VOLKSWAGEN

AKTIENGESELLSCHAFT

Group standard **TL 874**

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Descriptors: radiator, cooler, cooling system, temperature

Radiator

Functional Requirements

Previous issues

TL 874: 1973-11, 1996-10, 1998-12, 2006-02, 2010-06

Changes

The following changes have been made to TL 874: 2010-06:

– Section 4.7 "Static temperature and pressure loading" changed
– Section 4.10 "Temperature cycle test" changed
– Section 4.9 "Low-temperature test" changed

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Technical responsibility			The Standards department	
EGDB/3	Marcus Kesten	Tel.: +49 5361 9-28155	EKDV/4 Wolfgang Tiefenbach	EKDV
EGDB/3	Manfred Reuschel	Tel.: +49 5361 9-77196	Tel.: +49 5361 9 75357	Maik Gummert

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1 Scope

This Technical Supply Specification (TL) contains the tests necessary for production release of radiators. The objective is complete testing carried out at the sole responsibility of the supplier.

This standard applies to mechanically joined and soldered radiators for passenger cars and commercial vehicles with water-cooled engines.

2 Description

Functional requirements as per TL 874

3 General requirements

Approval of first supply and changes as per VW 01155.

The environmental requirements set forth in VW 91100 must be met.

The test equipment required for carrying out the procedures in this TL must be located directly at the production site. Alternative test methods are only permissible if correlation with the tests specified herein has been proven and this has been agreed upon with the purchaser.

Original couplings and fasteners (e.g., spring clamps) must be used for the tests.

The following applies to the coolant additive required in this standard as per TL 774: The additive approved by Volkswagen at the time of the test must be used.

3.1 As-received condition

Free of foreign matter (on the inside and on the outside). Ports and openings must be protected to exclude the possibility of soiling and damage during storage, transport, and installation.

3.2 Materials

Materials as per drawing.

3.3 Operating temperature

Operating temperature range (-40 to +135) °C

3.4 Subject to build sample approval

The requirements as per section 4 must be met for the mandatory build sample approval.

4 Radiator testing

A total of 20 radiators must be configured in all possible variants from at least two batches of reservoirs, pipes, and fins, and must undergo measurements for cooling performance and pressure drops. The measured values must be reported to the appropriate department. All radiators must meet the requirements for cooling performance and pressure drop set forth in the Performance Specifications.

4.1 Cooling performance

The operating points for cooling performance measurement and the limits for the performance data of the radiator must be taken from the vehicle-specific Radiator Performance Specification or the drawing.

The following must be submitted to the appropriate department for purposes of determining the cooling performance:

- One component with average cooling performance
- One component with minimum cooling performance

4.2 Pressure drop

The operating points for pressure drop measurements and the limits for the permissible pressure drops of the radiators must be taken from the vehicle-specific Radiator Performance Specification or the drawing.

The following must be submitted to the appropriate department for purposes of determining the pressure drops:

- One component with average cooling air pressure drop
- One component with maximum cooling air pressure drop
- One component with average coolant pressure drop
- One component with maximum coolant pressure drop

4.3 Leak tightness under pressure

100% testing at the supplier's facilities.

The method used for the leak tightness test may be chosen by the supplier.

Coolant must not escape from the radiator under any vehicle operating conditions.

4.3.1 Vacuum

Test medium	Air
Test temperature	(23 ± 5) °C
Test pressure	≤30 mbar absolute
Hold time after reaching the test pressure	5 s

Criterion for leak tightness

Pressure rise within the hold time	≤1 mbar

4.3.2 Over-pressure

Test medium	Air
Test temperature	(23 ± 5) °C
Test pressure	2.5 bar over-pressure, drawing note takes precedence
Hold time after reaching the test pressure	5 s

Criterion for leak tightness

No air bubbles rising from radiator to which the test pressure is applied and that is held under water.

