KQ 17602
July 1, 2011

Evaluation Guideline

for the KiwaQuality® product certificate for vulcanised rubber seals in plastic transport and storage systems for chemical liquids and gaseous fluids for industrial applications

Preface

This evaluation guideline has been accepted by the Kiwa Board of Experts "Plastics piping systems (LSK)", wherein all the relevant parties in the field of plastics piping systems for industrial applications are represented. These Boards of Experts also supervises the certification activities and where necessary require the evaluation guideline to be revised. All references to Board of Experts in this evaluation guideline pertain to the above mentioned Boards of Experts.

This evaluation guideline will be used by Kiwa in conjunction with the Kiwa-Regulations for Product Certification. This regulation details the method employed by Kiwa for conducting the necessary investigations prior to issuing the product certificate and the method of external control.

This evaluation guideline is to be assessed by the Board of Experts at least every 5 years, but at the latest on July 1, 2016.

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Validation
This evaluation guideline has been validated by the Director Certification and Inspection of Kiwa on July 1, 2011.

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1 Introduction

1.1 General

This evaluation guideline includes all relevant requirements which are adhered to by Kiwa as the basis for the issue and maintenance of a KiwaQuality® (KQ) product certificate for vulcanised rubber seals in plastic transport and storage systems for chemical liquids and gaseous fluids in industrial applications. In the further content of this evaluation guideline with the term “chemical liquid” is meant “chemical liquid and gaseous fluid”.

For the performance of its certification work, Kiwa is bound to the requirements as included in the clause 4.6 “conditions and procedures for granting, maintaining, extending, suspending and withdrawing certification” of EN 45011.

1.2 Field of application / scope

The products are intended to be applied as seals in plastic systems for the transport and storage of chemical (hazardous) liquids and gaseous fluids as well as of solid matter in fluids for industrial applications. Examples of industrial applications are installations in chemical plants, power plants, steel and metal industry, semiconductor industry and water treatment.

The intended systems comprehend plastic piping, fittings and connectors and plastic storage tanks. The systems are intended for underground as well as above ground applications. Pipes, fittings, connectors and tanks made of glass reinforced plastics (GRP) are also included in the scope.

Not covered by this evaluation guideline are:

- rubber elements that are part of the opening and closure function of valves, like seats in butterfly valves;
- rubber connecting elements, like flexible joints, compensators and hoses ;
- applications in the field of food and feed;
- vulcanised rubber products for drinking water applications; for these products the Kiwa Evaluation Guideline K17504 is applicable;
- vulcanised rubber pipe joint seals for waste water pipes; for these products the Kiwa Evaluation Guideline 2013 is applicable;
- vulcanised rubber seals for pipes and fittings for supply of gaseous fuels; for these products the Kiwa Gastec QA Approval Requirements 81 are applicable.

For applications especially in the field of transport of gaseous and chemical liquids national (legal) requirements, e.g. standards, evaluation guidelines, national certification scheme’s, may be applicable.

This evaluation guideline specifies the characteristics and requirements for vulcanised rubber seals for the intended applications. Seals made of thermoplastic elastomers (TPE) are not covered by this evaluation guideline.

For the certification of monolayer and multilayer plastic piping systems for industrial applications the Evaluation Guidelines KQ 17601 respectively KQ 17603 are applicable.

Remark: especially with regard to installation requirements it is advised to check whether any relevant (safety) regulations in respect of fire behaviour and explosion risk are applicable if applications are envisaged for inflammable media.

Certification is intended for actual products (seals). To reduce unnecessary testing it is also possible to issue a certificate on a rubber material intended to be used for the production of products afterwards. Having such a certificate will reduce the tests needed to be carried out on the actual products. An exception is made for O-rings with a protective surface coating, see 4.1.1.

1.3 Certification scheme in relation to chemical resistance testing

Within the framework of certification of vulcanised rubber seals for plastic transport and storage systems, the by the supplier proposed PAR (see 1.4) has to be confirmed by the certification body via the proposed tests and requirements of this evaluation guideline.

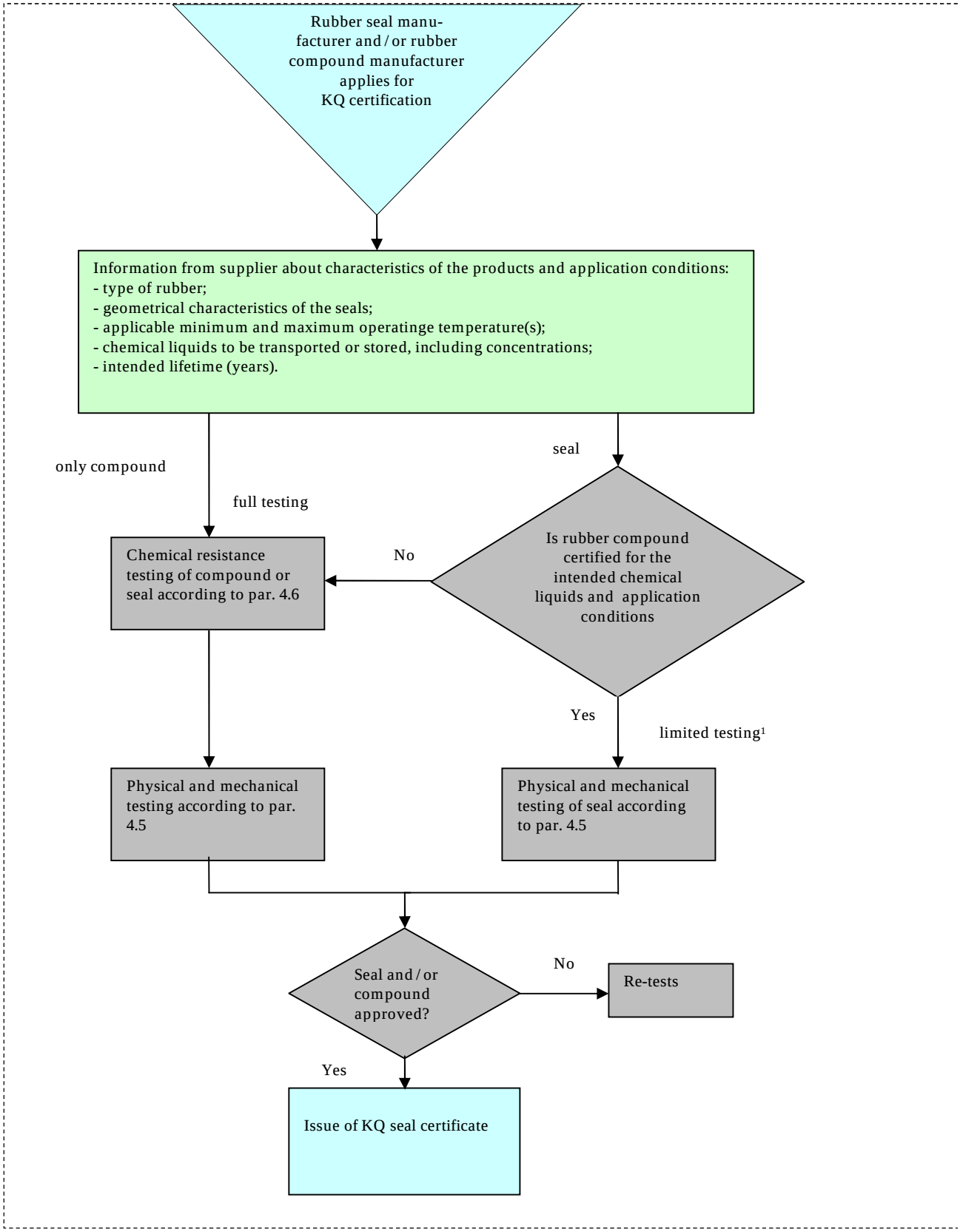
Within the framework of certification of a piping system (See evaluation guidelines KQ 17601 or KQ 17603) additional testing and approval takes place on the level of complete pipe constructions, including fittings with rubber seals that are certified according to this evaluation guideline.

1.4 Classification conditions: Product Approval Range

For each chemical liquid to be transported or stored in contact with the specified rubber seals, the product approval range (PAR) shall be stated by the supplier to Kiwa. On the basis of the specified PAR's, the test conditions for the tests are defined. When tested with positive result, the PAR's will be declared in the KQ-certificates to be issued.
The following has to be specified by the certification applicant for defining the PAR per chemical liquid to be transported or stored in contact with the specified rubber seals:

- the intended lifetime of the seals as applied in a system (years);
- the concentration profile, consisting of:
  - minimum concentration of the chemical liquid (%);
  - maximum concentration of the chemical liquid (%);
- the range of operating temperatures:
  - minimum operating temperature (T_{min} in ºC);
  - maximum operating temperature (T_{max} in ºC);
  - the time profile of the operating temperatures, if available;
- the periods of "wet" (system filled) and "dry" (system empty) condition, if applicable;
- the cleaning or maintenance regime, if applicable.

