Engineering Release Notice (ERN)	Location	Change Description A = Added D = Deleted W = Was	Document Release Status **RELEASED**	
		Changes from issue 01 to 02: see last page	Date	Modification Count

TABLE OF CONTENTS

Document Title
COOLANT HOSE
EPDM & SILICONE

VOLVO

Volvo 3P

Document Type
TECHNICAL REQUIREMENT

The legal owner of this document is stated as Design Location in KOLA and in associated Part Version Report

Document No	Issue Index	Volume No	Page No
20994097	**02**	**01**	**1(15)**

EDM-W 2000-04-01

1 REQUISITE DOCUMENTS

1.1 Drawing information

Drawing on actual hose including part documentation (PVR) and Category, see §3.2.
Drawing on concerned master hose (when applicable, see §2.2.2)

1.2 VOLVO Standards

黑名单

STD 100-0002	VOLVO black list – Chemicals that must not be used
STD 100-0003	VOLVO grey list
STD 105-0001	Critical characteristics 关键特点
STD 412-0001	Rubber
STD 1007,301	General delivery specifications, Rubber materials
STD 1024,1118	Compression set
STD 1024,2121	Tensile strength
STD 1024,2811	Adhesion strength
STD 1024,3716	Tearing strength
STD 1027,3231	Resistance to ozone
STD 1027,6131	Resistance of rubber materials to liquids
STD 5021,38	Product Approval (PA)
STD 5036,1	Initial sample approval (ISA)
STD 5051,16	Text marking on parts
STD 5065,21	Rules for measuring rubber parts
STD 5750,12	List of colours
STD 7411,182	Bulge Standard for pipes

And the standards referred to *inside* the standards listed here.

1.3 Independent standards

SAE J1684 JAN94	Test method for evaluating the electrochemical resistance of coolant system hoses
SAE J20 OCT97	Coolant system hoses
ISO 1629	Rubber and lattices – Nomenclature
ISO 4661-1	Rubber, vulcanized or thermoplastic – Preparation of test samples and test pieces.
ISO 3384:1999(E)	Determination of stress relaxation in compression at ambient and at elevated temperatures
ISO 9924-2	Thermo gravimetric analysis
ISO 812:1991	Cold impact

And the standards referred to *inside* the standards listed here.

1.4 Supplementary documents and information

Contact the responsible design department for any clarifications or supplementary information.

2 TECHNICAL REGULATION AND TYPE APPROVAL

2.1 About this TR

This TR states the test methods, performance requirements and delivery specifications which normally apply. **In case of deviations, the drawing and part documentation (PVR) applies.**

The purpose with the TR is to assure high durability and well performing coolant hoses by means of a selection of tests based on the functional environment described in §3, and to document material, construction and manufacturing methods of the hoses that fulfil the durability and performance requirements for future references.

This Technical Regulation (TR) is developed for an internally reinforced flexible coolant hose that distributes coolant - mixture of water, glycol, and additives - between the various components in the cooling and heating system of the engine, transmission, and the cab in the heavy and medium duty trucks at Volvo Group (VG).

2.2 TA – Type approval process

The responsible design department at Volvo Group (VG) gives type approvals.

The supplier provides VG design department with a test report (§2.4) and the requested tested material after completion of the type approval test. The supplier is also requested to send 12 new production hoses or other quantity agreed upon to design department for evaluation. These hoses must be produced in the same material and with the same manufacturing method as the tested hoses. VG normally also verify the hose quality in field tests and engine test cells. TA per Category is described in §3.1.