4.4 Pressure pulse resistance for quality assurance and build sample approval

The requirements as per section 4.3 must be met prior to the tests. Unless otherwise specified, the following test criteria apply:

Test procedure:

Test medium	100% coolant additive as per TL 774
Media temperature	(135 -5) °C[1)]
Test chamber temperature	(85 ±5) °C
Pressure pulse frequency	(0.5 to 1) Hz (sinusoidal)[2)]
Pressure pulse range	(1.25 ±1.15) bar over-pressure[1)]
P_{min}	0.1 bar over-pressure
P_{max}	2.4 bar over-pressure
Number of specimens	12 new parts
Minimum number of load cycles per radiator i	N ≥ 100 000
Number of load cycles for termination	250 000 LC
Criterion for process reliability λ	λ ≥100 000 LC

Formula for average value:

$$\bar{N} = 10^{\frac{1}{n}\sum_{i=1}^{n}\log_{10} N_i} \tag{1}$$

Formula for logarithmic standard deviation:

$$s_{log} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\log_{10} N_i - \log_{10} \bar{N}\right)^2} \tag{2}$$

Criterion for process reliability:

$$\lambda = 10^{\log_{10} \bar{N} - 2 s_{log}} \tag{3}$$

N = Number of load cycles upon failure of radiator i, or upon reaching the number of cycles for termination.

1) Measured at the inlet port

2) Permissible test range for system-specific reasons

A load cycle (LC) is defined as one period of the sinusoidal pressure pulse.

After testing, the specimens used must meet the functional requirements as per section 4.3.2.

4.5 Vibration resistance

The part to be tested must be mounted on the test bed in as-installed position with the designated fasteners; it must be fitted with all released add-on parts in the front end (if available); it must be filled completely with a mixture of 50% coolant additive as per TL 774 and 50% water.

The center of the top of the radiator must be chosen as the measuring point for the acceleration.

Number of specimens	2 new parts	
Direction of vibration	Vertical	
Acceleration of the DUT at ±2.5 g	Number of load cycles	$n = 10 \times 10^6$
Acceleration of the DUT at ±5 g	Number of load cycles	$n > 2 \times 10^6$
Vibration frequency	Constant at (20 ±3) Hz (add-on parts not resonant)	

For decoupled radiators, the test amplitudes must be based on the vehicle measurement values (if available).

Following the test, the components must be leak-tight as per section 4.3.2.

4.6 Vibration resistance with temperature load

This test applies only to mechanically joined radiators.

The part to be tested must be mounted on the test bed in as-installed position with the designated fasteners; it must be fitted with all released add-on parts in the front end (if available); it must be filled completely with a mixture of 50% coolant additive as per TL 774 and 50% water.

The center of the top of the radiator must be chosen as the measuring point for the acceleration.

Number of specimens	≥3 new parts
Test chamber temperature	≥60 °C
Vibration acceleration	±2.5 g
Number of cycles	$n \geq 10^7$
Vibration frequency	Constant at (20 ±3) Hz (add-on parts not resonant)

For decoupled radiators, the test amplitudes must be based on the vehicle measurement values (if available).

Following the test, the components must be leak-tight as per section 4.3.2.

4.7 Static temperature and pressure loading

The devices under test (DUTs) may be subjected to flow to the extent necessary to ensure a constant temperature. The maximum flow rate per DUT must be agreed with the responsible department prior to starting the test and must be documented using examples.

Erosion within the DUT caused by flow is not permitted.

Number of specimens	4 new parts
temperature	(135 -5) °C
System pressure	2 bar over-pressure, regulated
Test medium	Mixture of 60% coolant additive as per TL 774 and 40% water
Test duration	800 h

Procedure

Heating cycle

1. Heat the pressurized components to 135 °C
2. After 170 h, cool them down to room temperature
3. Store for 1 h at room temperature and replace existing test medium with new medium
4. Heat to 135 °C
5. Check for leak tightness

Repeat heating cycle until the component has been loaded for a total of 800 h.

Afterwards, determine residual loading capacity as per pressure pulse test in section 4.4, but with the following deviating specifications:

Test duration	60 000 load cycles or termination following leakage/cracks
Release criterion	Minimum number of load cycles for all radiators of 30 000 LC
	Following the test, the components must be leak-tight as per section 4.3.2

4.8 Corrosion specimen

Climate corrosion cycle test for 24 weeks as per Test Specification PV 1209

Number of specimens ≥5 new parts

After the test, the requirements of PV 1209, sections "Leak tightness test" and "Microsections" must be met.

For mechanically joined radiators with steel pipe bottoms, the external corrosion test must be performed for 1 200 h as per DIN EN ISO 9227.

Number of specimens ≥5

Following the test, the components must be leak-tight as per section 4.3.2.

