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TECHNICAL SPECIFICATION FOR THE SUPPLY OF ELASTOMER CONNECTIONS FOR WATER PIPES OF COOLING AND HEATING SYSTEMS INSTALLED ON STOCK WITH INTERNAL COMBUSTION ENGINES

UPDATING

Leaflet 852-1, 2nd edition, 1-1-1983			
Amendment		Amendment	
No.	Date	No.	Date

CONTENTS

1 - PURPOSE

1.1 - Nature of the components

This specification governs the supply of elastomer connections used for water pipes of cooling and heating systems on railway rolling stock with heat engines for working pressures of 5 bars or less and working temperatures between - 30° C and + 115° C.

All the necessary details for the carrying into effect of the contract shall be indicated in the order or its appended documents.

1.2 - Classification

There are two categories of elastomer connections as follows : A and B.

1.3 - Reference documents

In the text of this specification reference is made to the following documents :

ISO Recommendation R 36	: Determination of the adhesion of vulcanized rubbers to textile
ISO Standard 37	: Vulcanized rubber - Tensile test - elongation
ISO Standard 48	: Vulcanized elastomers - Determination of hardness (hardness between 30 and 85 D.I.D.C.)
ISO Standard 188	: Vulcanized rubber - Tests for resistance to accelerated ageing or to heat
ISO Standard 1402	: Elastomer pipes - Hydrostatic tests

ISO Standard 1431 : Vulcanized elastomers - Determination of resistance to cracking due to ozone under static conditions

ISO Standard 1817 : Vulcanized rubbers - Resistance to liquids - Test methods

ISO Standard 2285 : Vulcanized rubbers - Determination of the residual deformation after constant elongation, at normal and high temperatures.

2 - CHARACTERISTICS

2.1 - Composition of the connections

The connections shall consist of tubing and a lining of elastomers, joined together by means of textile reinforcement giving sufficient resistance and elasticity to the piping forming the connection.

2.11 - Tubing and lining of the connection

The choice of elastomer, which must be strong enough to satisfy the characteristics of this specification, shall be left to the initiative of the supplier, who shall advise details of its nature to the purchasing Railway, at the latter's request.

2.1.2 - Reinforcement

The choice of the nature of the textile used for the reinforcement shall be left to the initiative of the supplier, who shall provide the purchasing Railway with relevant details, at the latter's request.

2.2 - Physical characteristics

2.2.1 - Appearance

The connections shall have clean-cut edges, without burring : the sections of the ends shall be perpendicular to the longitudinal axis of the connection. The surfaces shall be smooth, without cracking or other apparent defects likely to be detrimental to the use of the connections. A fine texture giving the appearance of canvas may be tolerated on the external surface of the lining.

2.2.2 - Geometrical characteristics

The dimensions and tolerances of the connections, prescribed in the order and its appended documents, shall be stipulated by the purchasing Railway.

However, the thickness of the tubing must not be less than 2.2 mm and, in the absence of provisions to the contrary, the thickness of the lining must not be less than 2 mm.

2.2.3 - Mechanical and physico-chemical characteristics

The mechanical and physico-chemical characteristics of the connections in categories A and B are defined in Tables 1 and 2 below.

2.3 - Manufacturer's brand marks

The connections shall be marked indelibly in accordance with the instructions given in the order and its appended documents.

Failing any instruction, the connections shall be marked as follows :

- with the mark of the supplier,
- with the nominal inside diameter of the connection,
- with the date of manufacture (No. of the month and last two figures of the year),
- with the reference to this technical specification.

The marks shall appear once on each connection and at least once every 10 cm of length in the case of an order per linear metre.