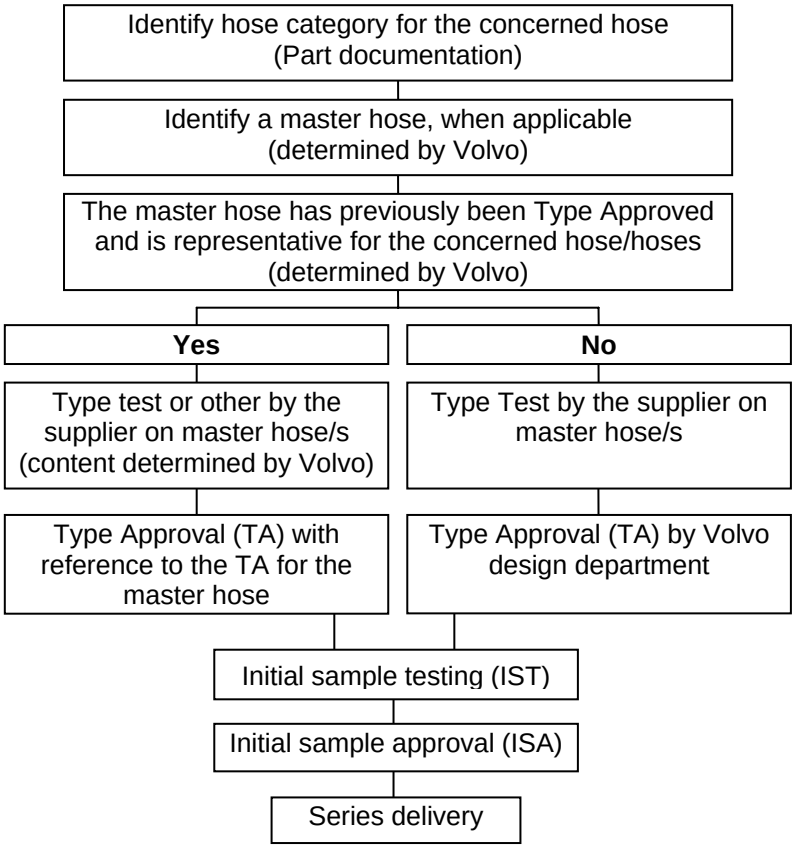

Figure 1: Type approval process in short

2.2.1 Type approval test

TA testing covers complete testing and documentation according to the TR, also read §3.1. Documentation should be stored for at least 5 years. Unless otherwise agreed, TA testing shall be performed when any of following applies:

- New supplier
- Currently approved supplier, but changed process, new hose quality, new material, new or untested master hose, etc.
- On regular basis by the supplier in order to assure the consistency of the process and product.
- On request from design department at Volvo Group.

2.2.2 Master hose

A master hose is a hose representative for one or several hose categories according to Table 2. The purpose with master hoses is to reduce the amount of testing without jeopardising quality. The master hose is normally selected from among the hoses intended for serial production at the concerned supplier. Note that for comparative test - the *same* master hose must be used.

A hose considered to be exposed to tougher conditions is selected as master hose. The hose is chosen by Volvo Group design department on a case-by-case basis, agreed together with the supplier. A master hose may be exchanged at introduction of a new hose, e.g. shorter, larger diameter, or other more complex shape than the previously approved master hose

2.3 IST and ISA – Initial sample testing and approval

Hoses for series production may not be delivered until the initial sample has been approved (ISA) according to STD 5036,1. Initial sample test is done on type approved hoses and the initial sample tests must in all respects agree with possible future series deliveries and must include at a minimum the following:

Confirmation of:

- the existence of a Type Approval granted by responsible design department

Determination of:

- Marking
- Dimensions and tolerances according to drawing
- Surface properties
- Cleanliness and transport handling
- Burst pressure
- Adhesion: rubber-rubber / rubber-reinforcement / rubber-inner liner
- Assembly performance
- Flexibility of the hose at room temperature

2.4 Test report and documentation

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 the Volvo Group. Report contents is described next to each test below and in the concerned standards and serves as a minimum specification of what the TR test report shall include. Use STD 1007,301 for reporting when applicable. The report must also include:

1. TR number and issue
2. Supplier identification number and supplier's designation
3. Test object: Hose part number, issue and Description of the design
4. Type test. If used: Master hose part number and issue
5. Reason for TR test (example: new supplier, new construction of the hose etc)
6. TR reviewed together with VG design department (date+reference/No)
7. Assessment of test equipment and evaluation methods by Volvo Group (date+reference/No)
8. Main test laboratory
9. Date, signature and clarification of signature

The following shall also be documented for each test in this TR:

- Test equipment
- Test object references (e.g. clamps, spigots) - when applicable
- Test method
- Test laboratory if other than main test laboratory (acc. to above)
- Date of the test

Any other pertinent details of the entire test and any relevant comments and observations

2.5 Delivery specifications and process control

All hoses referring to this TR shall be fully equivalent in all characteristics to those upon which Type Approval was originally granted. The supplier must have a process control that includes appropriate statistical tools used to analyse process production data.

No changes of the product after TA, such as material changes or production method changes, etc, are allowed on any hose without agreement and approval from Volvo Group. Nor may location of production and sub-supplier be changed before authorized Volvo approval.