Corrosion (e.g., surface damage such as pitting, blooming) is permissible only at the points that are defined on the drawing as unprotected for manufacturing reasons.

4.9 Low-temperature test

Number of specimens ≥2 new parts

In order for the seal to set, the radiators are aged at an ambient temperature of 130 °C for a period of 24 h. The radiators must be filled with a mixture of 50% coolant additive as per TL 774 and 50% water during this aging. To ensure a pressure build-up during the aging at 130 °C, the radiators must be tightly sealed.

The radiator must be sealed with production quick couplings including hose connections.

Afterwards, the radiators are aged at a temperature of -40 °C for a period of 8 h.

Immediately following removal of the radiators from the cold chamber, the test is performed on the assembly consisting of:

– Radiator
– Quick couplings
– Hose sections

As per section 4.3.2 with the following values changed:

Test pressure	1.2 bar over-pressure
Pressure hold time	5 min

Leakage is not permissible.

4.10 Temperature cycle test

The temperature cycle test is only regarded as a build sample approval test when carried out in consultation with the appropriate department. The test must only be performed on radiators with a soldered radiator core. (Temperature cycles have no damaging effect on radiators with a mating connection.)

Thermographic images of the radiator in the vehicle must be recorded in order to identify large temperature differences and to perform the test based on the most critical case. The test setup and test procedure are then specified in consultation with the appropriate department.

Recording operational loads

The loads on the radiator are recorded using strain gages and temperature sensors at the critical points of the radiator core during driving on the design-relevant courses of Volkswagen AG and Audi AG.

The measurements must only be performed at ambient temperatures that allow the critical loads to occur in large numbers.

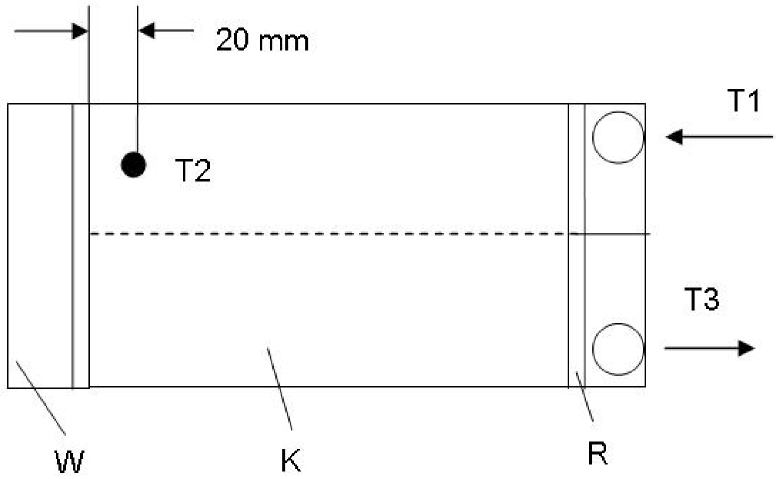
Load spectrums are determined from the strain amplitudes. For the temperature cycle tests on the test bed, the responsible department (EGDB or other) will provide a minimum stress-cycle diagram (mean value line) computed from these load spectrums, which will serve as the basis for evaluating the tests.

Test bed setup for the radiators

Cyclical flow through the air conditioning condenser and the radiator. Use of a production electric fan, equipped with production radiator fan mounting frame, that is actuated only during the cooling phase. For the positions of the temperature measuring points, see figure 1 for single-flow radiators and figure 2 for dual-flow radiators.

4.10.1 Single-flow radiator

Positions of temperature measuring points T1 to T3.



Legend

T1	Measuring point 1, inlet temperature	W	Reservoir
T2	Measuring point 2	K	Radiator core
T3	Measuring point 3, outlet temperature	R	Pipe bottom

Figure 1 – Single-flow radiator

Test conditions:

Test chamber temperature	(-10 ±3) °C
Inlet temperature	(130 ±3) °C
Test medium	100% coolant additive as per TL 774
Static internal pressure (p)	(1 ±0.1) bar over-pressure

