China Euro Vehicle Technology

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Document Name
CLAMPS AND QUICK CONNECTORS
Cooling systems

Part must comply with Restricted Substance Management Standard (RSMS) CS 105036,59

Technical Regulation

CLAMPS AND QUICK CONNECTEORS

Cooling systems

Contents

1. General

1.1 Purpose of this TR

This documents describes the technical requirements of clamps and quick connectors on cooling hoses that are to be used in projects developed by China Euro Vehicle Technology.

1.2 Revision history

Revision	Date	Description	Author (dept, name, phone)
001	2017-04-27	New TR based on TR 8888162944	Cooling, Mattias Ansebo, +46 706 590502
002	2018-01-19	3.1.7 updated; 3.3.7 added	Cooling, Mattias Ansebo, +46 706 590502

1.3 Requisite documents

1.3.1 CEVT documents

1.3.1.1 Standards and specifications

Reg. No./ID	Date	Document name
CS 105036,59	2017-01-24	Restricted Substance Management Standard (RSMS)
ISO 3384:1999(E)	1999-10-15	Rubber, vulcanized or thermoplastic
VCS 1223,09		
VCS 1223,119		
VCS 1024,11189	2014-04	Compression set – Rubber materials and rubber products
VCS 1024,21219	2005-12	Tensile strength – Rubber material
VCS 1024,31159	2005-10	Hardness – Rubber
VCS 1027,149	2002-06	Accelerated corrosion test – Atmospheric corrosion
VCS 1027,1449	2014-02	Accelerated corrosion test, version II – ACT II – Cyclic atmospheric corrosion test with salt load
VCS 1027,61319	2005-12	Resistance of rubber materials to liquids
VCS 1029,54739	2005-09	Adhesion – Paint and enamels
VCS 5089,19	2010-01	Tightness requirements
VCS 7161,639	2006-03	Hose clamps with worm screw – Testing and delivery specifications
WK 900		Hose clamps – Worm drive
TR 8888790892		Rubber hose Cooling system VEA Gen3

2. Functional environment

All components shall withstand the environment which they may be exposed to in a Volvo vehicle. The component shall be capable to withstand Volvo's vehicle sign-off tests such vehicle durability (e.g. VPT1 and VPT2) and vehicle corrosion (CORCAR previously called LPK) and not cause functional problems within the vehicle.
If the supplier believes that the component tests are missing in the Technical Regulation which are attached to the corresponding ESOW, the supplier shall respond with:
- What is missing
- Why
- Proposal(s) for additional or modified tests
- Reason for the additional/modified test(s) and any form of failure modes which the test(s) will help to detect.
- Agreement for additional test must be made with Volvo design department.

2.1 Sealings

Hose sealings shall unit various components in the cooling and heating system of the engine. The hose sealing will secure that no leakage will occur in joints in the cooling system. The coolant in the system shall consist of water and glycol 50/50 according to Volvo coolant drawing.

The sealing should be easy to assemble and possible to dismount/reassemble during lifetime.

2.2 Temperature

The temperature of the coolant can vary between -40°C and +135°C. Normal working temperature of coolant is 100 ±10°C. The sealings should fulfil our varying demands regarding ambient temperatures in the engine bay (-40°C – 220°C).

2.3 Pressure

The pressure in the system can vary from under pressure to overpressure within the values stated on the drawing.

3. Property requirements

3.1 Testing and documentation

Test methods and test equipment must be verified and approved by CEVT design department. In documentation of test results, the test equipment and test laboratory must be noted. All tested component must be measured before testing, such as: wall thickness of hose, diameter of plastic spigot. In the tests Volvo car corporation specification of coolant according to drawing is to be used if other not stated.

3.1.1 Recommendation of clamp/quick connector

Recommendation of clamp is made according to standard together with design department and clamp supplier. The clamp/quick connector should be chosen by the rubber hose/plastic pipe supplier. The clamp/quick connector should be made according to standard. New clamps/quick connectors can be suggested by the supplier, but must be accepted and implemented in standard.

3.1.2 Testing at supplier

It is strongly recommended that the TR is reviewed in detail together with the responsible design department at CEVT at an early stage in order to clarify any doubts before initiating any tests.

The supplier must show evidence to CEVT design department that it has the appropriate test equipment and evaluation methods in order to meet CEVT requirements. The same applies if the supplier decides to make tests at a third party.

An assessment of the suppliers testing capabilities is recommended to be made by means of a TR review according to above and a visit to the supplier by CEVT.

3.1.3 Test plan

A test plan should be agreed with CEVT before start of any test activities.

3.1.4 Test report

The documentation should be so complete that it would be possible to repeat the tests and evaluations at any time in the same way and at the same conditions.

The TR test report is only for use within CEVT. What shall be reported is described in connection with each test below and in the concerned standards and serves as a minimum specification of what the TR test report must include.

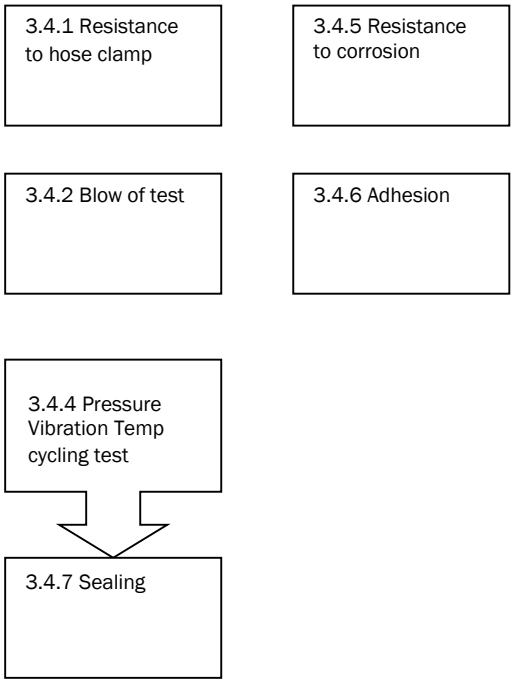
The repeatability of each test is important. Therefore the following must also be documented for each test in this TR:
TR number and issue.
Test equipment.
Test objects: clamp references such as part number and issue or equivalent.
Test object: part no and issue of hose (when applicable).
Test object: spigot dimension, supplier reference, other details of relevance (when applicable).
Test method.
Test laboratory if other than main test laboratory.
Date of the test.
Reason for TR test example: new supplier, new design of the hose.
Any other pertinent details of the entire test and any relevant comments and observations.

3.1.5 Amount of test samples

A minimum of tree hoses/test pieces are to be tested in each test in chapter 3.3 Material properties. Regarding tests in chapter 3.4 Functional properties a minimum of six sealings are to be tested if otherwise not stated.