TABLE 1

CHARACTERISTICS OF THE CONNECTIONS

Description of the characteristics	Stipulated conditions	
	Category A	Category B
1 - Resistance to pressure		
- as ready for submission	with test pressure 10 bars - variation in the external diameter : $\leqslant$ 10 %	with test pressure 25 bars - variation in the external diameter : $\leqslant$ 7,5 % for 10 mm $\leqslant \phi <$ 30 mm $\leqslant$ 8 % for 30 mm $\leqslant \phi <$ 55 mm $\leqslant$ 8,5 % for 55 mm $\leqslant \phi <$ 65 mm $\leqslant$ 9 % for 65 mm $\leqslant \phi <$ 100 mm $\leqslant$ 10 % for 100 mm $\leqslant \phi$
- after the action of diesel fuel and treated water	same conditions as when ready for submission	–
- after action of water - after action of oil	–	same conditions as when ready for submission
	In addition, the connections under test pressure, as ready for submission, also after the action of liquids, must not show any leakage, rupture or tearing. After cancellation of the test pressure, there must be no permanent deformation after a waiting period of 5 minutes.	
2 - Bursting pressure P		
- as ready for submission	P $\geqslant$ 25 bars	P $\geqslant$ 40 bars
- after the action of diesel fuel and treated water	Δ P $\leqslant$ 30 % of the value obtained as ready for submission (1)	–
- after action of water - after action of oil	–	Δ P $\leqslant$ 30 % of the value obtained as ready for submission (1)
3 - Adhesion of the component parts		
- as ready for submission	$\geqslant$ 30 N/cm	$\geqslant$ 30 N/cm
- after the action of diesel fuel and treated water	$\geqslant$ 25 N/cm	–
- after action of water - after action of oil	–	$\geqslant$ 25 N/cm

(1) Δ P = variation in bursting pressure

TABLE 2

CHARACTERISTICS OF THE COMPONENT PARTS OF THE CONNECTIONS

Description of the characteristics	Stipulated conditions			
	Category A		Category B	
	Tubing	Lining	Tubing	Lining
1 - Mechanical characteristics				
1.1 - As ready for submission				
DIDC hardness	In accordance with the specific provisions of the purchasing Railway		55 to 65	55 to 65
Ultimate strength			$\geqslant$ 400 %	$\geqslant$ 400 %
Elongation at rupture				
Residual deformation with 100 % elongation	$\leqslant$ 20 %	–	$\leqslant$ 20 %	–
Dynamic fatigue under repeated tensile loads	no rupture before 400 tensile loads	no rupture before 400 tensile loads	no rupture before 400 tensile loads	no rupture before 400 tensile loads
1.2 - After accelerated thermal ageing :				
- 7 days at 70 °C				
variation in hardness				$\lvert\Delta D\rvert \leqslant 8$ (1)
variation in elongation at rupture				$\left\lvert\frac{\Delta A}{A}\right\rvert \leqslant 30$ % (1)
- 7 days at 125 °C				
variation in ultimate strength	$\left\lvert\frac{\Delta R}{R}\right\rvert \leqslant 20$ % (1)	$\left\lvert\frac{\Delta R}{R}\right\rvert \leqslant 20$ % (1)	–	–
variation in elongation at rupture	$\left\lvert\frac{\Delta A}{A}\right\rvert \leqslant 30$ % (1)	$\left\lvert\frac{\Delta A}{A}\right\rvert \leqslant 30$ % (1)	–	–
2 - Physico-chemical characteristics				
2.1 - Resistance to liquids				
- ethylene glycol (70 h at 95 °C)	–	–	$\lvert\Delta D\rvert \leqslant 10$ (1); $\frac{\lvert\Delta R\rvert}{R} < 30$ %	–
- treated water + ethylene glycol (70 h at 120 °C)	$\frac{\Delta V}{V} \leqslant 5$ % (1)	–	–	–
- oil No. 3 - 7 days at 20 °C	–	$\frac{\Delta V}{V} \leqslant 50$ % (1)		$-25 \leqslant \Delta D \leqslant +2$ (1); $\frac{\Delta V}{V} \leqslant 50$ %
- 7 days at 100 °C	$\frac{\Delta V}{V} \leqslant 20$% (1)	–	$-10 \leqslant \Delta D \leqslant +2$ (1); $\frac{\Delta V}{V} \leqslant 20$ %	
2.2 - Resistance to ozone				
- 8 h at 200 ppcm	–	no cracking	–	–
- 24 h at 50 ppcm	–	–	–	no cracking

(1) ΔD = variation in hardness
$\lvert\Delta D\rvert$ = variation in hardness in absolute value
ΔA = variation in elongation at rupture
$\lvert\Delta A\rvert$ = variation in elongation at rupture in absolute value
$\lvert\Delta R\rvert$ = variation in ultimate strength in absolute value
ΔV = variation in volume

3 - MANUFACTURE

3.1 - Approval of suppliers

The manufacture of the reinforced elastomer connections of water pipes for cooling and heating systems may only be entrusted to suppliers approved by the purchasing Railway.