Volvo Group may request an evaluation of the manufacturing process according to the 'Rubber Index' (RI) model, which is set up particularly for evaluation of rubber part production. Volvo Group reserves the rights to request protocols from the process control, such as material property identification or other, at any time to check that the values are consistent and equivalent to the values given in the TR test report.

3 FUNCTIONAL ENVIRONMENT

The hose is usually a formed hose, vulcanised on either a curved mandrel and/or on a straight mandrel with varying inner diameters, or a running length hose with constant inner diameter.

The hose is mounted onto pipe ends with interference fit – i.e. the pipe has slightly larger external diameter than the inner diameter of the hose - and secured with hose clamps. Glycerine, water or glycol may be used as an assembly aid to reduce friction.

The hoses are exposed to all types of climates and road conditions and exposed to heat from the powertrain. Externally, the hose is exposed to air and ozone, oil, grease, engine cleaning agents and salt spray from the road.

Besides vibrations induced by the road through the chassis, the hoses are exposed to vibrations generated by the truck itself, e.g. vibrations induced by the engine or power transmission relative to the chassis frame. In some cases the hose provides flexibility for the relative movement up to 40 mm peak to peak at 7Hz between the connecting pipe ends. Shaped hoses that take up a relative movement are provided with an arrow on the drawing.

	Property	***Specification***
环境温度	Ambient hose temperature:	**–40°C** to **+100°C**
冷却液温度	Normal coolant operating temperature (IOT):	**+85°C** to **+100°C**
最高冷却液温度	Highest coolant temperature, continuously:	**+110°C, peak +130°C.** 峰值
压力	Operating pressure (OP), see Category in PVR:	normally **45 kPa** up to **160** or **240 kPa** depending on the application. **Max 250 kPa.**
负压	Underpressure (UP)	**-10 kPa**

Table 1: Functional environment specifications

For pressures levels see also Table 2, §3.2. The coolant hose must also resist breaking pressure levels and over speed pressure levels verified in the burst tests in this TR.
In production, at the initial filling operation - vacuum filling - of the coolant in the system, and at hot shut down of the engine, the hose can be exposed to an underpressure of –10kPa.

3.1 Categories and Type approval

Category characteristics apply when referred to unless else is specified on drawing. Type approval of a master hose in one Category normally gives TA for all other hoses in the same Category or lower Categories, if hose design/construction is identical. Also read §2.1.

3.2 Design properties and Category characteristics

The coolant hoses are grouped into hose categories according to Table 2 depending on pressure level (P) and whether the hose is exposed to relative movement (M) or not. Hose exposed to movement have a vector in the drawing to define direction. The length of the vector describes the amplitude and is defined in Table 5, page 12.

软管种类

Hose category	Normal max operating pressure (OP)	Relative movement (M)
P160 or P160-M	160 kPa	The extension **–M** indicates that the hose is exposed to relative movement, **-Mh** indicates high movement. Without rel. movement a category would be for example P200.
P200-M	200 kPa	
P240-M	240 kPa	
P280-M	280 kPa	
P320-M	320 kPa	
P480-M	480 kPa	

Table 2: Specification of categories

3.2.1 Material compounds

The supplier is requested to suggest appropriate material. Responsible design department can specify material in the drawing or PVR, preferably agreed with supplier. Each hose can be specified with unique material, treatment or linings, depending on application. Examples: if a hose is exposed to oil, oil derivatives or high ambient temperatures it may be specified with protective liner or heat reflector in drawing or PVR.

3.2.2 Colours

The hoses shall be black if nothing else is stated in drawing or PVR. Protective liner or heat cover may be specified with significant colour clearly deviating from the rest of the hose.

4 TESTING – REQUIREMENTS AND RECOMMENDATIONS

It is strongly recommended to review the TR in detail together with the responsible design department at Volvo Group at an early stage before initiating any tests. The supplier must present to Volvo Group design department the appropriate test equipment and evaluation methods in order to meet TR requirements. The same applies if the supplier decides to perform tests at a third part. An assessment of the suppliers testing capabilities is recommended by means of a TR review and a visit to the supplier by authorized Volvo Group design representative.

Required test material, total:
Recommendation: summon test material early to save lead time. Table can be used for planning.