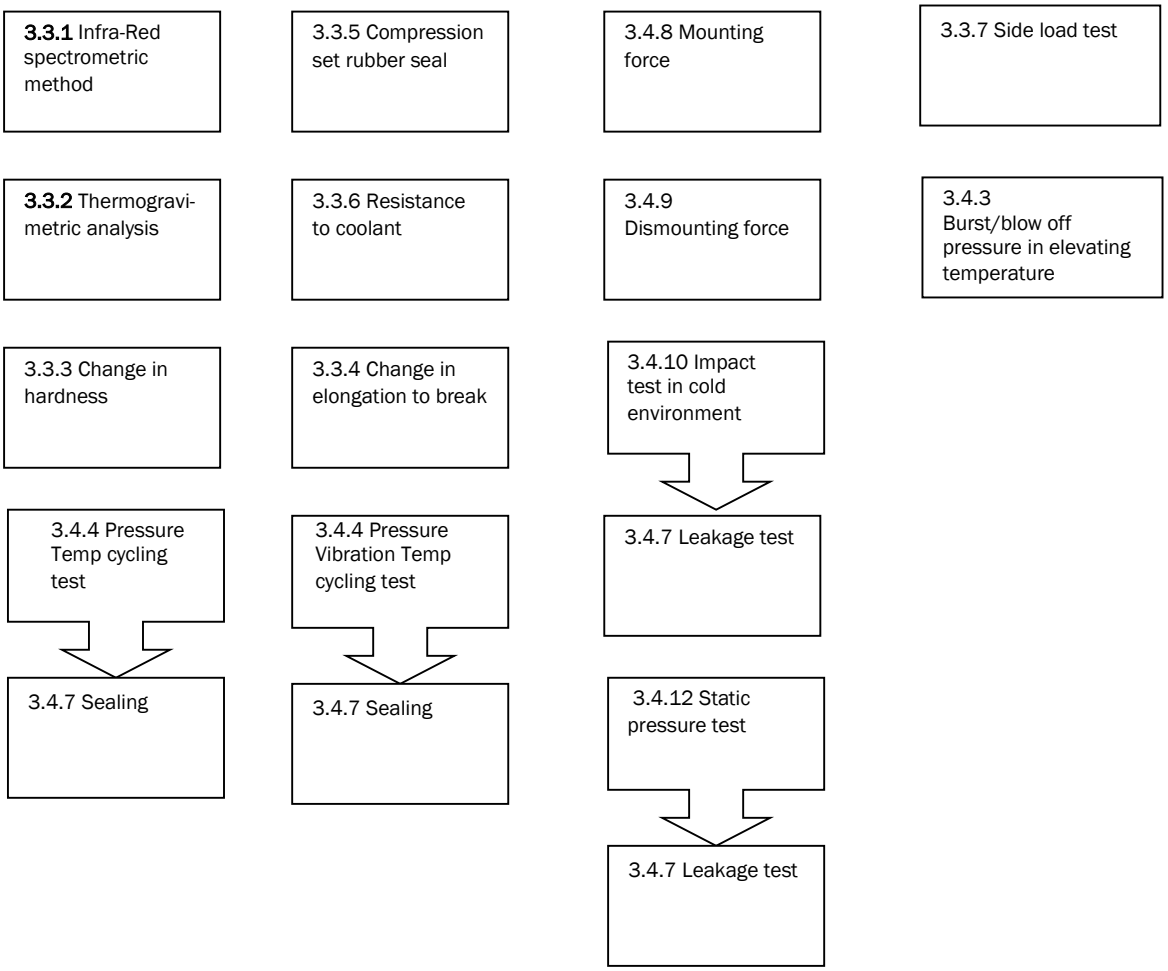
3.1.6 Test flow chart, clamps

Below flow charts shows when tests have to be performed in a sequence and when they should be performed as single tests.



3.1.7 Test flow chart, quick connectors

Below flow charts shows when and how tests have to be performed in a sequence and when they should be performed as single tests.



3.2 Test conditions

3.2.1 Assembling of clamp and quick connector

Production status of spigots, hoses, clamps and quick connectors must be used in testing. If there are reasons not to use production status (PPAP phase 1) component in testing, contact CEVT. Deviations of component status must be noted in test report.

Table 1. *The table describe assembling of worm screw clamps in testing.*

	Assembling with "High band tension"	**Assembling with "Low band tension"**
Torque (Nm)	Recommended torque + 0,4Nm	Recommended torque - 0,4Nm
Torque speed (rpm)	35 rpm	500 rpm
Assembly tool	Electrical tool	Electrical tool

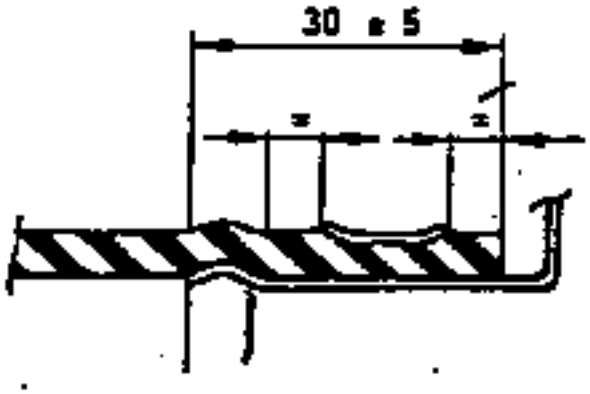


Figure 1. *The figure describe were to put worm screw clamp on spigot.*

Spring Band Clamps (SBC) should be positioned according to drawing. If SBC is glued on hose, clamp should also be glued on hose in testing.

Quick connectors are fitted to spigot when the spring has locked on the spigot.

3.2.2 Clamps and quick connectors

The clamps and quick connectors that are tested and documented according to this TR must be made of the same materials, and produced according to the same manufacturing methods as intended for future serial production, that is, they must fully correspond to regular production items in delivery conditions. The clamps and quick connectors must not be older than 6 months and they must not be re-used in the test.

3.2.3 Hoses

The hoses must not be re-used in the test.
Contact CEVT design department for correct hoses to use for the evaluations in the TR tests.

3.2.4 Spigots

Spigots must be shaped and with the material, dimensions and surface treatment as in production. Contact CEVT for status of spigot. The spigots are to be fitted to the test rig in such a way that the hose is positioned correctly in accordance with the drawing.

Spigot supplier must insure compatibility with the quick connector. This should be done by addition of quick connector part numbers on the spigot drawing.

Spigot design for spring band clamp and screw clamp could be according to DIN 3021-3.

3.2.5 Temperature

Testing is carried out at room temperature (23 ±2)°C unless otherwise specified.

3.2.6 Pressure

All pressure values given in this TR are overpressures.
Tolerances: Nominal value ±3%.