3.2 - Certification of the connections

Before any mass-production takes place, the connections must have been certified by the purchasing Railway, under the conditions of para. 4.2.

Certification, when given, shall remain valid for connections of different dimensions but manufactured with the same elastomer, and the same textile reinforcement, and using the same process as the connections which have successfully undergone the certification procedure.

Certification must be renewed each time there is a modification which changes the characteristics of the connections, particularly in the case of any modification to the drawing of the connections, their manufacturing process or the nature of the component parts.

3.3 - Manufacture of the connections

The supplier shall be free to choose the manufacturing processes, subject to the connections complying fully with the provisions of this specification.

3.4 - Repairs

Any repairs intended to conceal a defect likely adversely to affect the in-service performance of the component shall be prohibited. Any other repair must have received the prior agreement of the purchasing Railway.

4.1 -Inspection of the manufacture

The representative of the purchasing Railway must be informed of any changes made to the manufacturing process.

4.2 - Certification

Certification is the specific inspection procedure for the initial manufacture of a supplier, which leads to acceptance or rejection of the manufacture of that supplier.

4.2.1- Composition of the batch of connections intended for certification

When certification is to be effected, a sample comprising at least 10 connections of the model to be certified shall be taken from and identified in a batch of connections manufactured under conditions prescribed for mass-production by the representative of the purchasing Railway.

4.2.2- State of connections subjected to the certification procedure

The connections shall be submitted in finished condition.

4.2.3- Organisation of the certification tests

The tests to which the connections must be subjected as part of the certification process shall be those constituting the type tests and indicated in Table 4 of para. 4.3.2.

4.3 - Acceptance inspection of the connections

4.3.1- Submission for acceptance

4.3.1.1- State of the connections on submission for acceptance

The connections shall be submitted for acceptance in delivery condition.

4.3.1.2- Sorting into batches and sampling for test purposes

The connections shall be submitted for acceptance in batches of the same type of 1 000 m maximum, emanating from the same manufacture.

The connections intended for the tests and checks shall be taken at random from each batch submitted and marked indelibly.

The number of tests to be carried out, depending on the size of the batches, is given in Table 3 below :

TABLE 3

Size of batches	Number of tests
up to 50 metres	1
51 to 150 metres	2
151 to 500 metres	3
above 500 metres	4

4.3.1.3- Advice of submission

The date of submission shall be advised to the representative of the purchasing Railway by written memorandum signed by the factory manager or his authorized representative ; this memorandum must indicate the number of connections forming each batch, the references of the order by which they are covered, and the results of the checks and tests which the supplier is required to have carried out beforehand on the items submitted in accordance with this specification.

4.3.2- Nature of the tests and checks

The connections shall be subjected to the type tests or mass-production tests listed in Table 4 below, either during the certification or acceptance inspection procedure.

TABLE 4

Nature of the checks and tests	Type test	Mass-production tests	Category concerned	Test method	Number of test pieces per test	Shapes and dimensions of the test pieces
Checking of appearance	X	X	A and B	§ 4.4.3.1	At the choice of the inspector of the purchasing Railway	The connection itself
Checking of dimensions	X	X	A and B	§ 4.4.3.2	At the choice of the inspector of the purchasing Railway	The connection itself
Test under pressure :						
- when ready for submission	X	X	A and B	§ 4.4.3.3	1	Section of connection of minimum length 200 mm
- after action of treated water/diesel fuel	X		A		1	
- after action of hot water	X		B		1	
- after action of oil	X		B		1	
Bursting test :						
- when ready for submission	X	X	A and B	§ 4.4.3.4	1	Section of connection of minimum length 200 mm
- after action of treated water/diesel fuel	X		A		1	
- after action of hot water	X		B		1	
- after action of oil	X		B		1	