Test material		Lead time	Planned arrival	Ready to use	Comments
Hoses					
Spigots or pipe ends					
Worm screw / band clamp					
Rubber material test pieces					
Hose test pieces					
Coolant					

Table 3: Test material planning

Make sure to use correct test material, contact the responsible design department.
The hose should be mounted onto the pipe end and the hose clamps positioned according to specified assembly instruction. The hose clamps may not be re-used in the test.

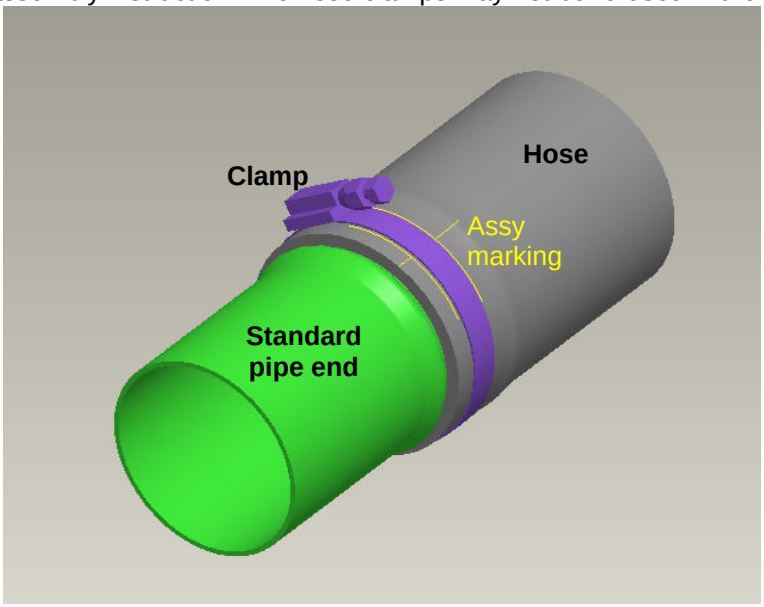

Figure 2. TR instruction describes clamp assembly, if nothing else is specified in drawing.

Note that, if a failure is experienced due to the hose clamp (the hose glides, slides off the pipe end or cracks by the clamp) while using hose clamps and assembly conditions according to above, alternative assembly or alternative clamps may be used to secure the hose firmly. The failure mode must however be reported in detail including the test conditions when the failure occurred (such as pressure level, etc) as well as the selected alternative. If cracks are present in the area by the clamp position, the damaged hoses should be sent to Volvo Group for analysis. Note also that an unsuitable shape of the hose may cause failure. Immediate feedback to the responsible design department at Volvo Group is therefore important.

4.1 Compression set: STD 1024,1118

压变测试

Scope: to determine basic material performance before initiating more advanced tests.

4.1a Performance requirements

According to Standard STD 412-0001.

4.1b Materials and equipment

According to Standard STD 412-0001.

4.1c Test procedure

According to Standard.

4.1d Test report

Use STD 1007,301 and see §2.4.

4.2 Resistance to liquid: STD 1027,6131

耐液体

Scope: Verify rubber material resistance to coolant liquid. 验证橡胶材料对冷却液的耐受性

4.2a Performance requirements

Maximum decrease of tensile strength: 30%. 强度降低最大30%

4.2b Materials and equipment

According to STD 1027,6131 and STD 1024,2121 but liquid(s) must be agreed with responsible design department.

4.2c Test procedure 试验过程

According to STD 1027,6131 and STD 1024,2121

4.2d Test report

Use STD 1007,301 and see §2.4.

4.3 Stress relaxation: ISO 3384:1999(E) 应力松弛

Scope: Sealing performance

4.3a Performance requirements

要求：在最后一个冷循环时，力≥20N

The minimum counterforce value between 480 min and 660 min at the 6th cold cycle obtained after stress relaxation test at constant compression is min 20N at the conditions given below.

4.3b Materials and equipment

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. Also see 4.3c.