Figure 1: Flow chart of chemical resistance testing as part of certification process



[1] Not possible for rings with a protective surface coating

1.5 Acceptance of test reports provided by the supplier

When reports from test institutions or laboratories are produced by the supplier in order to demonstrate that the product meets the requirements of this evaluation guideline, the institute or laboratory shall meet one of the applicable accreditation norms, being;

- EN-ISO / IEC 17025 for laboratories;
- EN 45004 for inspection bodies;
- EN 45011 for certification bodies certifying products;

A certificate of accreditation shall be shown, either issued by the Board of Accreditation (RvA) or one of the institutions with which the RvA an agreement of mutual acceptance has been concluded. Kiwa reserves the right to verify whether the accreditation norm is fulfilled.

The accreditation shall refer to the examination as required in this evaluation guideline. When no certificate of accreditation can be shown, Kiwa will verify whether the accreditation norm is fulfilled.

1.6 Quality declaration

The quality declarations to be issued by Kiwa are described as KiwaQuality® (KQ) product certificate.
A model of the certificate to be issued on the basis of this evaluation guideline has been included as an annex.

1.7 Legal requirements

This evaluation guideline does not take into account any legal or other relevant requirements with regard to installation, safety, environmental aspects etc of the piping systems with rubber seals to be installed.

2 Terms and definitions

In this evaluation guideline the following terms and definitions are applicable:

Evaluation Guideline: the agreements made within the Board of Experts on the subject of certification.

Board of Experts: The Board of Experts ”Plastics piping systems (LSK)”.

Supplier: the party that is responsible for ensuring that the products meet and continue to meet the requirements on which the certification is based.
Note: the ‘Supplier’ may also be the manufacturer of the certified product(s).

IQC scheme: a description of the quality inspections carried out by the supplier as part of his quality system.

Product requirements: requirements made specific by means of measures or figures, focusing on (identifiable) characteristics of products and containing a limiting value to be achieved, which limiting value can be calculated or measured in an unequivocal manner.

Precertification evaluation: investigation in order to ascertain that all the requirements recorded in the evaluation guideline are met.

Inspection visit: the surveillance inspections and tests carried out after the certificate has been granted in order to ascertain whether the certified products continue to meet the requirements recorded in the evaluation guideline.

Remark
The test matrix contains a summary showing what tests Kiwa will carry out in the precertification stage and in the event of inspections as well as showing the frequency with which the inspection tests will be carried out.

Product certificate: a document, in which Kiwa declares that a product may, on delivery, be deemed to comply with the product specification recorded in the product certificate.

Product approval range (PAR):
Definition of the applicable and approved operating temperature range, the maximum concentration or concentration range of the chemical liquid and lifetime of the vulcanised rubber seal within a plastic system for a certain chemical liquid to be transported or stored. For each chemical liquid the accompanying PAR has to be defined and will be included in the KQ-certificate.

Minimum operating temperature T_{min} :
Temperature of the conveyed or stored chemical liquid related to the circumstances for which the rubber seal has been designed; to be declared by the supplier for each chemical liquid (part of the PAR).

Maximum operating temperature T_{max} :
Highest long term continuous operating temperature of the conveyed or stored chemical liquid related to the circumstances for which the rubber seal has been designed; to be declared by the supplier for each chemical liquid (part of the PAR).

Malfunctioning temperature T_{mal} :
Highest temperature that can be reached when the control limits are exceeded; to be declared by the supplier for a chemical liquid to be transported (part of the PAR). Within the definition according to NEN-ISO 10508 this can occur up to a total of 10 h over a period of 5 years.

3 Procedure for granting the quality declaration

3.1 Precertification tests

The precertification-tests to be performed are based on the (product) requirements as included in this evaluation guideline including the test methods and contain, depending on the nature of the product to be certified:

- type testing to determine whether the products comply with the product and / or functional requirements,
- Production Process Assessment,
- Assessment of the quality system and the IQC-scheme,
- Assessment on the presence and functioning of the remaining procedure.

3.2 Granting the quality declaration

After finishing the precertification tests the results are presented to the person deciding on granting of certificate. This person evaluates the results and decides whether the certificate can be granted or additional data and / or tests are necessary.

4 Requirements and test methods

4.1 General

In the next chapters the requirements and test methods are embodied to which vulcanised rubber seals for plastic transport and storage systems have to comply to. Based on the PAR a qualified material expert under the responsibility of Kiwa will set up the necessary evaluation program. This might include the steps for the first evaluation as mentioned in 4.6.

4.1.1 Types of rubber seals

4.1.1.1 Solid rubber products (e.g. gaskets and flange seals)

The rubber shall fulfil the requirements of this evaluation guideline in 4.3 until 4.6. Joints shall also fulfil the requirements in 4.7.1 and 4.7.2.

4.1.1.2 O-rings

The rubber shall fulfil the requirements of this evaluation guideline in 4.3 until 4.6. Joints shall also fulfil the requirements in 4.7.1 and 4.7.2.
In this evaluation guideline test methods for O-rings are included in annex H. In annex B a classification of O-ring sizes in groups is given. For each group the compression set at the relevant elevated temperature has to be verified before approval by a certification institute can be granted.

4.1.1.3 Rings with a flexible protective surface coating

This applies to surface coatings with the purpose of protecting the rubber of the ring being directly in contact to chemical liquids. The rubber shall fulfil the requirements of this evaluation guideline in 4.3 until 4.7. At the tests 4.5.5, 4.5.8 and 4.6 the exposure shall be performed on rings with the coating; the coated rings shall be elongated one time until 100 % elongation 24 hours before the start of these tests, unless a reduced elongation is prescribed by a qualified person.

4.1.1.4 Rubber products combining two different rubber compounds (i.e. a hard and a soft rubber)

Both rubbers shall fulfil the requirements of this evaluation guideline in 4.3 until 4.7. In cases where one of the rubbers is meant to be a kind of back up ring which has no contact at all with the medium transported or stored, only the rubber intended to be in contact with the medium shall fulfil all requirements. The rubber used for the back up function shall fulfil the requirements with respect to the mechanical properties (4.5). The adhesion between the two rubbers shall fulfil the requirements of 4.7.

4.1.1.5 Rubbers vulcanized or attached to rigid materials

The rubber shall fulfil the requirements of this evaluation guideline in 4.3 until 4.6. The adhesion between the rubber and the other material shall fulfil the requirements in 4.7.

4.1.1.6 Rubber products containing other rigid non-adhered materials (eg metal springs)

The rubber shall fulfil the requirements of this evaluation guideline in 4.3 until 4.6. The non rubber material shall not have a negative influence on the functioning of the rubber, for instance by having sharp edges that could cut the rubber under deformation. This shall be judged by deforming the complete assembly in a way as intended during use followed by an inspection for damage to the rubber (outside and inside).

4.1.1.7 Product containing voids (not porosity)

The rubber shall fulfil the requirements of this evaluation guideline in 4.3 until 4.6. Joints shall also fulfil the requirements in 4.7.1 and 4.7.2.
In cases where the part containing the void has to function in the same manner as a solid rubber the complete product shall fulfil the requirements for the compression set as given in section 4.5.6 measured at the place of the void.

4.2 Material

4.2.1 General

Within the scope of this evaluation guideline all types of vulcanised rubber, including blends, may be used for manufacturing products.

4.2.2 Homogeneity

All ingredients shall be mixed in the rubber homogeneously.

4.3 Functional requirements

4.3.1 General

The rubber products shall be suitable for the intended purpose. The design, the type(s) of rubber selected and the construction shall be such that, with regard to the type of application, a good sealing under normal circumstances is assured.

4.3.2 Effect of rubber products on the pipe and/or fitting material

The rubber products may not contain substances that, under normal circumstances (PAR), can have an adverse effect on the material of the pipes and fittings.
In case of doubt a suitable method to verify this can be taken out of ISO 3865.

4.4 Appearance, homogeneity, dimensions and volume

4.4.1 Appearance

The appearance of the rubber products shall comply with ISO 9691. For the appearance of O-rings also reference can be made to ISO 3601-3. The appearance is judged on, at least five, random selected rubber products.

4.4.2 Homogeneity

The rubber products may not contain foreign bodies and shall be free of cracks, entrapped air, bubbles or other irregularities, i.e. ISO 9691. For testing a random selection of at least five products shall be taken and they shall be cut in flat slices or parts of about 2 mm in thickness. The slices shall be stretched approximately 100% and the findings shall be recorded.