Adhesion tests on component parts :						**Connection of internal diameter** > 25 mm : ring-shaped test piece : section of connection 35 mm to 40 mm in length taken from the connection or from a section of the connection which has undergone the corresponding ageing test. **Connection of internal diameter** ≤ 25 mm : Section of connection 200 mm in length taken from a part of the connection which has undergone the corresponding ageing test.
- when ready for submission	X	X	A and B	§ 4.4.3.5	2	
- after action of treated water/diesel fuel	X		A		2	
- after action of hot water	X		B		2	
- after action of oil	X		B		2	
Hardness test :						Test pieces taken from the connection itself or from a sample of the connection component which has previously undergone the corresponding ageing test or action of liquids.
- when ready for submission	X	X	A and B	§ 4.4.3.6	3 + 3	
- after thermal ageing	X	X	B		3 + 3	
- after action of ethylene glycol	X		B		3	
- after action of oil	X		B		3 + 3	

Nature of the checks and tests	Type test	Mass-production tests	Category concerned	Test method	Number of test pieces per test	Shapes and dimensions of the test pieces
Test for ultimate strength :						Dumb-bell shaped test pieces (see Appendix 1) as ready for submission, after action of ageing or of the corresponding liquid.
- as ready for submission	X	X	A	§ 4.4.3.7	3 + 3	
- after thermal ageing	X	X	A		3 + 3	
- after action of ethylene glycol	X		B		3	
Test for elongation at rupture :						Dumb-bell shaped test pieces (see Appendix 1) as ready for submission, after corresponding ageing.
- as ready for submission	X	X	A and B	§ 4.4.3.7	A { 3 + 3 / 3 + 3 } B { 3 / 3 }	
- after thermal ageing	X	X	A and B			
Test for residual deformation at elongation	X		A and B	§ 4.4.3.8	3	Dumb-bell shaped test pieces (see Appendix 1)

Dynamic fatigue test under repeated tensile loads	X	X	A and B	§ 4.4.3.9	2 | 2	Dumb-bell shaped test pieces (see Appendix 1) taken from the connection as ready for submission
Checking of the variation in volume :						
- after action of oil No. 3	X	X	A and B	§ 4.4.3.10	3 | 3	Test pieces whose volume is between 1 and 3 cm^3 and thickness 2 ± 0.2 mm
- after action of treated water + ethylene glycol	X		A		3	
Checking of the resistance to ozone	X		A and B	§ 4.4.3.11	3	Dumb-bell shaped test pieces as per Appendix 1.

The type tests shall be carried out in their entirety as part of the certification procedure for a type of connection.

The type tests can be renewed partly or completely in the course of a current manufacture, at the request of the representative of the purchasing Railway and, in particular, in the case of repeated rejections.

The mass-production tests shall be carried out on each submission of connections.

4.4 - Checks and tests

4.4.1 - Submission of test pieces

The test pieces necessary for the adhesion tests on the reinforcements are taken from the connection, either longitudinally for internal diameters $\leqslant$ 25 mm, or circumferentially for internal diameters $>$ 25 mm.

The test pieces necessary for the tests prescribed in paras 4.4.3.7, 4.4.3.8, 4.4.3.9, 4.4.3.11 are of type 2 of ISO Standard 37, and are taken in a circumferential direction for connections of internal diameter $>$ 25 mm, and longitudinally for connections of internal diameter $\leqslant$ 25 mm.

The test pieces necessary for the tests for resistance to liquids are those defined in ISO Standard 1817. They are taken longitudinally in the connection.

If the thickness of the test pieces is greater than the thickness prescribed, it must be reduced to that value by grinding or by suitable means, avoiding any heating.

4.4.2 - Treatment of test pieces

Certain characteristics of the connections or component parts of the connection shall be checked after ageing or action of liquids. The nature of the ageing and the procedures for obtaining the test pieces are defined below.

4.4.2.1- Thermal ageing

The test pieces intended for checking :

- the hardness,

- the ultimate strength,

- the elongation at rupture,

after accelerated thermal ageing, are taken from the lining and tubing of the connection as ready for submission and prepared in accordance with the instructions in § 4.4.1.

The test pieces shall be exposed to heat :

- for 7 days at 125 °C for connections in category A, and for
- 7 days at 70°C for connections in category B

under the conditions of ISO Standard 188.

