #2 Check Valve	Test #3 Check Valve
Structural Tests	6.5			
Proof Pressure Test	6.5.1		X	
Fatigue (Pressure Impulse) Test	6.5.2		X	
Operational Shocks Test	6.5.3			X
Vibration Test	6.5.4			X
Steady-State Acceleration Test	6.5.5			X
Surge Flow Test	6.5.6			X(If required)
Handling Loads Test	6.5.7			X
Wrench Loads Test	6.5.8			X
Flexural Strength	6.5.9			X(If required)
Destructive Tests	6.6			
Pressure Vessel Ultimate (Burst) Pressure	6.6.1(2)		X	
Additional Tests	6.7	As required		
Post Qualification Tests	6.8			
Acceptance Test	6.8.1	X		
Inspection	6.8.2	X		

NOTES:

1. For the tests that have the superscript (1) next to the test paragraph number, this requirement may be verified by a test conducted on a material test sample or coupon, or by analysis, similarity, or by historical data if approved by the Purchaser or the Contractor.

2. The ultimate (burst) pressure test is to follow the pressure impulse test.

3. If the check valve is to be installed in another component (for example, in a manifold):

   - Some of these tests may be conducted at the component level (to be agreed between the Purchaser or the Contractor and the Supplier).

   - The check valve should be installed in a representative test fixture for the qualification tests conducted at the component level.

The qualification tests should be conducted on check valves that are to the production standard and have passed the acceptance tests. The check valve used for qualification testing should be 100% inspected. The actual performance and dimensional measurements should be recorded before and after the completion of testing.

Before the commencement of testing, the Purchaser or the Contractor should approve any discrepancies between the test and production units.

All tests should be conducted at the ambient temperature between 60 to 100 °F (16 to 38 °C) and with the hydraulic fluid temperature between 70 to 160 °F (21 to 71 °C) unless otherwise specified.

The hydraulic fluid contamination limits per AS4059 should be specified in the Procurement Specification for these tests except for the endurance cycling test (refer to 6.3.2 for the specific test rig requirements).

For the proof and ultimate (burst) pressure tests, the pressure should be applied at a maximum rate of 25000 psi/min (172350 kPa/min).

If there are any tests that are additional to those listed in Table 1, then the Procurement Specification should:

a. State the test requirements.

b. Define which check valve(s) should be used for these additional tests.

6.1.1 Qualification by Similarity

The analysis to determine if all or some of the qualification tests may be waived should be conducted per AS4941 (there is no equivalent in AS8775).

6.1.2 Qualification Unit Functional Checks

Except for the fatigue (pressure impulse) test and the pressure vessel ultimate (burst) pressure tests, each test specimen should be subjected to the internal leakage (per 5.2.3) and the cracking pressure (per 5.2.4) before and after the completion of each qualification test.

The Procurement Specification should state if acceptance tests are required with the check valve at different attitudes or plumbing configurations.

6.2 Pressure Drop Test

The pressure drop test setup should follow the guidelines of ARP24.

The pressure drop through the check valve should be measured at a flow equal to the rated flow. The temperature of the hydraulic fluid should be maintained at 100 °F ± 5 °F (38 °C ± 3 °C). The net hydraulic fluid pressure drop through the check valve should not exceed the value specified in 3.3.5.

NOTE: If a pressure drop across a given component is critical, it is recommended to conduct a tare test before conducting the main flow test (gross). This test is conducted by installing a dummy spool piece of approximately the same length and port size as the component to be tested. The tare value is subtracted from the gross value giving the net pressure drop across the check valve.

The Procurement Specification should state if it is required to conduct the pressure drop test at more than one hydraulic fluid temperature and/or if pressure drop measurements are required at various flow rates up to the rated flow.

6.3 Functional Tests

6.3.1 Leakage

This test should be initially performed with the check valve held in the horizontal position.

Apply the low pressure as nominated in the Procurement Specification to the outlet port for 32 minutes. The leakage measurement period should begin 2 minutes after the application of the required pressure. The internal leakage should not exceed the amount recommended in 3.3.3.

Repeat the test at the nominal system return pressure having unseated the check valve poppet before the application of the test pressure. Then repeat the test at rated system pressure having again unseated the check valve poppet before the application of the test pressure.