4.4.3 Dimensions and volume

The nominal measurements - and in case it is relevant for the application - the nominal volume of the rubber products and the acceptable deviations shall be in accordance with the figures stated by the manufacturer and they shall be laid down in a drawing. Tolerances shall be specified from the appropriate classes of ISO 3302. For dimensions of O-rings also reference could be made to ISO 3601-1.
The dimensions shall be determined by means of appropriate measuring equipment (see ISO 23529).
The volume shall be determined using the method as given in ISO 1817 with an accuracy of 1 mg by weighing the rubber products first in air and then in water.

4.5 Physical and mechanical properties of the rubber

4.5.1 General

Unless stated otherwise tests must be carried out at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) % according to ISO 23529.

4.5.2 Hardness

4.5.2.1 General

The hardness shall be suitable for the material and the construction of the joints for which the rubber products are intended.
Therefore the hardness shall be set in consultation between the supplier of the plastic transport or storage system and the supplier of the rubber products.
Then the hardness concerned shall be reported to the inspection body as nominal hardness with the tolerance range which has been determined by mutual consent.
Usually the tolerance range for the rubber is ± 5 IRHD. When the customer or the type of construction demands a tighter tolerance range, this can be ± 3 IRHD.
The hardness shall be determined according to ISO 48.
Only in the case where the form and the dimensions of the ring do not allow measurement according to the standard mentioned previously, or in case of a check measurement (non destructive), the apparent hardness shall be determined in a way which both parties (buyer and manufacturer) have agreed upon. In that case the following issues must be laid down and submitted to the certification institute, for approval: the nominal apparent hardness plus the corresponding tolerance, the method of measurement and the place(s) of measurement.

4.5.2.2 Difference in hardness

The difference in hardness (the difference between the highest and lowest value measured) of a product shall not exceed 5 IRHD.

4.5.3 Class of hardness

The products shall have a nominal hardness falling within the range of values of table 1. The manufacturer shall submit the value of this nominal hardness, which shall be within the range of a class of hardness. All other tolerances only apply within the nominal hardness range of one class, as specified in table 1.

Table 1 - Class of hardness

Class of hardness in IRHD	Tolerance range of hardness class in IRHD
40	$\geq$ 36 en $\leq$ 45
50	$\geq$ 46 en $\leq$ 55
60	$\geq$ 56 en $\leq$ 65
70	$\geq$ 66 en $\leq$ 75
80	$\geq$ 76 en $\leq$ 85
90	$\geq$ 86 en $\leq$ 95

4.5.4 Mechanical properties

Tear resistance measured according to ISO 34-2 shall be at least 20 N.
Tensile strength and elongation at break according to ISO 37 shall, depending on the class of hardness, meet the requirements laid down in table 2.
Dumbbell shaped test pieces of type 2 is the preferred type. The test report shall state the type whenever type 2 is not used. See 4.8.3 for more information.

Table 2: Tensile strength and elongation at break

Hardness class [IRHD]	Tensile strength [MPa]	Elongation at break [%]
40	9	250
50	9	225
60	9	175
70	9	130
80	9	100
90	9	80

4.5.5 Long-term resistance to thermal load

After exposure during period 2 in air at T_{max} + 30 °C in accordance with ISO 188 the properties mentioned in table 3 shall not deviate from the original value by more than the values as listed in column A. If the change of a property is bigger, then the deviation from the original value shall not be more than the values as listed in column B, and the change in properties between period 1 and period 2 of exposure shall be smaller than the change between the original value and period 1 of exposure (stabilisation of the material).
The duration of period 1 and period 2 depends on the declared intended service life, see table 4.
In case a time profile of the operating temperatures is available from the supplier, the qualified material expert (see 4.1) may decide to carry out the exposure at a different test temperature, based on an evaluation of this time-temperature profile.

Table 3: Maximum changes allowed after exposure

Property	A	B
Hardness	≤ 7 units	≤ 10 units
Tensile strength	Max 30 %	Max 35 %
Stress at 50 % elongation	Max 35 %	Max 45 %
Elongation at break	Max +10 / -30 %	Max +15 / -50 %

Table 4: Relation between service life and duration of exposure test

Declared service life [years]	Duration of test [days]	
	Period 1	Period 2
≤ 15	28	56
15 – 20	35	70
20 – 25	49	98
25 – 30	56	112
30 - 35	112	256

4.5.6 Compression set

The compression set of the rubber determined according to ISO 815-1 (small test pieces) using the test conditions of table 5 shall not exceed the values given in the table.
Where the cross section is too small to obtain compression set buttons from the product, the tension set may be determined using the method specified in ISO 2285 with a strain of 50%. For this alternative test method the same test conditions (except strain) and requirements apply as used for the determination of the compression set.
The low temperature value is determined after 30 minutes of recovery.

Table 5: Compression set

Test conditions			Maximum permanent deformation in relation to the compression in %			
Temperature [°C]	Duration of compression [h]	Compression [%]	Nominal hardness [IRHD]			
			40 - 50	60	70	80 - 90
T_{min}[1)]	72	25	40	50	50	60
23	72	25	12	12	15	15
T_{max}	24	25	20	20	20	20

[1)] The test at minimum operating temperature is not necessary when the used type of elastomer is known to function well at a lower service temperature (e.g. in case the declared minimum operating is higher than 20 ºC the test is not necessary for practically all types of elastomers). See 4.1.

4.5.7 Stress relaxation

The stress relaxation shall be determined in accordance with ISO 3384 (compression, method A small test pieces) or ISO 6914 (tension).
Minimum measurements shall be taken after 3 hrs, 1, 3, 7 days for the 7 day test and after 3 hrs, 1, 3, 7, 30, 100 days for the 100 days test. The values obtained by regression shall not exceed the maximum values given in table 6.

The 100 days test shall be considered as a type approval test.

The best fit straight line shall be determined by regression analysis using a logarithmic time scale. The 7 and 100 days requirements are those derived from this straight line.
If the test piece is taken from a product, the measurement shall be carried out as far as possible in the direction of compression of the product in service.
Where the cross section is too small to obtain compression buttons from the product, as an alternative to moulding buttons, the stress relaxation in tension of the product may be determined using method A specified in ISO 6914 with the same requirements as for stress relaxation in compression.
The test at high temperature is always carried out according to ISO 6914.

Table 6: Stress relaxation

Maximum stress relaxation in % after		
(ISO 3384 or ISO 6914)		(ISO 6914)
7 days at 23 °C	100 days at 23 °C	6 weeks at (T_{max} + 30) °C
15	22	30

In case a time profile of the operating temperatures is available from the supplier, the qualified material expert (see 4.1) may decide to carry out the test at high temperature at a different temperature, based on an evaluation of this time-temperature profile.

4.5.8 Resistance to ozone attack

This requirement does not need to be tested on rubber compounds that only contain intrinsic 100 % ozone resistant elastomers (e.g. 100 % EPM / EPDM, IIR, FKM, FFKM compounds). See 4.1.
The rubber shall show no cracks when tested in accordance with ISO 1431-1 method A under conditions as given in table 7A and table 7B.
The resistance class to be used should be established by mutual agreement between the supplier, the client and the inspection body depending on the intended use (see the explanatory notes under table 7).

Table 7A - Resistance to ozone attack

Class of resistance	Ozone concentration [pphm]	Period of exposure [h]	Temperature [°C]
I	50	120	40 ± 1
II	50	48	40 ± 1
III	25	48	40 ± 1

Table 7B - Elongation to be used in the ozone test

Hardness class [IRHD]	Elongation [%]
40 – 70	20 ± 2
80	15 ± 2
90	10 ± 1

Explanatory notes

Class of resistance I is intended for products with a high risk of attack by ozone, for instance in case of separately supplied products without sufficient packaging or in case of connections with preinstalled rubbers under elongation.

Class of resistance II is intended for products for which a normal resistance to ozone is required.

Class of resistance III is only permissible for rubbers which are never (partly) exposed to the open air when they are in tension. Transport should always take place in sealed packages.

4.6 Chemical resistance properties of the rubber

4.6.1 General

In order to certify the rubber seals, the PAR has to be approved for the chemical liquid / rubber seal combination. Most of the PAR has to be verified and approved after chemical resistance testing.

4.6.2 First evaluation moment

Provided that a number of chemical liquid / seal combinations are brought in by the supplier, the proposed chemical liquid / seal combinations will first be divided into the following categories:
- chemical interaction (with or without physical interaction) expected;
- only physical interaction expected;
- no interaction expected.

Chemical liquid / seal combinations will be grouped within these categories.
Secondly, the exact test conditions have to be determined that are to be applied for the test procedures. The tests according to 4.6.3 and 4.6.5 have to be carried out for the most aggressive chemical liquid and the most aggressive test condition per group.