4.3c Test procedure

Test procedure according to ISO 3384:1999(E), method A, with following deviations and additions: Minimum 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 × actual thickness of the hose stacked in order to obtain sufficient sample height. 最少测试3个.每个试块由2个从胶管刻下的试片组成

圆柱试块：φ16±0.5

高度：以管实际厚度堆叠

室温下施加压力250N大约压缩15%；

110°C、-40°C循环

每5分钟测试一下压力

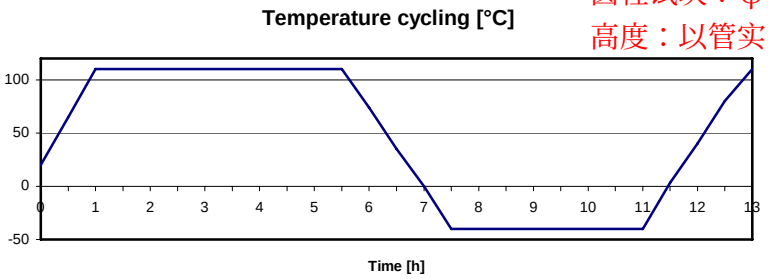

Diagram 1. One temperature test cycle in Stress relaxation test. Vary temperature between –40°C and +110°C. Test for 6 cycles in total.

Compress the measurement unit at room temperature so that a counterforce of (250+0/-5)N is obtained (approx 15% compression) and maintain this level of compression during the complete test. The temperature cycle according to diagram 1 above is started 20 minutes after mounting of measurement unit (after initial relaxation in room temp). Test duration is 6 temperature cycles (≥72h). Measure the counterforce continuously at least every 5 minutes. Repeat the test until all measurement units have been tested.

4.3d Test report

See STD 1007,301 and §2.4. Report the measured counterforce.

4.4 Adhesion between layers: STD 1024,2811

粘合强度

Scope: Performance of the hose as composite material. Manufacturing process control.

4.4a Performance requirements 性能要求

各层间粘合强度最小：2.0

The minimum adhesion strength is 2,0 kN/m between any of the various layers in the hose.

4.4b Materials and equipment

4 separate test pieces with the strip width 25±0,5 mm cut out from the hose.
Equipment required as per Volvo STD 1024,2811. 4片 25±0.5mm试片

4.4c Test procedure

As per Volvo STD 1024,2811: 180 degree pull direction. Rate of travel: 100±10 mm/minute

4.4d Test report

- As per STD 1007,301 and §2.4
- Adhesion strength for each test piece and each pair of layers.
- Document tested samples by means of photos so that the correct test piece size and position of extraction from the hose can be confirmed.

4.5 Cold impact test: ISO 812:1991 低温脆性

Scope: Brittleness at cold start-up.

4.5a Performance requirements

Visual examination according to Standard.

4.5b Material and equipment

According to Standard with 4 test pieces as Type A but cut out from hose: thickness as in hose.

4.5c Test procedure

According to Standard ISO 812:1991 Method B. Test temperature -40 ±2°C.

4.5d Test report

According to standard

4.6 Circumferential swell at overpressure 外径变化率

Scope: Volume change. Clearance to neighbouring components.

4.6.1 Performance requirements 内部110°C、2倍工作压力下，外径变化率≤10%，无渗漏裂纹等异常

Max 10% circumferential swell of the hose allowed when pressurized at 2xOP @ 110°C internal temperature, see Table1 (§3) and PVR. No leakage cracks or other defects may occur.

4.6.2 Material and equipment required

Pressure test equipment
Pressure media: fluid
Tape measure & marking pen
Min 1 hose, pipe ends and clamps 最少一根管子

4.6.3 Test method

A)管内部加液体，加压至2倍工作压力在室温下，按要求压力持续5min

Mount the hose onto pipe ends so that the hose ends obtain their theoretically correct relative position according to the drawing. Secure the hose with hose clamps.

A) Pressurize the hoses internally at room temperature, by use of a fluid, with the requested pressure during 5 minutes.
B) Pressurize the hoses internally at elevated temperature, 110°C, by use of a fluid, with the requested pressure during 5 minutes.

Keep the overpressure and measure the max value for the circumferential swell of the hose after these 5 minutes and mark the hose at that position. Document with photo(s) the shape of the hose when pressurized in order to understand how it will affect the clearance when installed.

Measure the circumference at the marked position again at atmospheric pressure
Document with photo(s) the shape of the hose again for reference and comparison with the previous photo(s)

Calculate the expansion.

4.6.4 Test report

- As per §2.4.
- The overpressure level.
- The max circumferential swell in %.
- The position of the max swell (and marking directly on the hose). 胶管最大膨胀位置标记于胶管上
- Photos with comments. 照片

Any remarks on clamps.

4.7 Collapse resistance test

Scope: Limit the flow restriction at low pressure levels, and preventing delaminating.