	Mechanical Water Pump	Electrical Water Pump
Hose	**Pressure stated on drawing**	**Pressure stated on drawing**
Inlet heater hose EGR hose Bypass hose	400 kPa	220 kPa
Upper radiator hose	220 kPa	220 kPa
Outlet heater hose Outlet engine oil cooling hose Degas bottle hose	200 kPa	160 kPa
Lower radiator hose Turbo hoses	160 kPa	160 kPa

Table 2. *Used pressure in testing.*

3.2.7 Assembly liquid

It shall be possible, without difficulty, to mount the hose onto a production spigot. Allowable means when mounting the hose in production are:

- Glycerol
- Water
- Propylene glycol

If other assembly liquid are desired the responsible designer has to be informed for consultation.

3.2.8 Coolant

Use coolant BASF Glysantin G64 in 50/50 (coolant/water) mixture, if other not stated.

3.3 Material properties

The supplier selects a composition, materials, and a manufacturing method of the sealing/rubber hose/QC, which ensures the function of the part during its lifetime in its installation based on the functional environment and the performance requirements in this TR. The material specification and the construction of the hose will be reported as detailed as possible, see below. Note material restrictions in RSMS, CS 105036,59. See standard for o-rings, STD VCS 1223,09.

3.3.1 Infra-Red spectrometric method

See ISO 4650:1984 for test method.
One test is needed.

Test report
Spectra of solvent extract.
Spectra of polymer.

3.3.2 Thermo gravimetric analysis

See ISO 9924:2000. The element in the ash is then determined with for example SEM-EDS or XRF.
One test is needed.

Test report
Carbon black content.
Polymer content.
Ash content.
Element in ash.

3.3.3 Change in hardness

The change of hardness is measured in accordance with VCS 1024,31159. The measurement must be performed on pieces cut from rubber component. If hose both from outer and inner layer.

Acceptance criteria
The change of hardness of the o-ring is for: EPDM max 15 IRHD. (125°C/1000h).
EPDM max 5 IRHD. (125°C/72h).

Test report
Note all measurements.

3.3.4 Change in elongation at break

The elongation at break is measured in accordance with VCS 1024,21219. The measurement must be performed on pieces cut from rubber component.

Acceptance criteria

Change in elongation at break is for:	EPDM max reduction of 60%. (125°C / 1000h).
Change in elongation at break is for:	EPDM max reduction of 30%. (125°C / 72h).

Test report

Note all elongation at break results.
Test temperature.

3.3.5 Compression set

The compression set is measured in accordance with VCS 1024,11189. The measurement must be performed on o-rings. Test pieces for 125°C/72h and 115°C/1500h.

After heat ageing, the test pieces shall be allowed to cool down to room temperature, 23 ± 2°C (to be checked), in the test equipment. They shall then be decompressed. The time to cool down to room temperature shall be at least 4h in room temperature before test piece is decompressed from test fixture. Measurement of compression set is then made after 30 sec after decompression and then after another 30 minutes.

Acceptance criteria

Compression set for 115°C/1500h:	max 75% (measurement 30 minutes after decompression).
Compression set for 125°C/72h:	see VCS 1223,119, figure1.

Test report

Note compression set value for 125°C/72h.
Note compression set in a plot until 115°C/1500h.
Note value after 30 seconds and 30 minutes.

3.3.6 Resistance to coolant

The measurement must be performed on pieces cut from rubber component. Pieces of the inner layer are boiled in VCC coolant (50/50, G/W), respectively, for 30 days. The temperature is to be kept at boiling temperature of the liquids. Before and after boiling, the hardness is measured in accordance with VCS 1024,31159, and the volume in accordance with VCS 1027.61319.

Acceptance criteria

Max change of hardness:	10 IRHD.
Max volume change:	EPDM 10 %.

Test report
Note change of hardness in a graph (hardness/time).
Note volume change for coolant in a graph (volume change/time).
Size and date of manufacture of test sample(s).
Vulcanisation time, temperature and pressure when producing the test sample(s).
Note coolant.

3.3.7 Side load test

See SAE J2044 Revised AUG2009, 6,4 Side load capability

Background

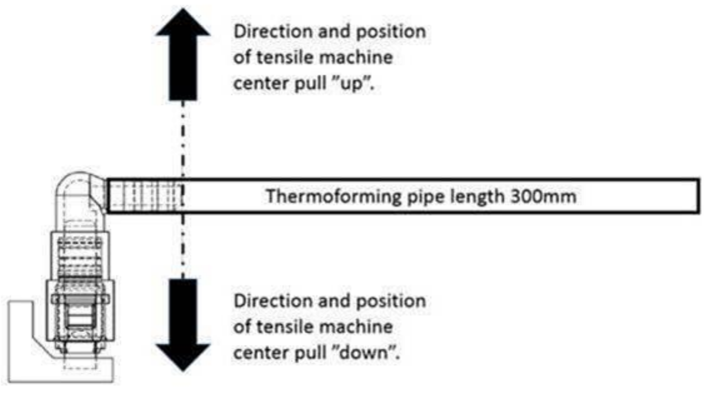
Quick connect couplings and other plastic parts with fir tree , must be able to withstand side loads typical of what might be imposed by hose routing in a
vehicle application as well as from having the hose pushed aside to reach other objects on the vehicle during service procedures. The side load capability is measured using a side load fracture test.

Sample preparation
Prepare samples according to picture 1.

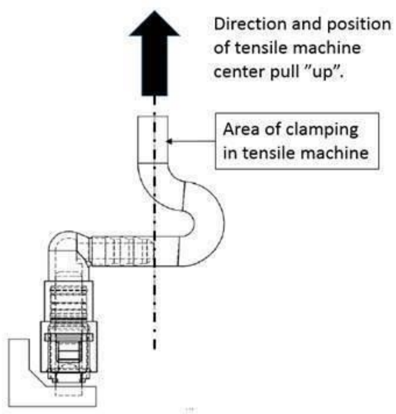
Precondition
Immerse 6 samples (for each direction) in water (typically fully immersed in 80°C water for 3 days, water evaporation can be reduced by table tennis balls) until steady state in weight, sample here after named WET.
Store WET samples when conditioned in closed plastic bags.
This test and conditioning can also be utilized with aged parts if so stated elsewhere in document

Test Procedure to be repeated for all directions and conditions.
a. Remove samples from plastic bags. Side load test should be performed maximum 30 min after removal from plastic bag.
b. Mount a sample in the fracture fixture, compare with figure 1 and 2, with vehicle intended male or female adapter mounted in test machine, side load tested part at a rate of 12.7 mm/min ± 5 mm/min
(0.5 in/min ± 0.2 in/min) until fracture of the part or tube occurs.

Acceptance Criteria (Side Load Fracture Test)
No fracture, rupture, or yield of the quick connector alt. fir tree for plastic part permitted below a minimum of 225N. In all directions and conditions.



Picture 1



Picture 2. Example of pull "up" test

3.4 Function properties

3.4.1 Resistance to hose clamp

The hose must not be damaged when the hose clamp is tightened.

