



# AEROSPACE RECOMMENDED PRACTICE

ARP4835™

REV. A

Issued 2006-09  
Revised 2021-08

Superseding ARP4835

(R) Recommended Design and Test Requirements  
for Hydraulic Thermal Expansion Relief Valves

## RATIONALE

ARP4835 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.

## TABLE OF CONTENTS

|       |                                    |   |
|-------|------------------------------------|---|
| 1.    | SCOPE .....                        | 4 |
| 1.1   | Purpose .....                      | 4 |
| 1.2   | Classification .....               | 4 |
| 2.    | REFERENCES .....                   | 4 |
| 2.1   | Applicable Documents .....         | 4 |
| 2.1.1 | SAE Publications .....             | 4 |
| 2.1.2 | U.S. Government Publications ..... | 5 |
| 2.2   | Definitions .....                  | 5 |
| 3.    | RECOMMENDED REQUIREMENTS .....     | 7 |
| 3.1   | General .....                      | 7 |
| 3.2   | Functional Requirements .....      | 8 |
| 3.3   | Performance Requirements .....     | 8 |
| 3.3.1 | Flow Requirements .....            | 8 |
| 3.3.2 | Minimum Reseat Pressure .....      | 8 |
| 3.3.3 | External Leakage .....             | 8 |
| 3.4   | Operating Temperature .....        | 8 |
| 3.4.1 | Ambient Temperature .....          | 8 |
| 3.4.2 | Hydraulic Fluid Temperature .....  | 9 |
| 3.5   | Construction .....                 | 9 |
| 3.5.1 | Materials .....                    | 9 |
| 3.5.2 | Corrosion Resistance .....         | 9 |
| 3.5.3 | Electro-Conductive Bonding .....   | 9 |
| 3.5.4 | Seals .....                        | 9 |
| 3.5.5 | Hydraulic Fluid .....              | 9 |
| 3.6   | Physical Requirements .....        | 9 |
| 3.6.1 | Mounting Requirements .....        | 9 |

SAE Executive Standards Committee Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2021 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

**TO PLACE A DOCUMENT ORDER:**  
Tel: 877-606-7323 (inside USA and Canada)  
Tel: +1 724-776-4970 (outside USA)  
Fax: 724-776-0790  
Email: CustomerService@sae.org  
http://www.sae.org

SAE WEB ADDRESS:

Full document details: SAE ARP4835A

For more information on this standard, visit  
<https://www.sae.org/standards/content/ARP4835A/>

Documents

Document Sharing Hub

|        |                                                |    |
|--------|------------------------------------------------|----|
| 3.7    | Strength.....                                  | 10 |
| 3.7.1  | Rated System Pressure .....                    | 10 |
| 3.7.2  | Proof Pressure .....                           | 10 |
| 3.7.3  | Ultimate (Burst) Pressure .....                | 10 |
| 3.7.4  | Fatigue (Pressure Impulse) .....               | 10 |
| 3.7.5  | Operational Shocks.....                        | 10 |
| 3.7.6  | Vibration .....                                | 11 |
| 3.7.7  | Acceleration Forces .....                      | 11 |
| 3.7.8  | Handling Loads.....                            | 11 |
| 3.7.9  | Maximum Wrenching Torque .....                 | 11 |
| 3.7.10 | Flexural Strength.....                         | 11 |
| 3.8    | Weight .....                                   | 11 |
| 3.9    | Environmental Requirements .....               | 11 |
| 3.10   | Operational and Safety Requirements .....      | 12 |
| 3.10.1 | Reliability .....                              | 12 |
| 3.10.2 | Endurance Life.....                            | 12 |
| 3.10.3 | Repeated Assembly .....                        | 12 |
| 3.10.4 | Storage.....                                   | 12 |
| 3.10.5 | Safety .....                                   | 12 |
| 3.11   | Marking.....                                   | 12 |
| 3.11.1 | General.....                                   | 12 |
| 3.11.2 | Detail Marking Requirements .....              | 12 |
| 4.     | RECOMMENDED QUALITY ASSURANCE PROVISIONS ..... | 13 |
| 4.1    | Responsibility for Inspection.....             | 13 |
| 4.1.1  | Physical Defect Inspection .....               | 13 |
| 4.2    | Classification of Tests .....                  | 13 |
| 4.3    | Test Stand Requirements.....                   | 13 |
| 4.3.1  | Test Medium .....                              | 13 |
| 4.4    | First Article Inspection.....                  | 13 |
| 4.4.1  | First Article Samples .....                    | 13 |
| 4.4.2  | First Article Inspection Report.....           | 14 |
| 4.4.3  | Rejection.....                                 | 14 |
| 5.     | RECOMMENDED PRODUCTION ACCEPTANCE TESTS .....  | 14 |
| 5.1    | Visual and Dimensional Examination.....        | 14 |
| 5.2    | Acceptance Test Program.....                   | 14 |
| 5.2.1  | General.....                                   | 14 |
| 5.2.2  | Proof Pressure Test .....                      | 15 |
| 5.2.3  | Flow Pressure Test.....                        | 15 |
| 5.2.4  | Reseat Pressure Test .....                     | 15 |
| 5.2.5  | Weight .....                                   | 15 |
| 5.2.6  | Electro-Conductive Bonding .....               | 15 |
| 5.3    | Preparation for Shipment .....                 | 15 |
| 5.3.1  | Storage and Packing.....                       | 15 |
| 6.     | RECOMMENDED QUALIFICATION TESTS .....          | 16 |
| 6.1    | General.....                                   | 16 |
| 6.1.1  | Qualification by Similarity .....              | 17 |
| 6.1.2  | Qualification Unit Functional Checks .....     | 17 |
| 6.2    | Functional Tests.....                          | 17 |
| 6.2.1  | Repeatability Test .....                       | 17 |
| 6.2.2  | Endurance Cycling.....                         | 18 |
| 6.2.3  | Repeated Assembly .....                        | 18 |
| 6.2.4  | Additional Functional Tests .....              | 18 |
| 6.3    | Environmental Tests .....                      | 18 |
| 6.3.1  | Temperature Tests.....                         | 19 |
| 6.3.2  | Humidity.....                                  | 20 |
| 6.3.3  | Fluids Susceptibility.....                     | 20 |
| 6.3.4  | Fungus Resistance/Fungus.....                  | 20 |