Repeat the tests with the check valve held in the vertical position as specified in 4.3.2 b.

There should be no external leakage at each test pressure.

6.3.2 Endurance Cycling

Unless otherwise specified in the Procurement Specification, the check valve should be cycled per the test procedure detailed below.

Using a test setup similar to that shown in Figure 1, the check valve should be subjected to 250000 endurance cycles (or as stipulated in the Procurement Specification and/or the guidelines of AS4941). The cycling rate should be agreed upon between the Purchaser or the Contractor and Supplier.

NOTE: Typical endurance testing cycle rates for check valves are between 30 to 100 cycles per minute.

Each cycle should consist of flow through the check valve at the rated flow, followed by a reversal of the direction of flow with the application of the maximum rated system pressure.

The peak pressure during the pressure application portion of each cycle should be 125% ± 5% of the test unit's rated operating pressure as specified in the Procurement Specification or drawing. The actual cycling rate, a picture of the pressure trace, and a schematic drawing of the test setup should be included in the qualification test report.

The test unit should complete five layers of endurance testing. Three layers should be conducted at the hydraulic fluid temperature of 60 to 160 °F (16 to 71 °C), one layer should be conducted at the maximum normal operating hydraulic fluid temperature, and one layer should be conducted at a low hydraulic fluid temperature.

NOTE: Ideally the hydraulic fluid temperature should be -40 °F (-40 °C) for the low temperature layer, but experience has shown that this is not practical due to the heating of the hydraulic fluid during this test. The Purchaser or the Contractor and Supplier should agree the hydraulic fluid temperature for this part of the test.

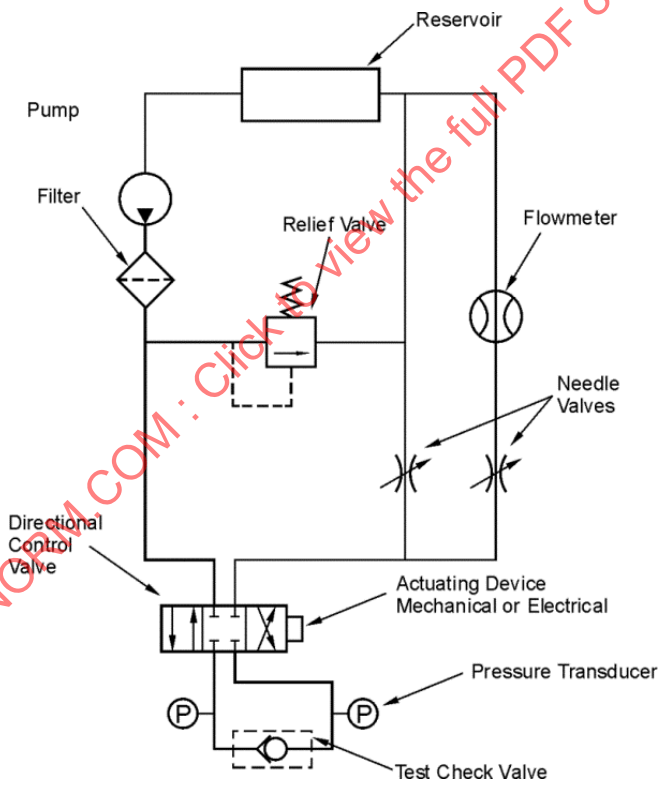

Figure 1 - Typical endurance test setup

Following the completion of each layer, the check valve should then satisfactorily complete the leakage test per 5.2.3 and the cracking pressure test per 5.2.4.

The hydraulic fluid used in the endurance test should be the same as that specified in the Procurement Specification. The endurance test rig should use filters that have the same filtration ratings that are used in the application. The Procurement Specification should provide the filtration details.

Before, and after the endurance test, the following inspections should be performed on the test unit.

a. Non-destructive testing to check for cracks.

b. The dimensions of all parts with critical tolerances that are subject to wear should be measured and recorded. Details and a list of parts to be measured should be submitted with the supplier's test procedure.

Any non-compliance with the functional or performance requirements, cracks or other injurious defects should be cause for rejection and/or test failure.