Test method
Measure spigot diameter and wall thickness of hose before assembly. The hose shall be mounted on spigot with production status. The hose shall be provided with the appropriate hose clamp. Assemble worm screw clamps according to Table 1 with “High band tension”.

Hose with mounted hose clamp shall be placed in an oven at +120±2°C for 24 h.

Measure spigot diameter after condition in oven. Disassemble hose sealing and investigate hose under clamp.

Acceptance criteria
Fracture or crushing of the rubber and/or reinforcement must not occur.
Change of spigot diameter, before and after 24h in 120°C, may not exceed 2%. Measurement is made at least 4 times uniformed distributed on the spigot with help of a Vernier gauge.

Test report
Note material specification and hardness of hose.
Note material specification of spigot.
Document with photographs if fracture/crushing of hose. Note length and depth of any fracture.
Note max change of spigot diameter.
Note spigot diameter and wall thickness of hose.

3.4.2 Blow of test

The hose sealing shall withstand overpressure without leakage.

Test method
Status of spigot, hose and clamp that is used in test must be the same as in production. Before assembled hose on spigot the spigot will be immersed in glycol/water mixture (50/50) and then drain for 30 seconds. Assemble hose on spigot according to serial production design. Clamp position according marking at hose. Tighten the clamp according Table 1, “Low band tension”.

The test shall be performed on the individual hose (shape acc. to drawing). The hose shall be assembled so that at least one hose end in unrestrained. Investigated sealing shall be fasten. Insert pressure medium near investigated hose sealing. Let the assembled hose sealing be in RT for 1 hour before investigate glide and blow of pressure.

Test parameters:

Ambient temperature:	23°C±3°C.
Pressure medium temperature:	23°C±3°C.
Pressure medium:	water
Rise of pressure:	0,5bar each 30 seconds, see **Table 3**.
Max pressure:	until blow of pressure.

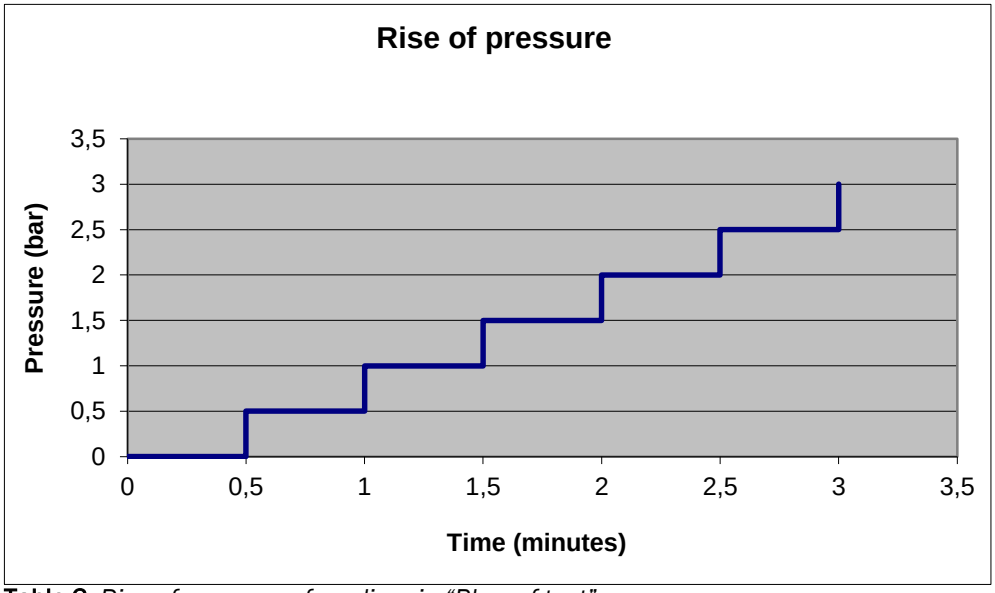


Table 3. *Rise of pressure of medium in "Blow of test".*

Acceptance criteria
Requirement for upper radiator hose (VED, VEP, GEP): 680 kPa
Requirement for other hoses (VED, VEP, GEP): min 200 kPa
No leakage under or at 2 times pressure, stated on drawing.

Test report
Note time/pressure when/if gliding occur.
Note time/pressure to leakage.
Note time/pressure to blow off.
Note material specification and hardness of hose.

3.4.3 Burst/blow off pressure in elevating temperature

The test is performed with complete sealing. The test is performed with pre-conditioned parts.

Pre conditioning of unaged part before test is made according to below method:

Pre-conditioning

* Ambient temperature:	90±3°C
* Circulating coolant temperature:	90±3°C
* Coolant mixture:	50/50 (G/W)
* Pressure:	100±5kPa
* Time:	96h

After pre-conditioning the sealings are to be conditioned at RT for 2± 1hours before burst/blow off according to below test. The test is performed with complete sealing. Temperature sensor must be fitted to hose/pipe surface. Surface temperature of hose/pipe must be measured in test.

The sealings are mounted in a rig with coolant as per vehicle installation.

Medium:	120±3°C.
Medium temperature:	120±3°C.
Pressure:	See **Table 3**
Ambient temperature:	120±3°C then continuously increased 15±3°C/h.

Acceptance criteria
The burst/ blow off temperature is to be minimum 140°C at surface of hose/pipe.

Test report
Note surface temperature when burst, leakage or blow off (or OK after 180°C) occur for all tested sealings and failure mode.
Note corresponding ambient temperature to surface temperature.

3.4.4 Pressure Vibration Temperature cycling test (body mounted)

This test is valid for body mounted hose sealing/quick connectors. Production status of spigots, hoses, clamps and quick connectors shall be mounted in a rig so that the ends of the hose obtain their theoretically correct position. The circulating movement shall be in the end plane of hose. Direction of movement is clock wise. Maximum length of hose is 400mm. If there are reasons not to use production status component in testing, contact CEVT.

Worm screw clamps shall be mounted with “Low band tension” according to Table 1.

A fluid consisting of glycol/water mixture (50/50) shall be allowed to flow through the hoses during the test. The pressure changes shall be regulated via the circulating fluid. See Table 2 for level of pressures in pressure cycling.

Circle vibration parameters: 80 rpm, r=7,5mm

Below sequence, 1-6 will be performed.