|          |                                       |    |
|----------|---------------------------------------|----|
| 6.3.5    | Salt Spray/Salt Fog .....             | 20 |
| 6.3.6    | Sand and Dust .....                   | 20 |
| 6.3.7    | Waterproofness.....                   | 20 |
| 6.3.8    | Icing.....                            | 20 |
| 6.4      | Structural Tests.....                 | 20 |
| 6.4.1    | Proof Pressure Tests .....            | 20 |
| 6.4.2    | Fatigue (Pressure Impulse) Test ..... | 20 |
| 6.4.3    | Operational Shocks Tests .....        | 21 |
| 6.4.4    | Vibration Tests.....                  | 21 |
| 6.4.5    | Steady-State Acceleration Test .....  | 22 |
| 6.4.6    | Handling Loads Test .....             | 22 |
| 6.4.7    | Wrench Load Test.....                 | 22 |
| 6.4.8    | Flexural Strength.....                | 22 |
| 6.5      | Destructive Tests .....               | 22 |
| 6.5.1    | Ultimate (Burst) Pressure .....       | 22 |
| 6.6      | Additional Tests .....                | 23 |
| 6.7      | Post Qualification Tests.....         | 23 |
| 6.7.1    | Acceptance Tests .....                | 23 |
| 6.7.2    | Inspection .....                      | 23 |
| 7.       | NOTES .....                           | 23 |
| 7.1      | Factors Affecting Test Results.....   | 23 |
| 7.2      | Revision Indicator .....              | 24 |
| Figure 1 | Pressure terms.....                   | 6  |
| Table 1  | Qualification test program .....      | 16 |

## 1. SCOPE

This Aerospace Recommended Practice (ARP) provides recommendations for the design and test requirements for a hydraulic thermal relief valve.

The thermal relief 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 hydraulic thermal relief valve (referred to in the rest of the document as a thermal relief 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 thermal relief 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 a 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 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

|         |                                                                                                         |
|---------|---------------------------------------------------------------------------------------------------------|
| ARP1185 | Flexure Testing of Hydraulic Tubing Joints and Fittings                                                 |
| ARP1383 | Aerospace - Impulse Testing of Aerospace 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, 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 Engineering Considerations and Laboratory Tests                                     |
| MIL-PRF-5606  | Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance (Inactive for new design)         |
| MIL-PRF-46170 | Hydraulic Fluid, Rust Inhibited, Fire-Resistant, Synthetic Hydrocarbon Base, NATO Code No. H-544  |
| MIL-PRF-83282 | Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, NATO Code No. H-537                  |
| MIL-PRF-87257 | Hydraulic Fluid, Fire Resistant: Low Temperature Synthetic Hydrocarbon Base, Aircraft and Missile |

## 2.2 Definitions

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

**THERMAL RELIEF VALVE:** This is a pressure-sensing valve, normally directly operated, which ports small amounts of hydraulic fluid to the low-pressure side of the hydraulic system at a preset pressure to prevent overpressure caused by thermal expansion of the hydraulic fluid.