6.3.3 Repeated Assembly

NOTE: This is only applicable to line-mounted check valves.

A tube assembly with the applicable fittings' interfaces should be assembled to each end of the check valve and disassembled for eight successive times, using the torque values for the specific fitting end style (for example, AS5148 for flareless or AS683 for flared style fitting ends) or as defined in the Procurement Specification. After the repeated assembly test, the check valve should then satisfactorily complete the proof pressure test specified in 5.2.2.

6.3.4 Additional Functional Tests

If the Procurement Specification required any additional functional tests, then these should be conducted after the completion of the repeated assembly test.

6.4 Environmental Tests

The following tests should be carried out on the check valve.

NOTE: Testing is not required if compliance to these environmental conditions can be demonstrated by similarity/analogy or analysis to the satisfaction of the Purchaser or the Contractor.

6.4.1 Temperature Tests

For these tests, the check valve should be connected to a static head of 1 to 3 feet (0.3 to 0.9 m) of the applicable hydraulic fluid in the check direction.

6.4.1.1 Temperature Survival Tests

6.4.1.1.1 Low Temperature

If the check valve contains nonmetallic parts other than static seals, the test setup should be maintained for 72 hours at a temperature not warmer than the lower of the specified ambient or the hydraulic fluid survival minimum temperatures. This period may be reduced to 24 hours if all of the parts except for the static seals are metal.

After this period, warm the check valve hydraulic fluid to the room ambient temperature. When the temperature of the check valve has stabilized, conduct the internal leakage test specified in 5.2.3 and the cracking pressure test as specified in 5.2.4.

The cracking pressure test should be accomplished with the results recorded but need not comply with the requirements of 5.2.3 at temperatures below 0 °F (-18 °C).

6.4.1.1.2 High Temperature

The temperature should be maintained for 24 hours at the higher of the specified ambient or the hydraulic fluid maximum survival temperature.

After this period, cool the check valve fluid to the room ambient temperature. When the temperature of the check valve has stabilized, conduct the internal leakage test specified in 5.2.3 and the cracking pressure test as specified in 5.2.4.

6.4.1.2 Temperature Functioning Tests

6.4.1.2.1 Low Temperature

If the check valve contains nonmetallic parts other than static seals, the test setup should be maintained for 72 hours at a temperature not warmer than the lower of the specified ambient or the hydraulic fluid operating. This period may be reduced to 24 hours if all of the parts except for the static seals are metallic.

After this period, the check valve poppet should then be actuated at least twice. At the end of this test while at the same temperature conditions above, the check valve should satisfactorily complete the leakage test specified in 5.2.3.

The cracking pressure test should be accomplished with the results recorded but need not comply with the requirements of 5.2.3 at temperatures below 0 °F (-18 °C).

6.4.1.2.2 Intermediate Temperature Functioning

The test setup should be warmed rapidly from the minimum operating temperature to the higher of the specified ambient or the hydraulic fluid maximum operating temperatures. The check valve should be actuated at increments of approximately 40 °F (22 °C) to determine that the check valve operates satisfactorily throughout the temperature range. These check tests should be made without waiting for the temperature of the whole unit to stabilize.

6.4.1.2.3 High-Temperature Functioning

The temperature should be maintained for 72 hours at the higher of the specified ambient or the hydraulic fluid maximum operating temperatures. This period may be reduced to 24 hours if all of the parts except for the static seals are metallic.

The poppet should then be actuated at least twice. At the end of this test while at the same temperature above, the check valve should then satisfactorily complete the leakage test specified in 5.2.3 and the cracking pressure test specified in 5.2.4.

6.4.2 Humidity

The analysis and/or testing should be per AS4941 or AS8775, as applicable.

6.4.3 Fluids Susceptibility

The analysis and/or testing should be per AS4941.

6.4.4 Fungus Resistance/Fungus

The analysis and/or testing should be per AS4941 or AS8775, as applicable.

6.4.5 Salt Spray/Salt Fog

The analysis and/or testing should be per AS4941 or AS8775, as applicable.

6.4.6 Sand and Dust

The analysis and/or testing should be per AS4941 or AS8775, as applicable.