1) Heat chamber from RT to a permanent temperature of 120°C (40 minutes)

a) Heating – coolant circulation	ON	temperature 120°C
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

2) Maintain chamber temperature of 120°C (2h + 45 minutes)

a) Heating – coolant circulation	ON	temperature 120°C
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

3) Reduce chamber temperature from 120°C to 100°C (15 minutes)

a) No heating – coolant circulation	ON	temperature RT
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

4) Reduce chamber temperature from 100°C to -40°C (3h + 30 minutes)

a) Heating – coolant circulation	OFF
b) Water pump	OFF
c) Vibration	OFF
d) Pressure cycling	OFF

5) Maintain chamber temperature of -40°C (30 minutes)

a) Heating – coolant circulation	OFF
b) Water pump	OFF
c) Vibration	OFF
d) Pressure cycling	OFF

6) Heat chamber to a permanent temperature of RT°C (20 minutes)

a) Heating – coolant circulation	ON	temperature 120°C
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

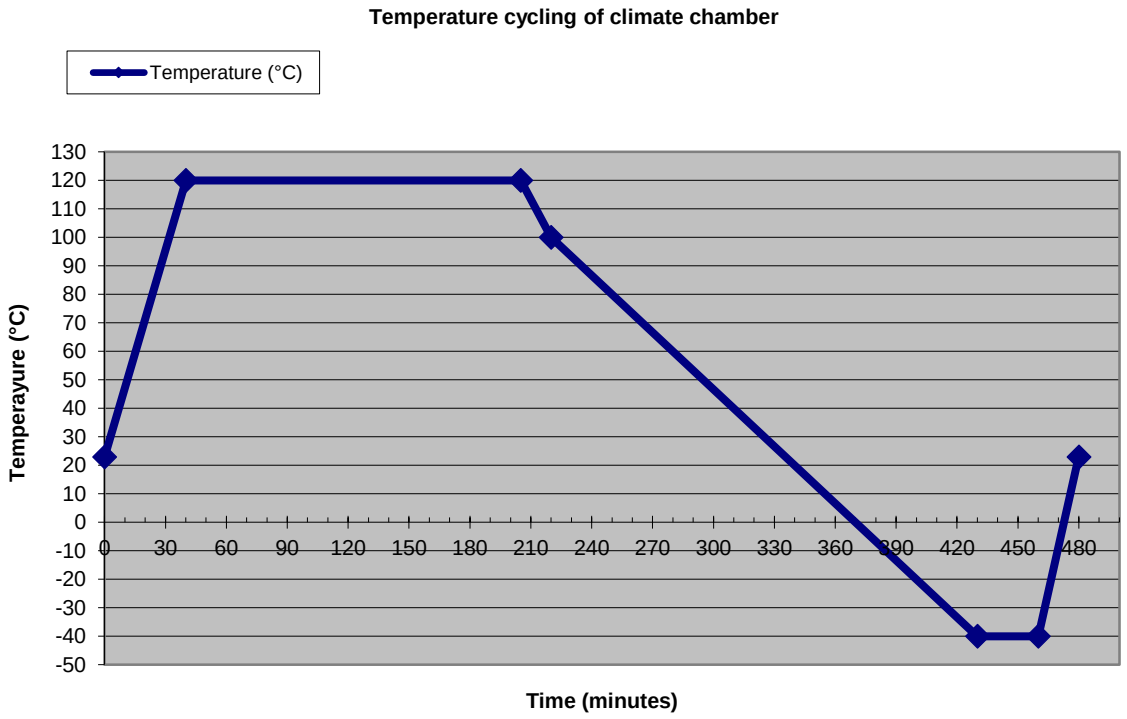


Figure 2. *Temperature cycle of climate chamber in PVT-test.*

Repeat the test starting with step 1-6 until 50 cycles (400h) are performed or failure occurs.

Acceptance criteria
No leakage.

Test report

- Note if/when gliding.
- Note material specification and hardness of hose.
- After test, disassembly clamp and/or quick connector and investigate if any cracks occurred together with CEVT verification responsible.
- Include temperature graph from one cycle of coolant outlet and a temperature graph from one cycle of climate chamber.
- Note flow of coolant in test.

3.4.5 Resistance to corrosion

The resistance to corrosion should be tested when a new clamp or a new supplier is chosen. It is not always necessary to test the resistance to corrosion when the hose material or the spigot material is changed this is to be decided after discussion with CEVT engineering department.

Test method:
The resistance to corrosion is tested according to Volvo VCS 1027,149 and 1027,1449, Volvo Indoor Corrosion Test (VICT). The test duration is 6 weeks.

- The hose clamps should be assembled on a hose on a spigot or mandrel.
- The hose material should be the same as in the application.
- The tightening torque should be “High band tension” according to Table 1.
- Six or more of each clamp variant should be tested. All tested clamps must fulfil the requirements for a variant to be approved.

The band, housing and screw are evaluated individually. The clamp is not approved when one or more of its components not is approved.

Acceptance criteria
General;
No galvanicly induced corrosion is allowed between hose and spigot or between hose and hose clamp.

A component with a surface treatment containing zinc;
Established white corrosion and only indications of red rust is acceptable after 6 weeks VICT. Slight red rust or worse is not acceptable.

A component made of stainless steel;
Only slight red rust on the cutting edges is acceptable after 6 weeks VICT. Established red rust on cutting edges and/or indications of red rust on other surfaces than cutting edges or worse is not acceptable.

A painted component;
White corrosion is only allowed on surfaces damaged while mounting after 6 weeks VICT. No blisters in the paint layer is allowed. No loss of paint is allowed.

Test report:
Include pictures of assembled clamps before and after test.
After test measure: dissembling torque, then free torque and finally deterioration torque.

3.4.6 Adhesion

On painted hose clamps the adhesion of the coating to the substrate should be tested.

Test method:
The test method is Volvo VCS 1029,54739, Adhesion. The test is to be carried out on the part itself, not on a test panel.

Acceptance criteria:
Grade 0 = Very good adhesion; no paint can be removed, according to scale of grade in VCS 1029,54739

3.4.7 Sealing

The resistance to leakage of the component shall be tested at two different temperatures according to the method below:

The test should be performed directly after previously conducted test. Leakage can be detected by coolant leakage or pressure. Each leakage test is performed for 5 minutes. Let sealing condition at least 2h at test temperature before start of leakage test.

Medium:	Coolant:
Pressure in heat:	Pressure acc. Table 2
Temperature (heat):	+130°C ± 5°C
Pressure in cold:	Pressure acc. Table 2
Temperature (cold):	-30°C ± 3°C

Requirement
No leakage.

3.4.8 Assembly force, pipe – quick connector

A spigot is assembled in a tensile testing machine. The quick connector is assembled on spigot with a speed of 50±10mm/min. If lubricant (assembly liquid) is used, it must be applied on the O-ring before the test. The test is performed at RT.

Acceptance criteria

VDA Quick connector:

Size	VDA 12	VDA 16	VDA 26	VDA 32
Assembly force	80 N	100 N	TBD	160 N

SAE Quick connector: See SAE J2044 AUG 2009

DN6 Quick connector: 50 N

3.4.9 Disassembly force, pipe – quick connector

A pipe assembled on a spigot is mounted in a tensile testing machine. The cooling pipe without looking clip is then pulled off the spigot. The pulling speed is 100±10 mm/min. The test is performed at RT.

Acceptance criteria
Pulling force required for dismounting shall be maximum 150N.

Test report
Note max force required for dismounting each test.
Note spigot outer diameter and quick connector internal diameter. Contact CEVT design department before measuring.