4.7a Performance requirements 10KPa×90°C×5min，外径变化率不得大于20%不得有脱层裂纹等不良

The smallest cross-sectional diameter measurement must not be less than 80% of the nominal dimension anywhere along the hose at an atmospheric underpressure of –10 kPa and 90°C. No delaminating, leakage, cracks or other defects may occur.

4.7b Material and equipment

Underpressure test equipment, pressure medium: air.
Tape measure & marking pen.
5 Hoses, hose clamps and pipe ends or spigots. 5根
Oven or heat chamber

4.7c Test procedure

首先将胶管加热到90°C然后负压将胶管吸瘪，标记吸瘪位置，然后撤去负压，5min后测量标记位置周长；然后负压10KPa，保持5min，测量标记位置周长，计算截面积。

Mount the hose on correct test pipe ends or spigots so that the hose ends obtain their theoretically correct relative position according to the drawing. Secure the hose with hose clamps and connect it to the underpressure equipment in the oven and heat it to 90°C.

Reduce the internal pressure until the hose collapses at its weakest area and mark that area. Unload to atmospheric pressure. Measure the hose circumference at the marked position after 5 minutes at atmospheric pressure.

Reduce pressure to atm. underpressure level –10 kPa, and keep it constant. Measure the circumference at the mark after 5 minutes and calculate reduction of cross-section dimension.

4.7d Test report

- See §2.4
- Cross section dimension reduction in % per hose and mean value. 每根胶管截面积减少值和均值
- Document the weakest position, preferably by a photo of the marked hose. 图片说明胶管吸瘪位置
- Any remarks on clamps.

4.8 Leakage test 泄露试验

Scope: Tightness at internal overpressure considering clamps and spigots

4.8a Performance requirements

Demand: Maximum leakage 2.5 cm^3/s. 最大泄露

4.8b Materials and equipment

Pressure test equipment with calibrated pressure gauges, pressure media: air. Soapy water.
Minimum 5 hoses, hose clamps, test spigots.
Hose plug or sealed test spigot.

4.8c Test procedure

Pressurize hose with air using OP±10% according to Table 1. Air temperature +25±5°C.
工作压力±10%，温度25±5℃

4.8d Test report

- As per STD 1007,301 and §2.4
- Leakage in [cm^3/s]
- Document where leakage occurs using soapy water. 记录说明位置发生泄露
- Any remarks on clamps or spigots.

4.9 Burst test 爆破试验

Scope: Resistance to over speed and peak pressure, investigation of material degradation, and possibility to follow up hose performance in the field. Evaluation of the hose/clamp/spigot joint.

4.9a Performance requirements 5倍工作压力；耐久试验后2倍工作压力；

New hose: minimum overpressure 5 × OP in Table 1 for the concerned hose category without leakage, cracks or other defects. After §4.6 Dynamic Endurance test: min 2 × OP.

4.9b Material and equipment

Pressure test equipment with calibrated pressure gauges, pressure media: air.
Minimum 5 hoses, hose clamps, test spigots. 至少5根
Hose plug or plugged test spigot.

4.9c Test procedure

1. Mount the hose onto appropriate spigots with one hose end plugged and free to move while the other hose end is kept fixed and connected to the pressure test equipment.
2. Assemble the hose clamps.
3. Insert pressure medium near the fixed hose end. Check leakage. 升压速率：1MPA/MIN
4. Increase the overpressure at a constant rate of 1 MPa/minute until the hose bursts, cracks or start leaking and note the pressure level at which this occurs. The burst pressure is defined by the maximum obtained pressure value at the test.

   Repeat for all hoses. Pre-shaped hoses: the free hose end must be the same at every test.

4.9d Test report

- As per STD 1007,301 and §2.4
- Max required overpressure resistance.
- Pre-shaped hose: document which hose end that was kept fixed during the test. 证明胶管两端被一直固定
- Max burst pressure for each hose and the mean value. 每一个胶管爆破压力和平均值
- Any remarks on clamps

4.10 Flexibility of pressurized hose

Scope: to indicate the level of load transmitted by the hose

4.10a Performance requirements

Pulling the hose end by 10mm 拉胶管10mm	max change 350N
Pushing the hose end by 10mm 退胶管10mm	max change 250N
For short hoses < 100 mm long	to be agreed with design department

4.10b Materials and equipment

Tensile test machine 拉力试验机

Minimum 5 hoses, hose clamps, test spigots. 至少5根胶管
Hose plug or plugged test spigot.