### NOTES:

1. If the thermal relief valve is protecting the system from the heating effects of an accumulator, then the increase in pressure is dominated by the heating of the accumulator's gas charge.
2. The thermal relief valve can be located within a sub-circuit isolated from the main system relief valve or in a component.
3. The actual relief setting is the preset pressure plus the return pressure that is subject to variations during the system operation.

**NOMINAL SYSTEM PRESSURE:** This is the steady-state pressure that has been generated by the hydraulic system power generation system or the pressure of a hydraulic sub-circuit that has been reduced by a pressure reducer valve (for example, a brake control system).

**RATED SYSTEM PRESSURE:** This is the steady-state pressure that is applied to the thermal relief valve inlet port.

### NOTES:

1. This is the nominal cracking pressure.
2. The Rated System Pressure is equivalent to the Design Operating Pressure (DOP) for civil aircraft and Working Pressure ( $P_w$ ) for military aircraft.

**CRACKING PRESSURE:** This is the pressure that corresponds to the leakage allowed on increasing pressure due to a thermal event.

**NOTE:** There are three performance requirements for a thermal relief valve, namely the cracking pressure, the flow pressure, and the reseal pressure. As it is difficult to consistently manufacture thermal relief valves that meet all three requirements, it is the industry practice to only require the flow pressure and the reseal pressure requirements to be complied with.

**FLOW PRESSURE:** This is the differential pressure at which a specified flow occurs.

**RESEAT PRESSURE:** This is the pressure that corresponds to the leakage allowed on decreasing pressure after a thermal event.