3.4.10 Impact test in cold environment

Two alternatives to measure cold impact are described below. Best suited method is chosen, method A or method B. Method A is suitable for flexible pipe and method B is suitable for non-flexible pipe, contact CEVT design department for guidance.

Before tensile test, all test pieces must be dry. Drying process: 24h in 110±3°C

Method A
A cooling hose is cooled to –35±3°C for at least four hours. As indicated in *Figure 3* a weight is dropped on the cooling hose from a height of 30 cm.

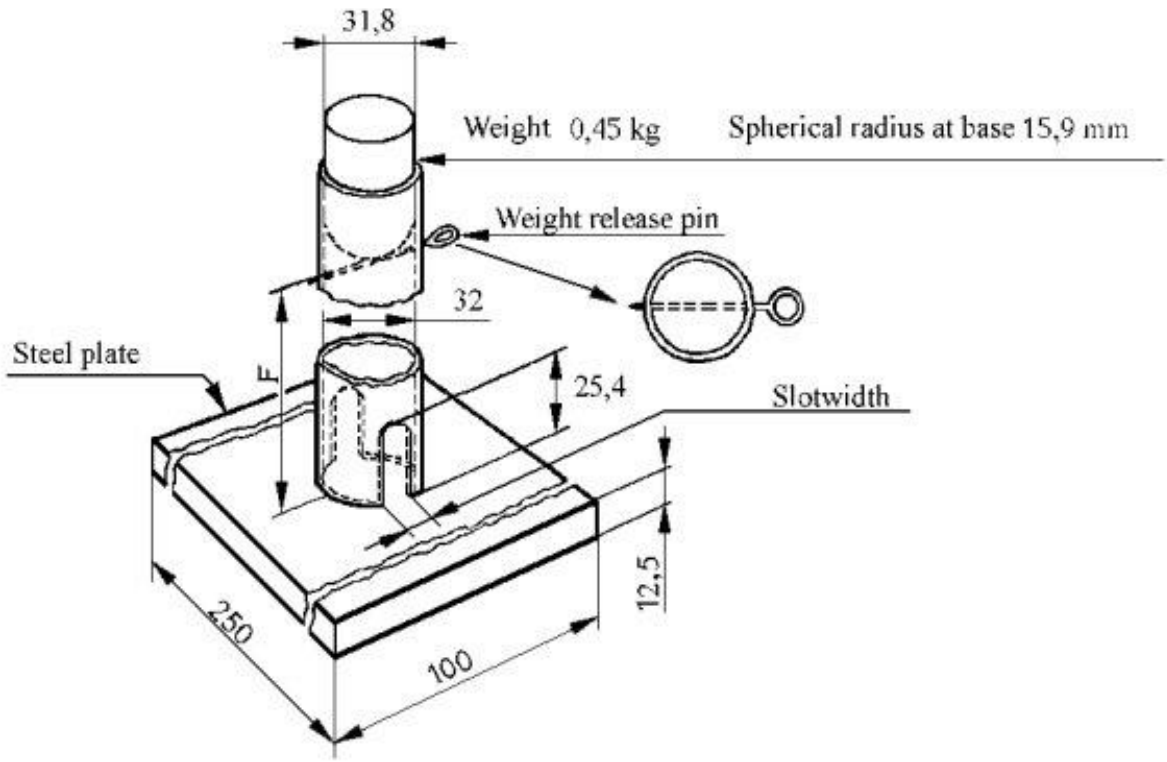


Figure 3. Test equipment for Impact test.

Method B
* Complete pipe shall be fitted onto a fixture.
* A steel ball (250±25 g) is dropped (0,8m) onto three different spots on the pipe (contact CEVT design department for guidance).
* The impact energy is 2Nm (m*g*h).
* The testing is to be performed at cold climate (-35°C±3C).

Acceptance criteria
No cracking is permitted.
This test is part of a sequence test. See Test flow chart.

Test report
Note failed or OK.
Note impact area at tested component with photo.

3.4.11 Leakage test

The complete pipes are pressurised and checked for leakage. Connections as in vehicle installation is used.
Test is performed under water and with air in the system.

Tightness requirements:	VCS 5089,19.
Medium:	Air.
Temperature:	RT
Pressure:	Pressure in Table 2 , Min 200 kPa

Acceptance criteria

Max leakage: 48 mm^3/s

Test report
Note failed or OK.
If failed note were leakage occurred.
Note leakage rate.

3.4.12 Static pressure test

The quick connector is assembled in a fixture in the same kind of fastening arrangement as per vehicle installation. The quick connector must be furnished with the same kind of hoses/pipes and other fastening arrangement as in vehicle. During the test, the quick connector assembly must be full with coolant.

Put the quick connector assembly into a heat chamber and add on the pressure.

Test parameters:

Temperature ambient:	120± 3 °C
Temperature coolant:	120± 3 °C
Gauge pressure, constant: see Table 2	
Time:	300h
Liquid:	70/30 blend of coolant/ water.

No circulation of coolant.

Document pressure during test. Visual inspection of complete quick connector assembly is made at least every 24h.

Acceptance criteria
No leakage.

Test report
Pressure diagram from testing.
Note time to leakage.
Document change of shape on both male and female part of the quick connector.

3.4.13 Pressure Temperature cycling test (engine mounted)

This test is valid for engine mounted hose sealing/quick connectors. Production status of spigots, hoses, clamps and quick connectors shall be assembled in a rig so that the ends of the hose obtain their theoretically correct position. Maximum length of hose is 400mm. If there are reasons not to use production status component in testing, contact CEVT.

Worm screw clamps shall be mounted with “Low band tension” according to Table 1.

A fluid consisting of glycol/water mixture (50/50) shall be allowed to flow through the hoses during the test. The pressure changes shall be regulated via the circulating fluid. See Table 2 for level of pressures in pressure cycling.

Below sequence, 1-6 will be performed.