4.6.2.1 Grouping

Chemical / seal combinations with the same lifetime and service conditions are grouped within a category. Only in the case of (a group of) chemical liquids having the same interaction on the rubber material and with the same declared lifetime and service conditions, the number of tests can be limited.

4.6.2.2 Determination of test conditions

On the basis of the test procedures according to 4.6.3 and 4.6.5, reliable test results have to be obtained from any chemical liquid / seal combination tested. This means that combinations with an on beforehand predictable interaction, as well as combinations with interactions which are regarded as 'less predictable" or "questionable" have to be able to be tested.
It has to be evaluated which type of interaction between chemical liquid and rubber is occurring, for example when the type of interaction is not known yet or cannot be predicted with certainty, or when 'non-conforming' interactions between the chemical and seal under the defined test conditions can be expected.
In principle testing will take place at maximum declared concentration of the PAR of the chemical liquid, although:

- in some cases a lower concentration may lead to a quicker chemical degradation than the maximum concentration;
- in some cases a combination of chemicals may lead to a higher physical and / or chemical interaction than each of the chemicals apart at the same concentration (e.g. a combination of strong inorganic acids);
- multi-component chemical liquids (blends) may lead to a higher physical and / or chemical interaction than the pure individual chemical liquids (e.g. the ethanol content in bio fuels).

Possible by-products of the chemicals to be transported or stored shall be taken into account also.
When it is expected that the highest interaction could be at a lower concentration or at unknown ratio (e.g. in multi-component liquids), test procedure I shall be carried out with at least 3 concentrations or ratios. If possible it can be decided to carry out test procedure I and II using one or more reference liquids according to ISO 1817, DIN 51604 or ASTM D471.

In case of volatile chemical liquids it might be the case that the rubber seal is (most of the time) in contact with the vapour phase of the liquid. Because the vapour phase can have a different composition than the liquid phase, especially in case of multi-component liquids, it is important to evaluate if the vapour phase could have a higher influence on the rubber than the liquid phase.

Test procedure I shall be carried out to cover all situations for all (group of) chemical liquid(s) / seal combinations.

4.6.3 Test procedure I

4.6.3.1 Influence of chemicals

Test procedure I consists of the program as outlined in table 8. The exposure tests in liquid shall be carried out in accordance with ISO 1817. The exposure tests in vapour shall be carried out based on the procedures according to ISO 1817 with the following adjustments:

- the exposure test is carried out in a sealed container;
- the container shall be filled with liquid for 1/3 of the volume;
- a grit shall be placed above the liquid to prevent contact between test pieces and test liquid.

Table 8: Test procedure I

	Tests in liquid		Tests in vapour[1)]		Tests in air
Property	A: 168 h at T_{max}	48 h at 40 °C in air, after A	48 h at 40 °C in air, after B	B: 168 h at T_{max}	C: 168 h at T_{max}
Change in hardness	x	x	x	x	x
Tensile properties Change in:					
- tensile strength	x			x	x
- elongation at break	x			x	x
- stress at 50 % elongation	x			x	x
Change in volume [%]	x	x	x	x	

[1)] only in case of contact with volatile vapour, see 4.6.2.2.

In case the change of volume test is performed as a quality control test (see 6.6) the following requirements are applicable, with respect to a maximum allowed deviation from the obtained value at the initial type test:

- max 2 % (absolute) at volume change ≤ 20 % (value at initial type test);
- max 10 % (relative) at volume change > 20 % (value at initial type test).

4.6.3.2 Extractable ingredients

The amount of extractable ingredients shall be determined by an extraction test according to ISO 1407, method A.

4.6.3.3 Global composition of the rubber

The global composition of the rubber shall be determined by thermo gravimetric analysis (TGA) in accordance with ISO 9924-3.

The results of 4.6.3.2 and 4.6.3.3 can be regarded as a “fingerprint” of the rubber compound.

4.6.4 Second evaluation moment

The results of test procedure I are evaluated with respect to the type of interaction that is expected to take place between chemical liquid and rubber for each declared PAR.
It might be the case that the results lead to the conclusion that exposure tests (4.6.3.1) have to be carried out again with adjusted test conditions (liquids).

The results of test procedure I indicate no chemical and no physical interaction between rubber and liquid or rubber and vapour in case of the following conditions:

- the changes in hardness obtained after exposition in liquid and in vapour are both smaller than the change obtained after exposition in air;
- the changes in tensile strength obtained after exposition in liquid and in vapour are both smaller than the change obtained after exposition in air;
- the changes in elongation at break obtained after exposition in liquid and in vapour are both smaller than the change obtained after exposition in air;
- the changes in stress at 50 % elongation obtained after exposition in liquid and in vapour are both smaller than the change obtained after exposition in air;
- the maximum change in volume after the required exposition tests in liquid and in vapour is between -3 and + 3 % for all tests.

In case all of these conditions are fulfilled no further testing is needed.

In case one or more of these conditions is not fulfilled, test procedure II as described in 4.6.5 is applicable. Based on the test results it is decided if the resistance tests are carried out in the liquid phase or the vapour phase and the other test details are chosen (e.g. the frequency of refreshing of test media) by the qualified material expert.

4.6.5 Test procedure II

4.6.5.1 Long-term resistance to chemical liquids

After exposure during period 2 in the referred chemical liquid or its vapour at T_{max} in accordance with ISO 1817 the properties mentioned in Table 9 shall not deviate from the original value by more than the values as listed in column A. If the change of a property is bigger, then the deviation from the original value shall not be more than the values as listed in column B, and the change in properties between period 1 and period 2 of exposure shall be smaller than the change between the original value and period 1 of exposure (stabilisation of the material).
The duration of period 1 and period 2 is depended on the declared intended service life, see table 4 in 4.5.5.

Table 9: Maximum changes allowed after exposure

Property	A	B
Hardness	≤ 7 units	≤ 10 units
Tensile strength	Max. 30 %	Max. 35 %
Stress at 50 % elongation	Max. 35 %	Max. 45 %
Elongation at break	Max. +10 / -30 %	Max. +15 / -50 %
Compression set	Max. 30 %	Max. 40 %
Volume change	Max. -3 / + 35 %	Max. -3 / + 40 %
Volume change after subsequent drying	Max. -5 %	Max. – 8 %

If the result of the assessment in the second evaluation moment (4.6.4) is that the interaction is only physical than period 1 is limited to 28 days and period 2 is limited to 56 days, regardless the service life.

4.6.5.2 Resistance to "dry-wet" cycling conditions

Only required if applicable according to the first evaluation moment.
This test comprises the following 24 h cycle:
At least 6 test pieces are mounted on a base plate in such a way that they have an elongation of 25 % and that one side of the test pieces is in contact with the base plate. Throughout the full test sequence the base plate is kept horizontal with the test pieces on top. The base plate shall consist of a material that is sufficiently resistant to the influence of chemical liquid and shall have a maximum surface roughness of 5 µm.
Alternatively at least 3 system assemblies including one seal each may be used.
The test pieces mounted on the base plate shall be immersed in liquid for 6 h at T_{max}.
Alternatively, the system assemblies shall be filled with liquid in such a way that the level of the liquid is higher than all parts of the seal, and then shall be exposed for 6 h at T_{max}.
After the exposure to liquid the test pieces mounted on the base plate shall be removed from the liquid. The system assemblies shall be emptied of liquid. It is important not to dry the test pieces or the system assemblies before immediately transferring them to a ventilated oven. The oven shall be operated for 18 h at a temperature of T_{max}.
The above mentioned cycle shall be repeated 12 times.

After exposure the test pieces or seals shall be inspected. The seals shall not show damages like cracks. The inspection shall be performed visually at approximately 100 % elongation. If the performance of the visual inspection is not applicable (depending on the properties of the test pieces e.g. diameter, hardness) or in case of any suspected change of the material, alternatively it shall be checked that the tensile strength and the stress at 50 % of elongation will not have changed more than 30 % when tested in accordance with ISO 37 on a minimum of 6 test pieces.

Remark: test pieces suitable for performing a tensile test shall be used.

4.7 Properties for special types of products

4.7.1 General requirements

A ring made of rubber which has been vulcanized in advance shall not contain more than one weld, separate from eventual joints between compounds, except by agreement between the manufacturer and the client.
A ring made from two compounds shall not contain more than one weld in the direction of the outline of the products.

4.7.2 Behaviour at elongation

4.7.2.1 Massive products with a weld or rings with a flexible protective surface coating

Elongate each rubber product with a weld or ring with a protective surface coating with a tensile speed of 500 mm / min to 100% elongation, unless a reduced elongation is prescribed by a qualified person. This must be reported to the inspection body. Keep the products or rings in an elongated state for at least 30 seconds. When tested the weld shall not crack or contract, or the coating shall not crack and shall not loose adhesion.