4.4.2.2- Action of liquids

4.4.2.2.1 - Action of liquids on the connection

4.4.2.2.1.1 - Combined action of treated water and diesel fuel

The sample connection intended for checking :

- the resistance to pressure,

- the resistance to bursting,

- the adhesion of the component parts,

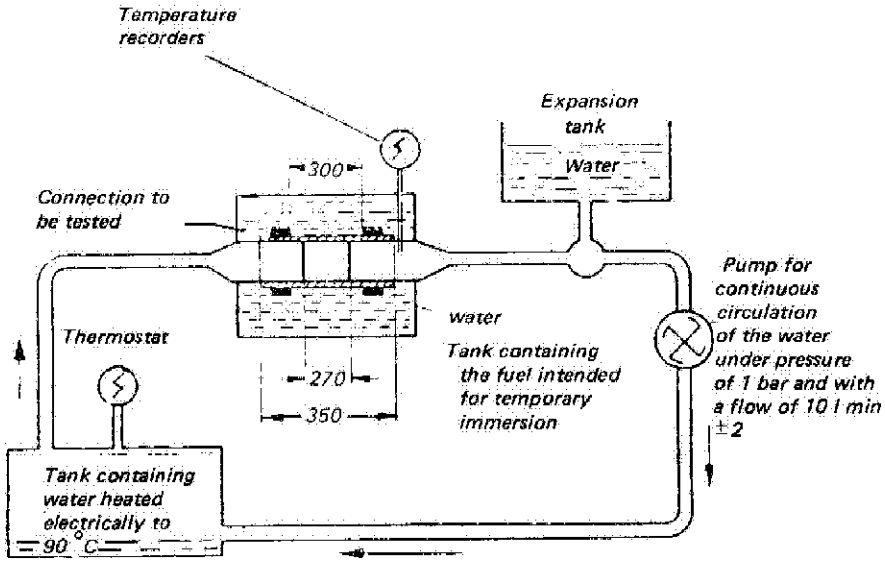
- the resistance to dynamic fatigue by repeated tensile loads,

shall be subjected internally for 240 hours to the action of a flow of treated water, brought up to and maintained at a temperature of 90°C.

At the beginning of the test, as soon as the water circulating in the section of the connection has reached its stable temperature, the external lining of the connection is completely immersed for 5 minutes by means of the testing apparatus shown in the diagram below, in diesel fuel previously heated and maintained at a temperature of 50°C.

After 5 minutes the connection, with the treated water inside continuing to flow, is withdrawn from the action of the diesel fuel without the lining being wiped.

After 120 hours the connection is again completely immersed in the diesel fuel under the same conditions of time and temperature as below and then withdrawn from it. Circulation of the treated water is maintained until the end of the test.



The water to be used for the test shall include an anti-corrosion product and/or an anti-freeze product, the nature and proportions of which shall be left to the initiative of the purchasing Railway.

The fuel to be used shall be a mixture of hydrocarbons of mineral or synthetic origin, intended particularly for internal combustion engines and with the following characteristics :

- Viscosity at 20°C : $\leqslant$ 9.5 mm^2/s

- Sulphur content : $\leqslant$ 0.90 % by mass

- Flash point : $\geqslant$ 55°C.

- Aniline point : 69°C ± 1.5°C

- Cetane index : $\geqslant$ 40

- Distillation : Less than 65 % at 250°C.

The sections of connection intended for checking the resistance to pressure and resistance to bursting are cut from the sample subjected to the combined action of treated water and diesel fuel.

The test pieces necessary for the checks on adhesion and resistance to repeated dynamic fatigue are taken from the sample subjected to the combined action of treated water and diesel fuel.

4.4.2.2.1.2 - Action of hot water

The sample connection intended for checking :

- the resistance to pressure,

- the resistance to bursting, and

- the adhesion of the component parts,

is sealed hermetically at one end and filled with distilled water. It is then placed vertically in an oven regulated at a temperature of 85°C ; its upper end is covered with watch glass. The piping is maintained at this temperature for 168 hours ; twice a day the level of the water in the piping is topped up with hot water. Following this treatment, the sample is emptied immediately and kept for one hour at ambient temperature.

The ends of the sample are then cropped to give a length of 20 mm and the test pieces necessary for the tests are cut from it.

The tests for resistance to pressure and bursting must be carried out no later than 2 hours after removal from the oven.