1) Heat chamber from RT to a permanent temperature of 120°C (40 minutes)

a) Heating – coolant circulation	ON	temperature 120°C
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

2) Maintain chamber temperature of 120°C (2h + 45 minutes)

a) Heating – coolant circulation	ON	temperature 120°C
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

3) Reduce chamber temperature from 120°C to 100°C (15 minutes)

a) No heating – coolant circulation	ON	temperature RT
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

4) Reduce chamber temperature from 100°C to -40°C (3h + 30 minutes)

a) Heating – coolant circulation	OFF
b) Water pump	OFF
c) Vibration	OFF
d) Pressure cycling	OFF

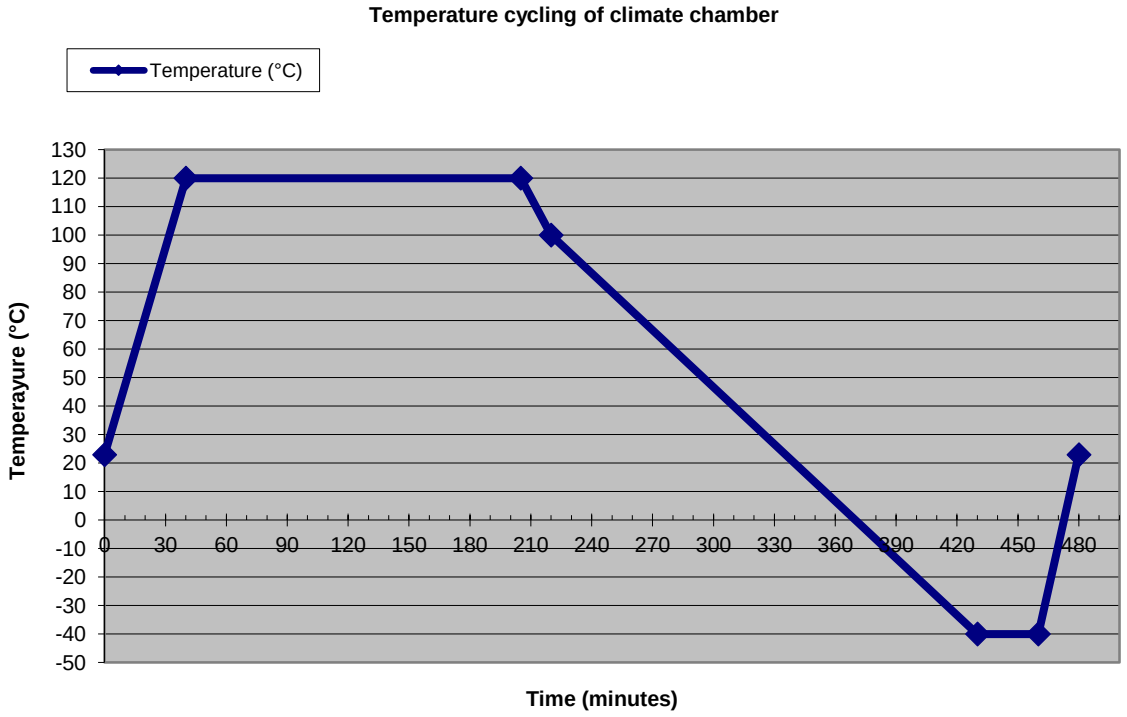
5) Maintain chamber temperature of -40°C (30 minutes)

a) Heating – coolant circulation	OFF
b) Water pump	OFF
c) Vibration	OFF
d) Pressure cycling	OFF

6) Heat chamber to a permanent temperature of RT°C (20 minutes)

a) Heating – coolant circulation	ON	temperature 120°C
b) Water pump	ON	flow > 10 l/min
c) Vibration	ON	
d) Pressure cycling	ON	

Figure 4. *Temperature cycle of climate chamber in PVT-test.*



Repeat the test starting with step 1-6 until 50 cycles (400h) are performed or failure occurs.

Acceptance criteria
No leakage.

Test report

Note if/when gliding.
Note material specification and hardness of hose.
After test, dismount clamp and/or quick connector and investigate if any cracks occurred together with CEVT-engineers.
Include temperature graph from one cycle of coolant outlet and a temperature graph from one cycle of climate chamber.
Note flow of coolant in test.

3.5 Vehicles tests

CEVT design department together with testing departments will decide, based on application, new- or re-design, which vehicle tests that have to be performed prior to start of production.

<< The requisite requirements, in excess of the ones indicated on drawing or any other requirement-specifying document, shall be stated and also the test conditions necessary for determining the requirements.

4. Guideline hose clamp sealing

4.1 Properties

This part (4.1 Properties) of TR contains tests that investigates hose clamps properties. There are no acceptance criteria for these tests. The results gives an understanding about hose clamp properties.

4.2 Worm screw clamp material specification

Table 4. Material specification for the most common hose clamps with worm screw.

Denotes	Band	Housing	Screw
W1	steel, often zinc-alloy surface*	steel, often zinc-alloyed surface*	steel, often yellow chromate on a zinc- alloyed surface
W2	stainless steel, quality 1.4016 or similar	stainless steel, quality 1.4016 or similar	steel, often yellow chromate on a zinc- alloyed surface
W3	stainless steel, quality 1.4016 or similar	stainless steel, quality 1.4016 or similar	stainless steel, quality 1.4016 or similar
W4	stainless steel, quality 1.4301 or similar	stainless steel, quality 1.4301 or similar	stainless steel, quality 1.4301 or similar
W5	stainless steel, quality 1.4401 or similar	stainless steel, quality 1.4401 or similar	stainless steel, quality 1.4401 or similar

* Often aluminium-zinc coating 150g/m^2, two sides = 10µm/side
Spring inserts are often made of stainless steel, the quality varies.

4.2.1 Uniform clamping force distribution

These tests investigate hose clamp force distribution. Only test results from the same test equipment with the same hose used could be compared to each other.
The test unit spigot contains of 8-channel force measurement. The diameter of test unit spigot will be the same as used spigot in vehicle, if other CEVT will decide diameter.

Test procedure
Calibrate force measurement on test unit spigot to zero.
New hose is assembled on test unit spigot. Note forces from hose and put to zero.
Tightened the clamp with the centre of band 15±2mm from spigot end. Use following assembling parameters: recommended nominal torque, 100rpm and electrical tool.
Measure forces immediately after assembled and note. Wait 3 minutes and measure the forces again and note result.

Test report
Note force distribution result in chart.
Note material specification and hardness of hose.
Note achieved assembly torque in test.

1-channel force measurement
This test investigate properties of clamps such as: free torque, deterioration torque, band tension force at nominal torque and deterioration torque of torque control cap if used.

Test procedure:
Tightened the clamp on the test mandrel. The test mandrel, see Figure 5, shall measure the force continuously during tightening. Torque speed 100 rpm. Tightening the clamp until failure.

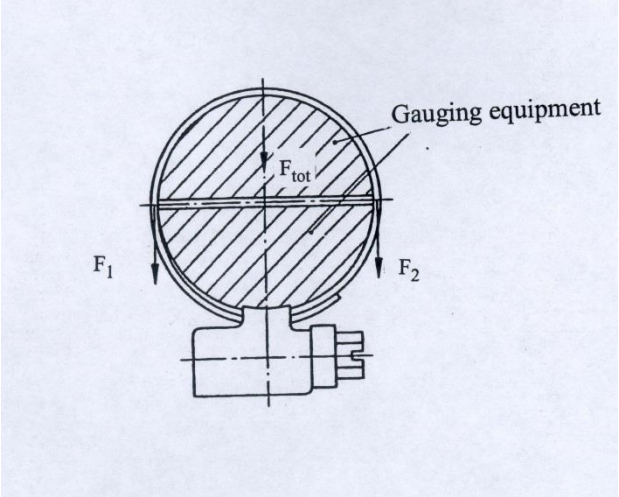


Figure 5. Equipment used when investigating band tension. $F_{tot} = F_1 + F_2$

Test report:
Free torque: Mean value of torque during the lap 2-5 before the band of the clamp enclosing the mandrel.
Deterioration torque: Torque when failure of clamp occur and the torque drops.
Deterioration torque of control cap: Torque when torque control cap break.
Band tension force at nominal torque according to CEVT/supplier recommendation.