4.10c Test procedure

1. Mount the hose onto test equipment , using clamps and spigots as for vehicle installation. When applicable - use arrow in drawing for load direction.
2. Pressurize hose to OP, see Table 1. 加压1倍工作压力
3. Record the Change in force resulting due to movement from the installed nominal position.

4.10d Test report

- as per §2.4
- Change in force when compressing the hose by 10mm
- Change in force when extending the hose by 10mm

4.11 Dynamic endurance test 耐久测试

Scope: Decreasing performance of the hose at elevated temperature under simultaneous pressure and movement cycles. Delaminating between layers.

4.11a Performance requirements 爆破压力2倍工作压力

The hoses must pass the endurance test without any leakage, visible cracks or other defects. Burst pressure minimum 2 x OP (Table 1) according to §4.8c after passing the endurance test. Compare Leakage, Burst pressure, Brittleness in cold, and Adhesion between layers.
比较渗漏、低温脆性、层间附着力、爆破压力

4.11b Materials and equipment

5 hoses, 10 clamps, 10 pipe ends or spigots
Hose plugs, assembly fixture
Calibrated ageing oven with controlled and evenly distributed temperature.
Pressure test equipment
Pressure/Vibration/Temperature (PVT) cycling test facility.

4.11c Test procedure

- **Pre-ageing** 110±2°C，360h（15day）
  Attach the spigots or pipe ends to hose ends. Pre-age in oven at +110±2°C for 360 hours.
- **Pressure-Vibration-Temperature**
  Allow the hoses to cool down to room temperature and install them as test units in the rig. Do not disconnect the hose/clamp spigot during the test. The test unit must be assembled so that the hose ends obtain correct relative position given by the hose drawing. For hoses that take up a relative movement (-M), a vector in the drawing indicates direction. Amplitude values to be used should be according to Table 4, as indicated by the design department.

No marking	R=3 mm
Marked '-M'	R=20 mm
Marked '-Mh'	R=36 mm

Table 5: Amplitude values to be indicated by the design department.

根据表5、图2、图3给出的试验计划，从第1阶段开始，到第2阶段结束，依次进行耐久性试验。环境温度为(+110±2)℃

Perform the endurance test starting with phase 1, continuing with phase 2, etc according to the test plan given in Table 5, Diagram 2 and 3. The ambient temperature is (+110 ±2)°C.

PHASE	PRESSURE		MOVEMENT			TEMPERATURE	Approx. duration [h]
	Pressure levels [kPa]	Pressure cycles	Amplitude [mm]	Frequency [Hz]	Movement cycles		
1	90→OP→90	≥ 30.240	≥ ± R/6	≥7	≥ 4.233.600	Ambient temp. 110± 2°C	168
2	90→OP→90	≥ 21.600	≥ ± R/4	≥5	≥2.160.000	Coolant temperature IOT = 110 ± 2°C	120
3	90→OP→90	≥ 12.960	≥ ± R/2	≥3	≥777.600		72
4	90→OP→90	≥ 8.640	≥ ± R	≥2	≥345.600		48
	Total: ≥ 73.440 cycles		Total: ≥ 7.516.800 cycles				Total: 408

Table 5: Endurance test after pre-ageing. OP=operating pressure, R=movement vector, IOT=internal operating temperature, see Table 1.

Additional descriptions of endurance load cycles in diagrams below. Please contact design departments for any questions or comments before initiating test.

Pressure cycling (atmospheric overpressure)

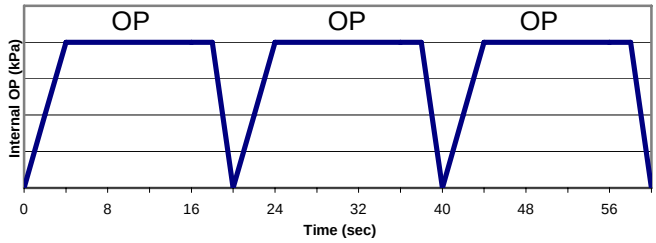

Diagram 2. Pressure cycles in one minute: One cycle = 20 seconds. OP, operating pressure level must not vary more than max 10% from the nominal values given in Table 2, page 6. Ramping up: 4 ± 1 sec.
Ramping down: 2 ± 1 sec.