4.7.2.2 Products made from two compounds

Elongate test pieces containing the joint between the two materials with a tensile speed of 500 mm / min to 100% elongation. Keep the test pieces in an elongated state for at least 30 seconds. When tested the joint shall not crack or contract.

4.7.2.3 Durability test for welded products

The requirements for the tensile properties as specified in 4.5.5 and 4.6.5 shall also be met for test pieces that include the weld.

4.7.2.4 Adhesion between different types of rubber or between rubber and a rigid material

The adhesion between both types of rubber or between rubber and the other material shall be at least 100 N / 25 mm when tested according to ISO 813. In cases where the test piece is too small for a test according to ISO 813 the rubber shall tear and not detach when it is tried to separate the bond.

4.8 Sampling, test material and test pieces

4.8.1 Sampling

The sample shall be representative for the product to be checked and shall be taken out of a normal production lot.

4.8.2 Test material

4.8.2.1 Test pieces from products

If the dimensions of the rubber products are such that it is possible to take out the test pieces from them, the tests shall be carried out on such test pieces.
Depending on the dimensions of the products it is allowed and can be necessary to take test pieces with other (smaller) dimensions then those prescribed in the standards. A guideline for this preparation is given in annex G.

4.8.2.2 Test piece of complete product

In carrying out the tests according to 4.4 a complete rubber product or an unmachined part of a rubber product shall be used.

4.8.2.3 Test pieces from test plates

If the dimensions of the rubber products are such that the test pieces required cannot be manufactured from them, test plates produced in the manufacturer's own laboratory shall be used. Care has to be taken that the vulcanisation conditions for the sheets are similar to those for the products to obtain matching properties. Details with respect to the vulcanisation and the direction of milling shall be given to the inspection body.

4.8.3 Test pieces

The test pieces required shall, in accordance with ISO 23529, be made out of the products (see 4.8.2.1) or out of the test sheets (see 4.8.2.3).
By preparing test pieces out of actual products it is unavoidable that some deviations from the standards are allowed. For details see 4.8.2 and Annex G. In case the products are O-rings a more product specific approach is chosen. For such products the procedure as mentioned in Annex H shall be followed.

In cases where test sheets are used, the test pieces for tensile strength and elongation at break, as well as those for tear resistance, shall be taken perpendicular to the direction of milling and compression moulding or the direction of injection moulding flow.

5 Marking

5.1 General

The products have to be marked with following indelible marks and indications:

- supplier's name and / or trade name and / or system name and / or logo;
- nominal dimension or dimensions in mm;
- nominal outside diameter of the corresponding pipe in mm;
- production code (e.g. clock with indication of year and month);
- nominal hardness;
- type of rubber applied by means of the letter codes of the nomenclature according to ISO 1629; see Annex I for the most common abbreviations;
- on products from blends, the letter B ("blend") shall be placed behind de first letter code;
- the ozone resistance class ("Ozone I, II or III).

If the dimensions are such that the indications applied to them may impair the product, the products may be marked per package in consultation with the supplier, the buyer and the inspection body.
Products produced by cutting or die cutting out of sheets may be marked per package.

Recommendation:
It is practically not possible to mark the products with all approved PAR. All required information is laid down in the certificates to be issued. It is important and recommended that during as well as after installation the certificate is available at the end-user / owner.
Further, it is common practice that the designer or owner of the installation has an identification system for each transport or storage system (as well as for metal as other materials) for maintenance purposes. It is recommended to have an identification system available in all cases.

It is the responsibility of the certificate holder(s) to inform their customers, installers, end-users etc, about the contents of the KiwaQuality certificate(s). The version number and date of issue can be verified via the front page of the certificate(s) which are published on the Kiwa website.

5.2 Certification mark

After concluding a Kiwa certification agreement the certified products shall, beside the marks indicated in the respective standards, be indelible marked with the word mark "KQ® Industry" or "KiwaQuality® Industry".

6 Requirements in respect of the quality system

6.1 General

This chapter contains the requirements which have to be met by the supplier's quality system.

6.2 Manager of the quality system

Within the supplier's organizational structure an employee shall be appointed who is in charge of managing the supplier's quality system.

6.3 Internal quality control/quality plan

The supplier shall have implemented an internal quality control scheme (IQC scheme).

The following shall be demonstrably recorded in this IQC scheme:

- which aspects are checked by the producer;
- according to which methods such inspections are carried out;
- how often these inspections are carried out;
- in what way the inspection results are recorded and filed.

This IQC scheme should at least be an equivalent derivative of the model IQC scheme included in the addendum. The schedule must be detailed in such a way that it provides Kiwa sufficient confidence that requirements will be continuously fulfilled.

6.4 Procedures and working instructions

The supplier shall be able to submit the following:

- procedures for:
    - dealing with non-conforming products;
    - corrective actions to be taken if non-conformities are found;
    - dealing with complaints about products and / or services delivered;
- working instructions and inspection forms used;
- instructions for packaging and closing off of products during storage and transport.

6.5 External inspection

The supplier's quality system shall be assessed by Kiwa with regard to at least the aspects mentioned in the Kiwa-Regulations for Product Certification.
The Central Board of Experts will determine the inspection frequency. At the time of validation of this evaluation guideline this frequency has been fixed at 4 inspection visits per year.

6.6 Quality control of rubber products

The following routine tests shall be carried out according to the test methods mentioned in this evaluation guideline:

a. dimensions
b. surface imperfections
c. hardness
d. tensile strength and elongation at break
e. compression set for 24 hours at T_{max}
f. change in volume after immersion test 168 h at T_{max} in liquid, according to test procedure I, see 4.6.3.1

The product control tests shall be carried out on lots of finished components using sampling procedures in accordance with either:

a) ISO 2859-l with a specified inspection level of S2 and an AQL of 2,5 % for attributes; or
b) ISO 3951 with a specified inspection level of S3 and an AQL of 2,5 % for variables.

These requirements do not preclude the use by the manufacturer of more stringent combinations of inspection levels and AQL values from ISO 2859-1 and ISO 3951.

7 Summary of tests and inspections

This chapter contains a summary of tests and inspections to be carried out during:
Precertification evaluation: the investigation necessary in order to determine whether all requirements of the evaluation guideline are fulfilled,
Inspection visit: the surveillance inspections and tests carried out after issue of the certificate in order to determine whether the certified products continuously fulfil the requirements of this evaluation guideline. The inspections are carried out according to the frequency indicated.
Inspection of the quality system: inspection with regard to the correct implementation of the IQC-schedule and procedures.

7.1 Test matrix

Table 10

Description of requirement	Article KQ 17602	Tests within the scope of		
		Pre certification	Supervision by Kiwa after granting of certificate	
			Inspection[1)]	frequency (no./year)
Effect of rubber products on the pipe and / or fitting material	4.3.2	X	X[2)]	1x year
Appearance	4.4.1	X	X	1x year
Homogeneity	4.4.2	X	X	1x year
Dimensions and volume	4.4.3	X	X	1x year
Hardness	4.5.2	X	X	1x year
Mechanical properties	4.5.4	X	X	1x year
Resistance to thermal load	4.5.5	X	X	1x year
Compression set	4.5.6	X	X	1x year
Stress relaxation	4.5.7	X (100d)	X (7d)	1x year
Resistance to ozone attack	4.5.8	X	X	1x year
Chemical resistance	4.6	X	X[3)]	1x year
Behaviour at elongation	4.7.2	X	X	1x year
Marks to be applied	4.9	X	X	1x year

1) All product properties which can be determined within the inspection time (maximum 1 day) are determined by the inspector or by the certificate holder in presence of an inspector. When this is not possible arrangements, how inspection will take place, will be made for this aspect between the certification body and the certificate holder.

2) This aspect is compared on the basis of IQC inspection (indirectly by means of direct related parameters) with the aspect found for approval

3) Only in liquid, according to test procedure I, see 4.6.

7.2 Inspection of the quality system

The quality system will be checked by Kiwa on the basis of the IQC scheme.
The inspection contains at least those aspects mentioned in the Kiwa Regulations for Product certification

7.3 Change in design, in material and/or in the production method

Any changes in design, in material and / or in the production method - other than routine in-process adjustments, and / or extensions of the product range – having impact on the quality of the product(s), can lead to retesting, see 5.1. It is the responsibility of the certificate holder to inform Kiwa about relevant changes. Any retesting shall be agreed upon between the supplier and Kiwa.

8 Agreements on the implementation of certification

8.1 General

Beside the requirements included in this evaluation guideline, also the general rules for certification as included in the Kiwa Regulations for Product Certification apply.