4.2.2 Hose sealing relaxation in heat/cold cycle, 72h

A test unit according to *Figure 5* will be used to measure the force from a hose sealing. At least every 5 minutes the force are noted.

Assembly a hose on the test mandrel, see *Figure 5*. Put the force sensor to zero. The whole set up are adjusted at ambient temperature. Tightened the clamp with the centre of band 15±2mm from spigot end. The torque of clamp is chosen according to CEVT recommendation. Speed of torque 100rpm with electrical tool. The force measurements are started 10 minutes after assembling of hose sealing. The temperature cycles, see *Figure 6*, is started 20 minutes after assembly of hose sealing. Test duration are 6 temperature cycles (72h).

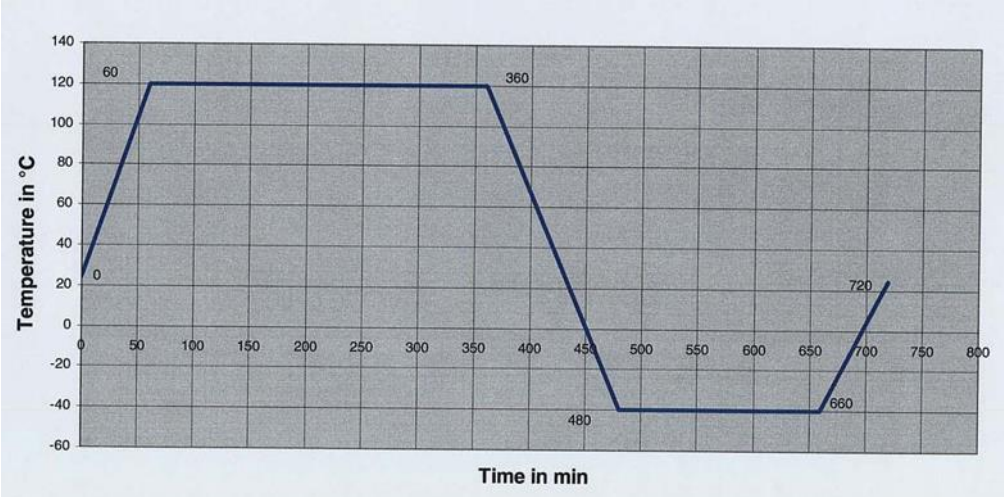


Figure 6. Temperature cycle in test "Hose sealing relaxation in heat/cold cycle, 72h".

Test report:
The results are documented in a chart (force/time).
Note torque of clamp.
Note hardness of hose and material specification.
Include climate chamber temperature graph.

4.2.3 Stress relaxation of rubber hose material in compression

Test equipment according to ISO 3384:1999(E), but with a test chamber with possibility to vary the temperature from –40°C to +110°C in cycles, and compression plates. Min 3 "measurement units" must be tested and reported. A measurement unit consists of 2 cylindrical test pieces cut out from the hose, ∅16 mm ±0,5mm with actual thickness of the hose stacked in order to obtain sufficient sample height. On shaped hoses the test piece is taken from the area where the hose clamp will be located. Compress the measurement unit at room temperature to 15±2% compression and maintain this level of compression during the complete test. The assembly of the test piece into the test equipment should max take 30 seconds. The temperature cycle according to ***Figure 6*** is started 20 minutes after mounting of measurement unit (after initial relaxation in room temp). Test duration is 5 temperature cycles (≥60h). Measure the counter force at least every 5 minutes. Repeat the test until all measurement units have been tested.

Acceptance criteria:
The minimum counter force value between 480 min and 660 min at the 5th cold cycle obtained after stress relaxation test at constant compression is min 30N at the conditions given below. Report the measured counter force according to below.

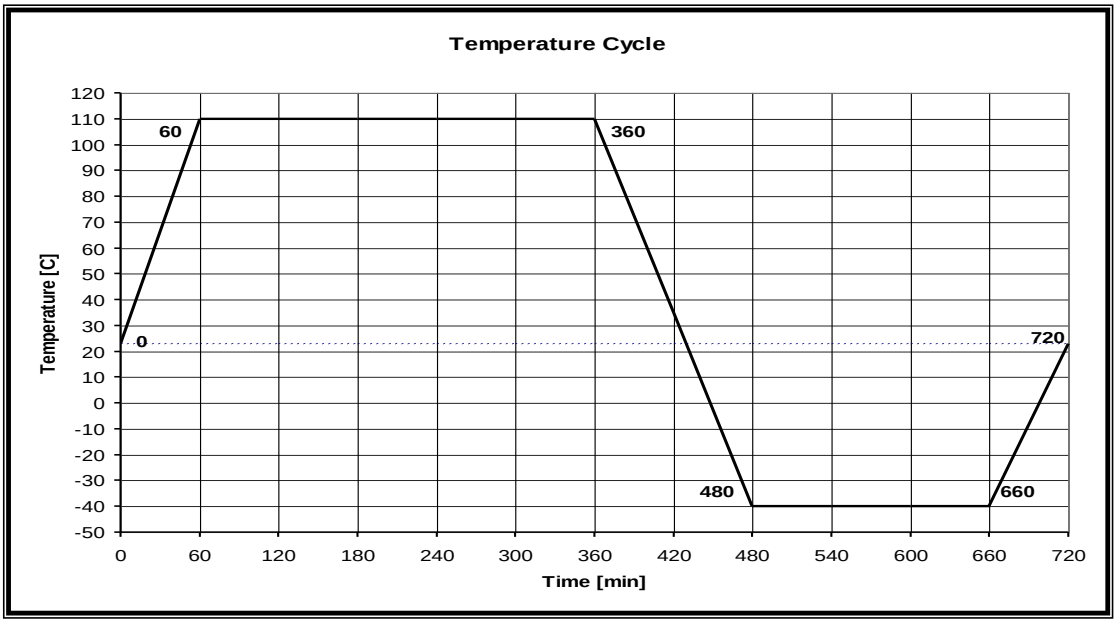


Figure 7. One temperature test cycle at the stress relaxation test.

Test report
A plot of the counter force and temperature as a function of time for each measurement unit. Summarise also the counter force measurement results for each measurement unit in a table with the following information:
Force level:

- after 10 min in room temperature.
- at 360 min at the first hot cycle.
- the minimum value between 480 min and 660 min at the first cold cycle.
- at 360 min at the 5th hot cycle.
- the minimum value between 480 min and 660 min at the 5th cold cycle.