4.4.2.2.1.3 - Action of oil

The sample connections necessary for the test, also the procedures for the action of the liquid and the removal of test pieces, are identical to those defined in § 4.4.2.2.1.2. In this case, the distilled water is replaced by oil No. 3.

4.4.2.2.2 - Action of liquids on the component parts of the connections

The test pieces which are to be subjected to the action of liquids are selected, depending on the nature of the tests to be carried out, in accordance with the conditions defined in § 4.4.1.

The action of the liquids on the component parts of the connections shall take place in accordance with the conditions of ISO Standard 1817.

The test pieces shall be immersed, as the case may be, in the following immersion liquids :

- a solution of ethylene glycol in water (proportion by volume 50 % - 50 %) for 70 h at a temperature of 95°C, for connections in category B,

- a solution of treated water and ethylene glycol (proportion by volume 70 % - 30 %) for 70 hours at a temperature of 120°C for connections in category A. The nature of the anti-corrosion products and their concentration shall be stipulated by the purchasing Railway.

- oil No. 3, namely :

  - for 7 days at a temperature of 20°C for the tubing,

  - for 7 days at a temperature of 100°C for the external linings.

The immersion liquid must be renewed for each test.

4.4.3- Organisation of the checks and tests

4.4.3.1- Checking of the appearance

The conditions prescribed in § 2.2.1 must be observed.

4.4.3.2 - Checking of dimensions

The dimensions of the connections shall be measured by means of the usual instruments appropriate to the size of these parts and to the level of accuracy required.

For the internal diameter of the connections, truncated or graduated internal cylindrical gauges must be used.

The dimensions of the component parts of the connections shall be checked by means of a profile projector or equivalent method.

4.4.3.3 - Test under pressure

The test shall be carried out in accordance with the provisions of ISO Standard 1402.

The test piece shall consist of a section of connection approximately 200 mm in length secured loosely with collars on a perforated metal tube, with blocked ends, to allow for the application for 15 minutes of hydraulic pressure corresponding to the test pressure. The distance between collars must not be less than 150 mm.

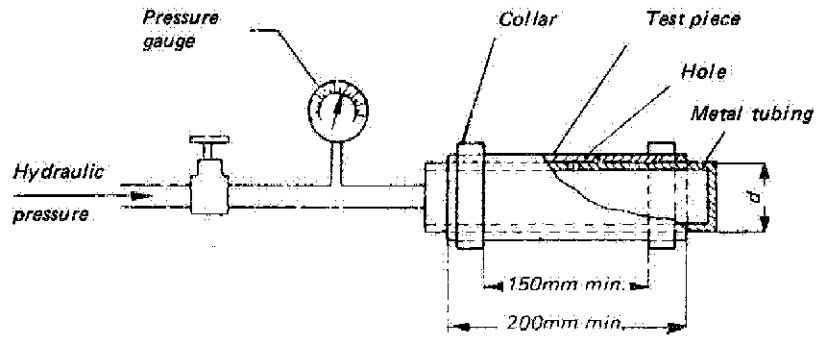
Before the test pressure is applied, the external diameter of the connection shall be measured after positioning, in its centre, to the nearest 0.5 mm.

The test pressure shall then be exerted on the connection.

The temperature of the water used shall be 20°C ± 2°C for connections in category A and, failing provision to the contrary, 90°C ± 2°C for connections in category B.

After 15 minutes, the diameter in the centre is measured again.

The principle of the assembly is given in the following diagram :



Depending on the categories of connections, the test pieces shall be subjected to the pressure test :

- as ready for submission,

- after action of the treated water and diesel fuel under the conditions of § 4.4.2.2.1.1

- after action of hot water or oil under the conditions of § 4.4.2.2.1.2 and § 4.4.2.2.1.3.

The connections must satisfy the requirements of § 2.2.3.

4.4.3.4 - Bursting test

Having undergone the pressure test, the connection shall then be subjected internally to a hydraulic pressure raised gradually from about 10 bars per minute, until bursting occurs.

Depending on the categories of connections, the test pieces shall be subjected to the bursting test :

- as ready for submission,

- after action of treated water and diesel fuel in accordance with the conditions of § 4.4.2.2.1.1,

- after action of hot water or oil in accordance with the conditions of § 4.4.2.2.1.2 and § 4.4.2.2.1.3.