These rules are in particular

- The general rules for conducting the precertification tests, to be distinguished in:
  - the way suppliers are to be informed about how an application is being handled,
  - how the test are conducted,
  - the decision to be taken as a result of the precertification tests.
- The general directions for conducting inspections and the aspects to be audited,
- The measurements to be taken by Kiwa in case of Non Conformities,
- Measurements taken by Kiwa in case of improper Use of Certificates, Certification Marks, Pictograms and Logos,
- Terms for termination of the certificate,
- The possibility to appeal to decisions of measurements taken by Kiwa.

8.2 Certification staff

The staff involved in the certification may be sub-divided into:

- certification experts: they are in charge of carrying out the precertification tests and assessing the inspectors' reports;
- inspectors: they are in charge of carrying out external inspections at the supplier's works;
- decision-makers: they are in charge of taking decisions in connection with the precertification tests carried out, continuing the certification in connection with the inspections carried out and taking decisions with respect to corrective actions;
- qualified material experts: they are in charge of the set up of the program and the evaluation of the precertification tests.

8.2.1 Qualification requirements

The following qualification requirements have been set by the Board of Experts for the subject matter of this Evaluation Guideline:

EN45011	Certification Expert	Inspector	Decision maker	Qualified Material Expert
Education - general	• Technical higher-level professional education • Internal training certification and Kiwa policy • Training auditing	• Intermediate-level professional education • Internal training certification and Kiwa policy • Training auditing	• Higher level professional education • Internal training certification and Kiwa policy • Training auditing	• Higher level professional education
Education - specific	• for evaluation guideline relevant technical education • specific studies and training (know-how and skills)	• for evaluation guideline relevant technical education • specific studies and training (know-how and skills)	• not applicable	• training and education in rubber technology
Experience - general	• 1 year of relevant work experience with at least 4 precertification tests of which one carried out independent under supervision.	• 1 year of relevant work experience with at least 4 inspections of which one carried out independent under supervision	• 4 year of relevant work experience with at least 1 year in certification	• 5 year of relevant work experience
Experience - specific	• Detailed knowledge of the evaluation guideline and 4 certification tests carried out on the basis of the guideline or one related.	• Detailed knowledge of the evaluation guideline and 4 inspections carried out on the basis of the guideline or one related.	• general knowledge of the evaluation guideline	• Detailed knowledge of the evaluation guideline • knowledge of life time prediction

The level of education and the experience of the certification staff involved should be demonstrably recorded.

8.2.2 Qualification

The qualification of the Certification staff shall be demonstrated by means of assessing the education and experience to the requirements mentioned before. In case staff is to be qualified on the basis of deflecting criteria, written records shall be kept.

The authority to qualify staff is dedicated to:

- decision makers: qualification of certification experts, inspectors and qualified material experts;
- Management of Kiwa: qualification of decision makers.

8.3 Report Precertification tests

Kiwa records the results of the precertification tests in a report. This report shall comply with the following requirements:

- completeness: the reports verdicts about all requirements included in the evaluation guideline,
- traceability: the findings on which the verdicts have been based shall be recorded traceable,
- basis for decision: the decision maker shall be able to base his decision on the findings included in the report.

8.4 Decision for granting the certificate

The decision for granting the certificate shall be made by a qualified decision maker which has not been involved in the precertification tests. The decision shall be recorded traceable.

8.5 Lay out of quality declaration

The product certificate shall be conform the model included as an annex

8.6 Nature and frequency of external inspections

The certification body shall carry out Audits at the supplier at regular intervals to check whether the supplier complies with his obligations. About the frequency of inspections the Board of Experts decides.
At the time this Evaluation Guideline took effect, the frequency was set at number of four inspection visits per year.

Inspections shall at least refer to:

- The supplier's IQC-scheme and the results obtained from inspections carried out by the supplier,
- The correct way of marking of certified products
- Complying with required procedures.

The results of each inspection shall be traceable recorded in a report.

8.7 Interpretation of requirements

The Board of Experts may record the interpretation of requirements of these evaluation guidelines in one separate interpretation document.

9 Mentioned documents

9.1 Standards / normative documents:

ISO 10508	Plastics piping systems for hot and cold water installations - Guidance for classification and design
EN 681-1	Elastomeric seals – Materials requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanised rubber
Amendment sheet EN 681-1 / A1	Elastomeric seals – Materials requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanised rubber
Amendment sheet EN 681-1 / A2	Elastomeric seals – Materials requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanised rubber
Corrigendum EN 681-1 / C1	Elastomeric seals – Materials requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanised rubber
DIN 51604-1	FAM testing fluid for polymer materials; Composition and requirements
DIN 51604-2	Methanolic FAM testing fluid for polymer materials; composition and requirements
DIN 51604-3	Methanolic lower layer FAM testing fluid for polymer materials; composition and requirements
ASTM D471	Standard Test Method for Rubber Property—Effect of Liquids
ISO 1629	Rubber and lattices – Nomenclature
ISO 34-2	Determination of the tear strength of small test pieces (Delft test pieces)
ISO 37	Rubber, vulcanised or thermoplastic - Determination of tensile stress - strain properties
ISO 48	Rubber, vulcanised or thermoplastic - Determination of hardness (hardness between 30 and 85 IRHD)
ISO 188	Rubber, vulcanised – Accelerated ageing or heat-resistance tests
ISO 813	Rubber, vulcanised - Determination of adhesion to metal: one-plate method
ISO 815-1	Rubber, vulcanised or thermoplastic - Determination of compression set at ambient, elevated or low temperatures
ISO 1431-1	Rubber, vulcanised or thermoplastic - Resistance to ozone cracking - Part 1: Static strain test
ISO 1817	Rubber, vulcanised – Determination of the effect of liquids

ISO 2285	Rubber, vulcanised or thermoplastic - Determination of tension set at normal and high temperatures
ISO 3302	Rubber - Dimensional tolerances for use with products
ISO 3384	Rubber, vulcanised or thermoplastic – Determination of stress relaxation in compression at ambient and at elevated temperatures
EN 3601-1	Fluid power systems - O-rings - Part 1: Inside diameters, cross-sections, tolerances and designation codes
ISO 3601-3	Fluid power systems - O-rings - Part 3: Quality acceptance criteria
ISO 3865	Rubber, vulcanized or thermoplastic - Methods of test for staining in contact with organic material
ISO 4661	Rubber, vulcanised or thermoplastic – Preparation of samples and test pieces
ISO 6914	Rubber, vulcanized; Determination of ageing characteristics by measurement of stress at a given elongation
ISO 9691	Rubber – Recommendation for the workmanship of pipe joint rings – Description and classification of imperfections
ISO 23529	Rubber – General procedures for preparing and conditioning test pieces for physical test methods

ANNEX A

Summary of the material requirements for rubber products and rubber sheets

Table 11: Summary of the requirements for the physical and mechanical properties of rubber products

Property	Units	Method	Requirement for hardness classes					
			40	50	60	70	80	90
Hardness (a, b)*	IRHD	ISO 48	± 5	± 5	± 5	± 5	± 5	± 5
Tear resistance Minimum	N	ISO 816	20	20	20	20	20	20
Tensile strength on sheet test piece	MPa	ISO 37	≥ 9	≥ 9	≥ 9	≥ 9	≥ 9	≥ 9
Tensile strength on product test piece (b)*	MPa	ISO 37	≥ 9	≥ 9	≥ 9	≥ 9	≥ 9	≥ 9
Elongation at break on sheet test piece	%	ISO 37	≥ 250	≥ 225	≥ 175	≥130	≥ 100	≥ 80
Elongation at break on product test piece (b)*	%	ISO 37	≥ 250	≥ 225	≥ 175	≥ 130	≥ 100	≥ 80
Ageing in air at T_{max} +30°C Period in table 4 (c) Change in:		ISO 188			A		B	
- hardness	IRHD	ISO 48			≤ 7		≤ 10	
- tensile strength	%	ISO 37			max 30		max 35	
- stress at 50% elongation	%	ISO 37			max 35		max 45	
- elongation	%	ISO 37			max +10 / - 30		max + 15 / - 50	
Compression set	%	ISO 815						
- 72 h, T_{min}		EN 681	≤ 40	≤ 40	≤ 50	≤ 50	≤ 60	≤ 60
- 72 h, 23°C		Annex B	≤ 12	≤ 12	≤ 12	≤ 15	≤ 15	≤ 15
- 24 h, T_{max} (b*)			≤ 20	≤ 20	≤ 20	≤ 20	≤ 20	≤ 20
Stress relaxation	%	ISO 6914						
- 168 h at 23°C (b*)		or	≤ 15	≤ 15	≤ 15	≤ 15	≤ 15	≤ 15
- 100 days at 23°C		ISO 3384	≤ 22	≤ 22	≤ 22	≤ 22	≤ 22	≤ 22
- 6 weeks at T_{max}+30°C			≤ 30	≤ 30	≤ 30	≤ 30	≤ 30	≤ 30
Ozone resistance	-	ISO						
Class I		1431 / 1	20 %	20 %	20 %	20 %	15 %	10 %
120h, 40°C, 50 pphm			No cracks	No cracks	No cracks	No cracks	No cracks	No cracks
Class II			20 %	20 %	20 %	20 %	15 %	10 %
48 h, 40°C, 50 pphm			No cracks	No cracks	No cracks	No cracks	No cracks	No cracks
Class III			20 %	20 %	20 %	20 %	15 %	10 %
48 h, 40°C, 25 pphm			No cracks	No cracks	No cracks	No cracks	No cracks	No cracks

a) When the customer or the type of construction demands such the tolerance range can be ± 3 IRHD.
b) Properties marked with (*) will be determined for a (reduced) test on product test pieces.
c) For detailed information see 4.5.5.