Changeover criteria

– Stop inflow of heated coolant

Temperature T2	T_{upper} = (83 ±3) °C
Cool down with fan power	P = 100%

– Start new cycle after cooling down

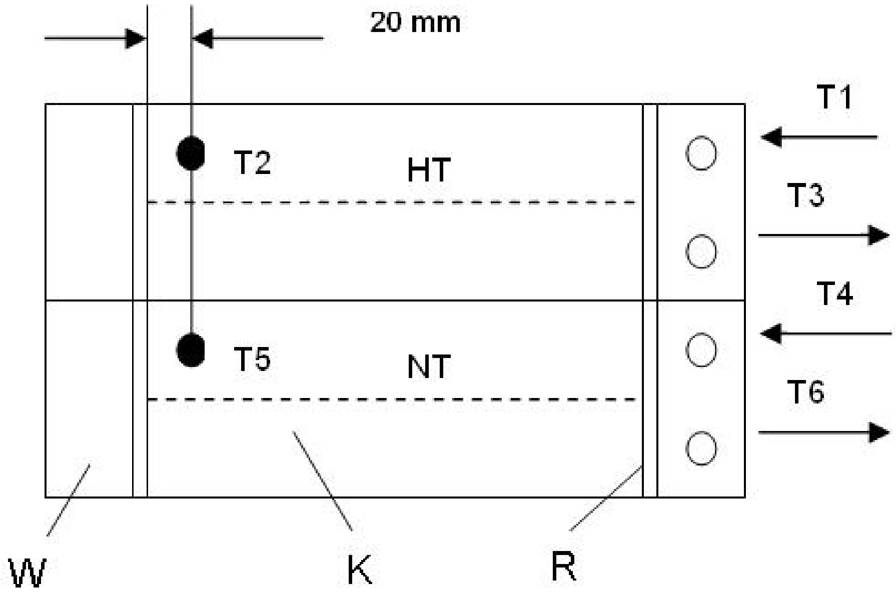
Temperature T2	T_{lower} = (-1 ±3) °C
Double amplitude	ΔT = 84 °C

The number of load cycles required will be specified based on vehicle measurements. For this purpose, temperature values for control temperature point T2 are assigned to the strains based on calibration on the test bed. The minimum stress-cycle diagram must be complied with.

Number of specimens	3 new parts

4.10.2 Dual-flow radiator

Positions of temperature measuring points (T1 to T6)



Legend

T1 and T4	Measuring points for the inlet temperature
T2 and T5	Position of measuring points T2 and T5: 20 mm from pipe bottom, center of the upper radiator core, bottom side of the top pipe
T3 and T6	Measuring points for the outlet temperature
HT	High-temperature radiator
NT	Low-temperature radiator
W	Reservoir
K	Radiator core
R	Pipe bottom

Figure 2 – Dual-flow radiator

The timing of the inflow of the heated coolant must be the same for the high-temperature and low-temperature radiators in each cycle.

For test conditions for the high-temperature radiator (HT), see section 4.10.1

Test conditions for the low-temperature radiator (NT):

Test chamber temperature	(-10 ±3) °C
Inlet temperature	(70 ±3) °C
Test medium	100% coolant additive as per TL 774
Static internal pressure (p)	(1 ±0.1) bar over-pressure

Changeover criteria

– Stop inflow of heated coolant

Temperature T5	T_{upper} = (50 ±3) °C
Cool down with fan power	P = 100%

– Start new cycle after cooling down

Temperature T5	T_{lower} = (-1 ±3) °C
Double amplitude	ΔT = 51 °C

The number of load cycles required will be specified based on vehicle measurements. For this purpose, temperature values for control temperature point T2 are assigned to the strains based on calibration on the test bed. The minimum stress-cycle diagram must be complied with.

Number of specimens	3 new parts

5 Applicable documents

The following documents cited in this standard are necessary to its application.

Some of the cited documents are translations from the German original. The translations of German terms in such documents may differ from those used in this standard, resulting in terminological inconsistency.

Standards whose titles are given in German may be available only in German. Editions in other languages may be available from the institution issuing the standard.

PV 1209	Condensers, Radiators, and Charge Air Coolers Made of Aluminum Alloys; Corrosion Test (Environmental Corrosion Cycle Test)
TL 774	Ethylene Glycol-Based Coolant Additive; Materials Requirements
VW 01155	Vehicle Parts; Approval of First Supply and Changes
VW 91100	Environmental Standard for Vehicles; Vehicle Parts, Materials, Operating Fluids; Policy, Specifications
DIN EN ISO 9227	Corrosion tests in artificial atmospheres - Salt spray tests