The connections must satisfy the requirements of § 2.2.3.

4.4.3.5 - Test for adhesion of the reinforcements

The test pieces shall be taken, depending on the diameters of the connections, as indicated in § 4.4.1.

The lining and the reinforcement, and the tubing and the reinforcement, shall be separated in turn on a dynamometer in accordance with the provisions of ISO Recommendation R 36, and the efforts necessary to bring about separation shall be recorded.

Depending on the categories of connections, the test pieces shall be subjected to the adhesion test :

- as ready for submission,

- after action of treated water and diesel fuel in accordance with the conditions of § 4.4.2.2.1.1,

- after action of hot water or oil in accordance with the conditions of § 4.4.2.2.1.2 and § 4.4.2.2.1.3.

The connections must satisfy the requirements of § 2.2.3.

4.4.3.6 - Checking of hardness

Checking of hardness shall be carried out in accordance with the instructions in ISO Standard 48.

The test pieces shall be taken from the tubing or/and from the lining of the connection in accordance with the instructions in § 4.4.1.

Depending on the category of connection, the test pieces shall be subjected to checking of hardness :

- as ready for submission,

- after thermal ageing under the conditions of § 4.4.2.1,

- after action of ethylene glycol under the conditions of § 4.4.2.2.2,

- after action of oil :
  - No. 3 at 20° C,
  - No. 3 at 100° C.

under the conditions of § 4.4.2.2.2.

The connections must satisfy the requirements of § 2.2.3.

4.4.3.7 - Checking of the tensile strength

The checking of the ultimate strength and of the elongation at rupture shall be carried out in accordance with the instructions in ISO Standard 37.

The test piece chosen shall be that of type 2 defined in Appendix 1 to this leaflet.

The test pieces shall be taken from the tubing and/or lining of the connection in accordance with the instructions in § 4.4.1.

Depending on the category of connection, the test pieces shall be subjected to checking of the ultimate strength and/or eleongation at rupture :

- as ready for submission,

- after thermal ageing under the conditions of § 4.4.2.1,

- after action of ethylene glycol under the conditions of § 4.4.2.2.2.

The tensile strength as ready for submission and its variation after ageing must satisfy the requirements of § 2.2.3.

4.4.3.8 - Test for residual deformation by stretching of the tube when static

The test shall be carried out in accordance with the provisions of ISO Standard 2285.

The test pieces used shall be of the dumb-bell type as per Appendix 1. They shall be taken from the tubing of the connection in accordance with the instructions in § 4.4.1.

The length Lo of the calibrated part of the test piece shall be marked by lines on the concave surface. This distance Lo = 20 mm ± 0.2 mm shall be measured between the inside edges of the marks. The test pieces shall then be stretched so that the distance between marks is increased from Lo to 2 Lo ; they shall then be placed in an oven and maintained at a temperature of 70° C ± 1° C for 24 h $^{+0}_{-2}$ h.

The residual deformation is measured 30 minutes $^{+3}_{0}$ minutes after the test piece has been completely released from all stress.

The distance L between marks is measured between the internal edges of the marks to the nearest 0.1 mm, by means of a micrometric lens with a magnification of 7X.

The residual deformation resulting from stretching of the tubing of the connection when static shall be calculated by the formula.

$$\frac{L1 - Lo}{Ls - Lo} \times 100$$

- Lo being the initial length between marks,
- Ls being the reference length in the elongated state,
- L1 being the length measured after deformation.

The connections must satisfy the requirements of § 2.2.3.

4.4.3.9 - Dynamic fatigue test under repeated tensile loads on the tubing and lining

The test pieces shall be taken as indicated in § 4.4.1 from the tubing and from the lining as ready for submission.

Each test piece shall then be subjected, on a suitable machine, to successive tensile loads under the following conditions .

- the length Lo (20 mm) marked on the calibrated part of the test piece shall be increased to 2 Lo by an initial tensile load,

- the machine shall then be regulated so that the length 2 Lo is increased to 3 for each tensile load, and then reduced to 3 Lo. This operation shall be repeated at a frequency of 30 tensile loads per minute.

The connections must satisfy the requirements of § 2.2.3.

4.4.3.10 - Variation in Volume after action of liquids

The variation in volume after action of liquids shall be determined in accordance with the provisions of ISO Standard 1817.