Table 12: Summary of the tests to carry out and the requirements for the chemical resistance of rubber products

Property	Units	Method					
Test procedure I			Tests in liquid		Tests in vapour [1)]		Tests in air
		ISO 1817	A: 168 h at T_{max}	48 h at 40 °C in air after A	B: 168 h at T_{max}	48 h at 40 °C in air after B	C: 168 h at T_{max}
Change in:							
- hardness		ISO 48	x	x	x	x	x
- tensile strength		ISO 37	x		x		x
- stress at 50% elongation		ISO 37	x		x		x
- elongation		ISO 37	x		x		x
- volume *		ISO 1817	x	x	x	x	
Deviation of change in volume compared to value at initial type test	%	ISO 1817	max 2 (absolute) or max 10 (relative) (f)				
Extractable ingredients		ISO 1407 Meth A	x				
Global composition (TGA)		ISO 9924-3	x				
Test Procedure II							
Ageing in liquid or vapour at T_{max} Period in table 4 (d)		ISO 1817		A		B	
Change in:							
- hardness	IRHD	ISO 48		≤ 7		≤ 10	
- tensile strength	%	ISO 37		max 30		max 35	
- stress at 50% elongation	%	ISO 37		max 35		max 45	
- elongation	%	ISO 37		max +10 / - 30		max + 15 / - 50	
- compression set	%	ISO 815		≤ 30		≤ 40	
- volume	%	ISO 1817		max – 3 / + 35		max – 3 / + 40	
- volume after subsequent drying	%	ISO 1817		max – 5		max – 8	

[1)] Only in case of contact with volatile vapour, see 4.6.2.2.

d) For detailed information see 4.6.3 until 4.6.5.

e) Properties marked with (*) will be determined for a (reduced) test on product test pieces.

f) Only for routine control test. For detailed information see 4.6.3.1.

ANNEX B

Categorisation of O-ring sizes

Table 11: Categorisation of O-ring sizes in groups

Groups of products	Cross section diameter	
	Minimum [mm]	Maximum [mm]
A	0,8	1,5
B	1,5	2,5
C	2,5	5
D	5	8
E	8	12
F	12	20
G	20	30
H	> 30	-

ANNEX C
Explanations (informative)

C.1 Explanations

C.1.1 Permanent seal under load

When applying seals in pipe fittings it must be kept in mind that under the load and the own weight of the pipe, after a certain lapse of time the deformation of the ring may be such that the seal is no longer sufficient on the opposite side. The pipe manufacturer is recommended to take measures to prevent this.

C.1.2 Recommendations of a general nature

C.1.2.1 Percentage of compression

The extent, to which different types of rubber are compressed in the fittings, varies. General rules cannot be given. The following factors affect the acceptable percentage of compression:

- the type of rubber and the way the rings are manufactured;
- the construction of the fitting;
- the conditions (temperature, pressure, medium and additional assembly tensions).

Therefore, the type of rubber to be used must always be determined in consultation with the buyer, the pipe manufacturer and the rubber manufacturer.

C.1.2.2 Additional requirements

Sometimes it is necessary to have additional requirements, e.g. with regards to rigidity. Also, it may be useful to demand better resistance against ozone when long-term storage under extreme conditions is planned.
If additional requirements are judged necessary, the manufacturer of the pipes or attachments shall inform the rubber manufacturer and the inspection body of such requirements.

C.1.2.3 Application

TR 7620 can be used as a first reference of application of the various types of rubber.

C.2 Recommendations for the storage and use of rubber products

During storage and use of rubber products, appropriate measures must be taken to shield off environment influences (light, air, humidity and temperature).
The preservation of quality is aided as follows.

C.2.1 Storage in a warehouse or temporary indoor storage

a. Preferably, use a separate and closed room:
   - screened against artificial and day light;
   - ventilated with air containing as little ozone as possible (ozone is produced e.g. by generators, electric motors and arc welding);
   - with an ambient temperature between 5 and 25 °C;
   - with a relative humidity between 40% and 70%;
   - free of oil, grease and other hydrocarbons and / or vapours emanating from these.

b. Keep the storage time as short as possible.
   Apply the "first in - first out" method.
   In the case of indoor storage for a period exceeding 6 months, extra measures are required despite good conditions. These include airtight package, female ends of pipes, attachments or fittings.
   Hanging or stacking may cause extra load -pressure, elongation or tensile- and thus the formation of cracks.

C.2.2 Outdoor transport and storage

It is recommended to protect the rubber products as much as possible during transport or outdoor storage.

a. Keep exposure to influences of weather as short as possible and certainly protect against frost (temperature below -5 °C).
b. In the case of exposure to outdoor conditions for a period exceeding 2 weeks, extra measures are required such as packing, covering and screening against weather influences.
   Always prefer indoor storage or covered outdoor storage.

C.3 Processing

Some general preventive rules for processing are:

a. Keep attachments and ends free of dust, sand and dirt in order to prevent damage at assembly.
b. At assembly, loose products shall be processed directly from the - possibly temporary - package.
c. Rubber products are susceptible to mechanical damage caused by sharp objects, burrs, cutting edges and undue elongation, distortion and forcing. Check the male ends of the pipes for burrs etc. prior to assembly.
d. In the case of repeated of long term arc welding in ambient air, the rubbers shall be protected.
e. Avoid contact with oil, grease, petrol, etc. and their vapours.
f. Cleaning with chemical products varies for many applications; follow the instructions of the manufacturer.
g. Application of lubricants shall take place strictly according to the instructions of the manufacturer or supplier.
h. After processing, make sure the joint is not exposed to frost; therefore cover in time.

C.4 Products in aboveground installations

Rubber products in aboveground installations or in permanent contact with atmospheric conditions require extra attention with regard to long term resistance. Not all rubber compounds and / or types are suitable for long term aboveground applications. The choice of a rubber compound shall therefore be well-considered.

C.5 Informative background to this Evaluation Guideline

The aim of this evaluation guideline is to cover all possible conditions at which rubber seals have to function during the intended service life with respect to the contact with liquid media at operating temperatures, within the scope of the guideline. The applicant for product certification shall state the mentioned service conditions in a Product Approval Range (PAR).

It is the responsibility of the applicant for the choice of the right rubber material in order that the rubber products to be certified are resistant to the conditions as stated in the PAR during the intended service life.

Some informative background is given here about the procedures that are used to assess the suitability of the products.

The requirements for the physical and mechanical properties (tear strength, tensile properties, compression set and stress relaxation) have the purpose to assure a minimum basic quality level that all vulcanised rubber seals should have and can match when using proper material recipes and state of the art production methods.

The requirements for the compression set are based on experience of which level is needed for a proper sealing function. Long-term compression set tests are not required in air as they are a part of the tests in the intended liquids. The procedure for the assessment of the resistance to thermal load is based on EN 14241-1, in which a service life of 15 years is intended to be covered. For longer service lives the duration of the tests is chosen based on an assumed log time relation, depending on the declared service life in the PAR. Stress relaxation requirements are based on evaluation guideline K 17504 and EN 681-1 with an extra requirement at high temperature; the combination 6 weeks at 30 °C above the maximum operating temperature (T_{max}+30 °C) is based on experienced test data and extrapolations using Arrhenius relation to cover a sufficient service life at T_{max}.

The evaluations of the chemical resistance are always carried out by a qualified person under the responsibility of Kiwa.

For the assessment of the chemical resistance at the declared PAR a test procedure in two steps is used. The evaluation guideline covers all possible conditions (within the scope) in which chemical resistant rubber seals can be used. For many PAR it will not be known beforehand which kind of interaction between rubber and contact medium can be expected. The interaction is therefore assessed in a short test procedure I in which the changes in properties are tested after contact of the rubber with the intended liquid(s) or its vapour(s) after one week at the maximum operating temperature.