Vibration amplitude

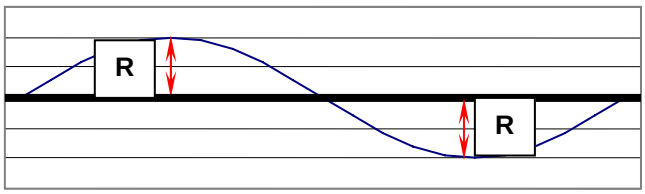

Diagram 3. Vibration amplitudes, see Table 5.
For hoses marked with –M (exposed to relative movement).

After Phase 5, follow-up by performing:

- ✓ **Leakage**
  Verify and compare according to §4.7b/c without disassembling the clamps/spigots. Use all 5 hoses from §4.10 above.

- ✓ **Burst pressure**
  Allow the hose to cool down to room temperature and verify Burst pressure according to §4.8b/c without disassembling the clamps/spigots. Use 4 hoses of the hoses above.

- ✓ **Cold Impact test**

Verify and compare according to §4.5b/c. Cut out 4 test pieces from 1 hose from 4.10.

- ✓ **Adhesion between layers**
  Verify and compare according to §4.4b/c. Cut out 4 test pieces from 1 hose, same as above.

4.11d Test report

- As per STD 1007,301 and §2.4
- Leakage: in [cm^3/s] and reduction (in %) compared with new hoses. 渗漏与新管比较
- Burst pressure reductions (in %) compared with new hoses.
- Cold impact: describe changes. 低温脆性
- Change in adhesion (in %) 粘合
- Protective liner/cover: describe with text and photo any cracks, splits, delaminating or other defects.
- Any remarks on clamps.
- All 5 samples used on the endurance test shall be submitted back to Volvo group design department.

NOTE**!: Keep failed area intact after the burst test for further inspection.**
保持失效胶管完整性

4.12 Assembly performance
装配性能

Scope: Ability to mount the hose onto the connecting pipe end without difficulty.

4.12a Performance requirements
要求最大推力50N，如果内径大于32，推力可以再适当的大点

Maximum push-on force 50N in general. For hoses with inner diameter > 32mm the push-on force may be higher, depending on application. To be agreed with responsible design department.

4.12b Materials and equipment

Tensile test machine.
Test piece: one 35±5 mm long straight hose cut from the hose end. 试片：35±5mm长胶管
One Pipe end according to standard.

4.12c Test procedure

Assemble the hose end rigidly in a vertical position. Locate the hose vertically on top of the pipe end and press the hose the dry pipe while measuring the counter force continuously. Repeat but now use soapy water from spray bottle.

4.12d Test report

- As per §2.4
- Size and date of manufacture of test samples. 测试样本的规格、生产日期
- Document with photos showing test equipment, samples and set-up. 图片显示装配
- Graph showing Force versus Time 图表显示推力及时间
- Comments and evaluation

4.13 TGA: ISO 9924-2, and IR

Scope: Material identification. Rubber compound (IR for type of material, TGA for contents). The supplier is requested to make an infrared (IR) and a thermo gravimetric analysis (TGA) of the rubber compounds in the hose

4.13a Performance requirements

Document the content of softener, polymer and ash for the rubber materials.

4.13b Materials and equipment

According to Standard.

4.13c Test procedure

TGA: according to standard ISO 9924-2.

4.13d Test report

- As per STD 1007,301 and §2.4
- IR spectra and Thermograms (TGA).
- Size and date of manufacture of test samples.
- Vulcanisation time, temperature and pressure when producing the test samples.

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CHANGES from previous TR20450330 to TR20994097

TA according to 20450330 issue 03 is valid also in TR20994097 issue 01 if following tests are re-tested and passed:

4.3, page 8
4.6, page 9
4.9, page 11

1. Purpose with new TR is to have common requirements within the Volvo Group.
2. It is mainly general info and Volvo routines that are excluded from the preceding TR20450330.
3. The 3 tests above are changed due to a quality issue at VTNA.
4. Dynamic endurance test shortened some, but increased in number of high amplitude cycles.
5. Definition of amplitude corrected in Diagram 3, page 13, and amplitude size accordingly.
6. Clamp assembly description replaced with reference to Assembly instruction.
7. Standard list has been updated.

CHANGES on issue 02

3.2 page 6- table 2, added pressure value P480
4.4c page 9- added details on the pull direction.
4.11c page12- added tabulated values for the displacement: table 5
4.11d page14- added requirement on returning hoses to Volvo design department.