The test pieces necessary for carrying out these tests shall be removed under the conditions defined in § 4.4.1.

Depending on the category of the connection, the test pieces shall be subjected to the action :

- of treated water and ethylene glycol,

- of oil No. 3, for 7 days at 20° C for the lining,

- of oil No. 3 for 7 days at 100° C for the tubing, under the conditions of § 4.4.2.2.2.

The connections must satisfy the requirements of § 2.2.3.

4.4.3.1.1. - Test for resistance to cracking due to ozone under static conditions of the lining.

The test must be carried out in accordance with ISO Standard 1431.

The test pieces of the dumb-bell type as per Appendix 1 selected in accordance with the instructions in § 4.4.1 from the lining of the connection, shall be elongated by 20 %, and then placed :

- for 8 hours in surroundings where the concentration of ozone is 200 ± 20 parts per 100 million by volume, for connections in category A,

- for 24 hours in surroundings where the concentration of ozone is 50 ± 5 parts per 100 million by volume, for connections in category B ; the temperature is maintained at 30° C ± 2° C throughout the test.

The test pieces shall be examined under tension by means of a lens with a magnification of 7X.

The connections must satisfy the requirements of § 2.2.3.

4.5 - Conclusion of the inspections

Any defect in appearance or any dimensional deviation likely to adversely affect their satisfactory use in service shall result in rejection of the connection or connections in question.

Any result not conforming to any one of the tests prescribed shall give rise to rejection of the corresponding batch.

Fresh tests may only be carried out, at the request of the supplier, with the prior agreement of the purchasing Railway.

5 - DELIVERY

The connections must be suitably protected against impacts.

Connections must not have been manufactured more than three months before delivery.

6 - GUARANTEE

The guarantee period of connections shall be three years against any defect due to manufacture and not detected during inspection at the factory.

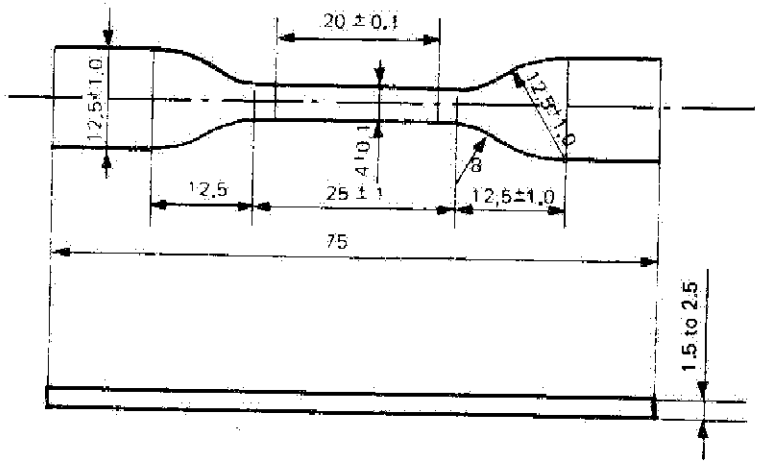
Connections which have been rejected because they do not conform, during the guarantee period, shall be maintained at the disposal of the supplier with a view to their replacement or reimbursement at their value in new condition at the time of withdrawal.

During any period of storage the connections must be conserved in straight lengths, laid flat in unstressed conditions, in ventilated premises maintained between temperatures of 10° C and 20° C and with a relative humidity of 65 %, away from light.

Under these conditions of storage, they must retain the characteristics stipulated in this specification during the corresponding guarantee period.

APPENDIX 1

TEST PIECE H 2 ISO 37



APPLICATION

All Railways in the Union.

RECORD REFERENCES

Headings under which the question has been dealt with :

- Preparation of standard specifications concerning the parts or component units used in the construction of Diesel locomotives or rail-cars.

a) Flexible pipes for fuel and oil ;

b) Flexible pipes for hot water ;

c) Electric cables resistant to water, fuel and oil.

(Vth Committee : Di. : Paris, June, 1957 ; Budapest, June, 1958).

- Finalising of revised UIC Leaflet No. 852-1 «Flexible connections for water cooling and for hot water pipes installed on stock with internal combustion engines».

(Sub-Committee for Specifications : Paris, January, 1982).