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

**NOTE:** Figure 1 provides a graphical pressure of the pressure terms used in this document.

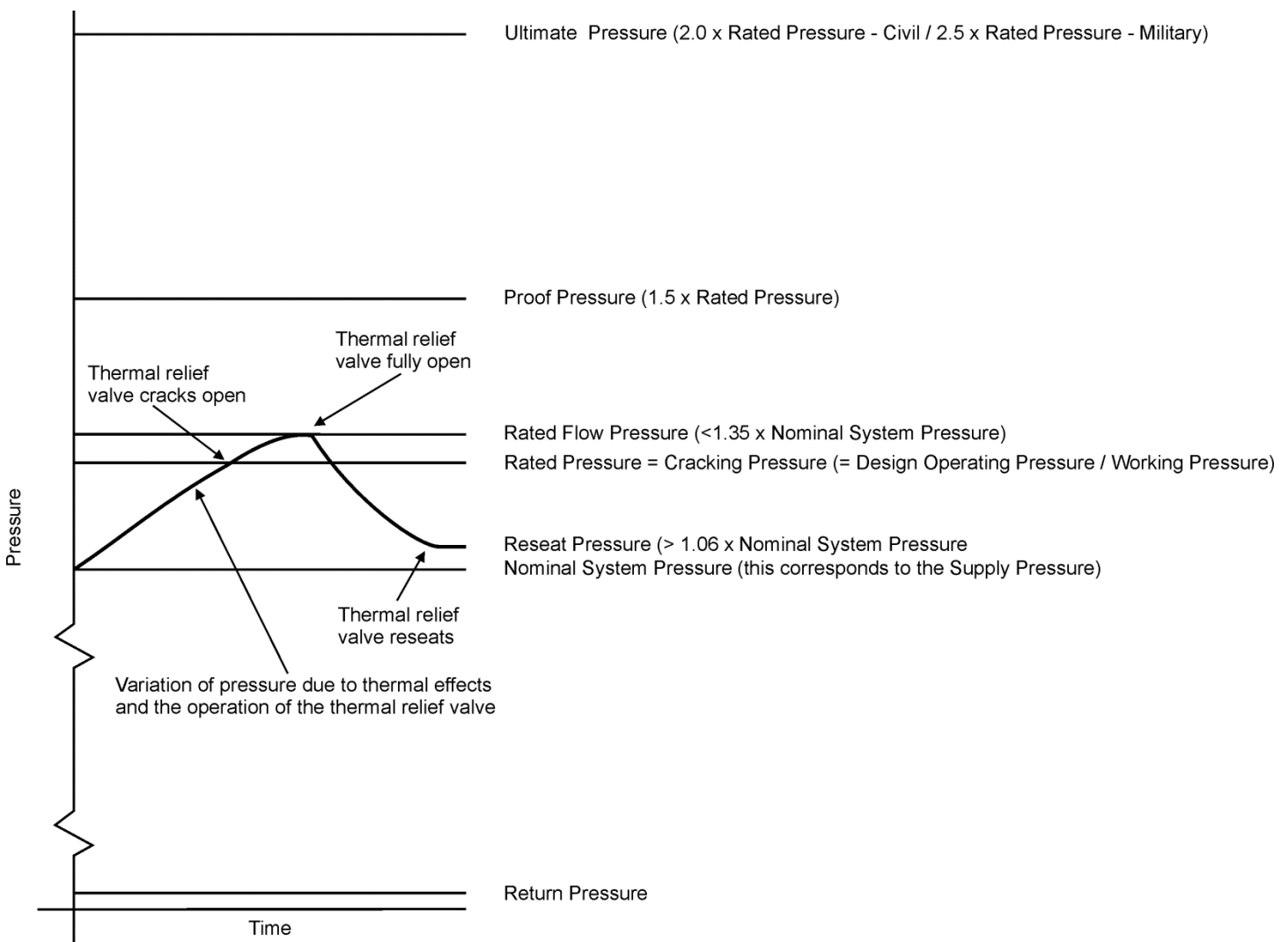


**Figure 1 - Pressure terms**

**RATED FLOW:** This is the maximum operating flow that is permitted through the thermal relief valve.

**PRESSURE DECAY RATE:** This is the decrease in pressure of the system, sub-system, or a component (as applicable) with time after a thermal event opens the thermal relief valve.

## NOTES:

1. This term may apply to an aircraft system or a test volume used to monitor thermal relief valve reseal performance.
2. The pressure decay rate decreases with an increasing system or test volume.

**INLET PORT:** This is the port where the high-pressure side of the hydraulic system or a component is connected to the thermal relief valve.

**OUTLET PORT:** This is the port where the thermal relief valve is connected to the low-pressure side of the hydraulic system or a component.

**ENDURANCE TEST:** This is the test that is intended to determine if the thermal relief 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 thermal relief 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 thermal relief 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 thermal relief 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 thermal relief 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 thermal relief 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 thermal relief valve should meet all the requirements when it is installed or operated as defined by the applicable Procurement Specification.

The thermal relief valve should not be sensitive to spatial orientation.

If the thermal relief valve contains non-metallic parts other than static seals, it should conform to all the functional and performance requirements specified hereinafter 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 non-metallic 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 thermal relief valve should permit the flow of hydraulic fluid to return when the pressure at the inlet port exceeds the cracking pressure and reseats when the pressure subsequently decays to the reseal pressure.

### 3.3 Performance Requirements

NOTE: Care should be taken in the selection of the cracking pressure, the flow pressure, and the reseal pressure. This is because the thermal relief valve should not open under the normal operation of the hydraulic system (including transient pressures) or act as the system pressure relief valve in the event of the failure of a pump pressure controller.

#### 3.3.1 Flow Requirements

The rated flow should occur on increasing pressure at a maximum pressure not to exceed 135% of the nominal system pressure. For this inlet pressure, the rated flow should not exceed 50 x the minimum specified flow.

The following minimum flow rates are recommended but additional flow rates may be specified.

- a. Size 5 - 5 ml per minute minimum
- b. Size 15 - 15 ml per minute minimum

#### 3.3.2 Minimum Reseat Pressure

On decreasing pressure, the minimum reseal pressure should not be less than 106% of the nominal system pressure. At the minimum reseal pressure, the leakage should not exceed the maximum allowable leakage over the specified ambient and hydraulic fluid temperature range.

It is recommended that one of the following maximum allowable leakage rates be specified:

- a. Size 5 (low leakage) - 0.05 ml per minute (approximately 1 drop/minute)
- b. Size 5 (normal leakage) - 1 ml per minute (approximately 20 drops/minute)
- c. Size 15 (low leakage) - 0.1 ml per minute (approximately 2 drops/minute)
- d. Size 15 (normal leakage) - 1.5 ml per minute (approximately 30 drops/minute)

#### 3.3.3 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.

### 3.4 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.