The results of test procedure I give the input for the additional tests to be carried out in the next procedure II (no interaction: no further testing needed; only physical interaction: test program at limited exposure period; chemical interaction: full test program). The procedure for the assessment of the long-term chemical resistance is based on EN 14241-1, in which a service life of 15 years is covered for the specific application (as can be regarded as a PAR). For longer service lives the duration of the tests is chosen based on an assumed log time relation, depending on the declared service life in the PAR. For applications where seals have to function in both, alternating, “wet” (system filled with medium) and “dry” (empty system) conditions, an additional assessment procedure is carried out, based on EN 14241-1.

ANNEX D

Partner for progress

Example KQ Certificate

Number	K12345 / 01	**Replaces**	
Issued	2011-01-01	**Date**	-

Certificate

Product Certificate

Vulcanised rubber seals in plastic transport and storage systems for chemical liquids and gaseous fluids

Based on pre-certification tests as well as periodic inspections by Kiwa, the products referred to in this certificate and marked with the KiwaQuality-mark as indicated under 'marking', manufactured by

XYZ Company

may, on delivery, be relied upon to comply with the KiwaQuality evaluation guideline KQ17602 "Vulcanised rubber seals in plastic transport and storage systems for chemical liquids and gaseous fluids for industrial applications".

Kiwa N.V.

Ing. B. Meekma
Director

This certificate is issued in accordance with the Kiwa-regulations for Product Certification and consists of … pages.
Publication of the certificate is allowed.

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kiwa approved KQ

Product Certificate

Vulcanised rubber seals in plastic transport and storage systems for chemical liquids and gaseous fluids

PRODUCT SPECIFICATION

General

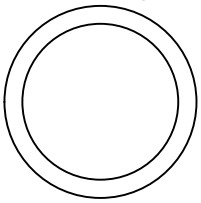
Vulcanised rubber seals made of ……., intended for the underground and above ground plastic transport and storage systems for chemical liquids and gaseous fluids for industrial applications according to evaluation guideline KQ17602.

Specification

The nominal dimensions of the seals as mentioned in the table below belong to this product certificate.

Nominal dimension
X
Y
Z

Cross section of product



Remarks

The colour of the seals is: …….

APPLICATION AND USE

The seals are designed to be used in plastic piping systems and tanks for the transport and storage of the chemical liquids and gaseous fluids at the application conditions as mentioned in the table below. In this table the product approval range (PAR) is given for each chemical liquid to be transported.

Chemical liquids	Concentration range (%)	Temperature range T_{min} - T_{max} (°C)	Minimum expected lifetime (years)
Liquid 1	1 – 2	1- 2	1
Liquid 2	2 – 3	2- 3	2
Liquid 3	3 - 4	3- 4	3

With regard to above ground applications, the rubber seals are/are not intended to be exposed to direct sunlight and weathering during the minimum expected lifetime(s) as indicated in the table above.

MARKING

The seals are marked with the KiwaQuality-mark (KQ-mark).

The minimum required marking of the seals is:

- **KQ Industry (or KiwaQuality®Industry) word mark, if not possible, then only on the smallest packaging unit;**
- **manufacturer's name and/or trade name and/or system name and/or logo;**
- **nominal dimension or dimensions in mm;**
- **nominal outside diameter of the corresponding pipe in mm;**
- **production code (e.g. clock with indication of year and month);**
- **nominal hardness;**
- **type of rubber applied by means of the letter codes of the nomenclature according to NEN-ISO 1629; see Annex I for the most common abbreviations;**
- **on products from blends, the letter B ("blend") shall be placed behind de first letter code;**
- **the ozone resistance class ("Ozone I, II or III).**

If the dimensions are such that the indications applied to them may impair the product, the products may be marked per package in consultation with the manufacturer, the buyer and the inspection body.

Products produced by cutting or die cutting out of sheets may be marked per package.

Product Certificate

Vulcanised rubber seals in plastic transport and storage systems for chemical liquids and gaseous fluids

RECOMMENDATIONS FOR USERS

1. **Check at the time of delivery whether:**
   - 1.1 **the producer has delivered in accordance with the agreement;**
   - 1.2 **the mark and the marking method are correct;**
   - 1.3 **the products show no visible defects as a result of e.g. transport.**

2. **If you should reject a product on the basis of the above, please contact:**
   - 2.1 **Company name**
     and, if necessary,
   - 2.2 **Kiwa N.V.**

3. **Consult the producer's processing guidelines for the proper storage and transport methods.**

4. **Check whether this certificate is still valid by consulting the Kiwa internet site: www.kiwa.nl.**

ANNEX E
Model IQC-scheme

Subjects	Aspects	Method	Frequency	Registration
Raw materials or materials supplied: • recipe sheets • incoming goods inspection raw materials	• Recipe according annex product agreement • Hardness • Tensile strength • Elongation at break	Comparison supplied certificate with agreement ISO 48 ISO 37 ISO 37	Each delivery Each delivery	Entry control document
Production process, production equipment, material: • Procedures • Equipment • Release of product	• Tuning parameters • Maintenance aspects • Dimensions and soundness	Adjustments of machine Maintenance schedule Measuring and visual inspection	Continuously Continuously Start up new product	Digital Work sheet Inspection document
End products	• Soundness • Dimensions • Tensile strength • Compression set	Visual Measuring ISO 37 ISO 815	Continuously Every 3 hours Per day per product per machine	End control Documents
Measuring and testing equipment • Measuring equipment • Calibration	• Proper functioning • Accuracy within range of measurement	During usage Record of non-conformities	Continuously 1 x year	End control document Calibration document
Logistics • Internal transport • Storage • Preservation • Packaging • Identification	• Circumstances in practice • Comparison with order	Comparison with procedure Visual inspection	Continuously	Keep logistical procedures up to date

ANNEX F

Difference between requirements on raw material and those on products (informative)

In the table beneath an overview is given on what tests are applicable for each certificate.

	Raw material (sheet)	Product [1)]	
		Compound certificate available	
		yes	no
Hardness	X	X	X
Tensile strength	X	X	X
Elongation at break	X	X	X
Compression set in air			
- 72 h at 23°C	X		X
- 24 h at T_{max}	X	X	X
- 72 h at T_{min}	X		X
Chemical resistance in liquids or vapours	X		X
Stress relaxation			
- 168 h at 23°C	X	X	X
- 100 days at 23°C	X		X
- 6 weeks at T_{max} + 30°C	X		X
Ozone resistance	X	X	X
Strength of bond or weld (if applicable)		X	X

1) When dimensions of products are suitable.

ANNEX G

Test pieces from products

Out of end products it is often not possible to prepare test pieces having all the dimensions as prescribed in the standard. Still knowing about the properties of the actual products is useful because they have to function well in practice. Therefore it is decided for this evaluation guideline that some deviations with respect to the dimensions are to be allowed.

Most end products are rings. There using a knife the rubber part can be separated from eventually present other materials. From that point further preparation can be done using the techniques given in ISO 23529:2004. By selecting the appropriate shape and part of the product for preparing the test pieces the following things should be kept in mind:

- For hardness also small pieces can be used by taking the micro method of ISO 48
- For tensile strength and elongation, ISO 37 gives also smaller test pieces (type 3 and 4) and ring test pieces, but using type 2 is preferred. Furthermore having a constant cross section of the parallel section is the most important. Using thinner test pieces or missing a few parts of the clamping sections will hardly influence the results as long as failure stays within the parallel section. This combined with the possible smaller test pieces make that almost every end product can be tested.
- Compression set is a material property which is not very sensitive to dimensions of the test pieces. Taking rectangular test pieces lead to the same results. Combined with the possibility of stacking up to three layers almost every product can be tested. In case of too thin material available the test pieces can be scaled down to a smaller thickness. Then of course other spacers have to be applied to get a compression of about 25 %. More important than having a compression of exact 25 % is knowing the compressed height exactly. It is known that a compression between 20 and 30 % will lead to the same results.
- For the change in volume the thickness is more important then length or width. Also here it is not really necessary to have complete flat test pieces. Often parts of the full products can be used without having different results.
- For stress relaxation more or less the same applies as with compression set, although here knowing the exact deformation is of no importance at all.
- For ozone resistance it is important to have none machined surfaces. Here, for small products, taking full sections of the products is often better and giving more realistic results then trying to get the test pieces as mentioned in the standard.

For all preparations it goes that after preparation the test pieces should be conditioned at least 16 hours before testing.

ANNEX H

Testing in case the products are O-rings

How to test depends on the size of the rings.

Over 100 x 10 mm
These products are big enough to prepare proper test pieces in accordance with ISO 23529 and annex G. No special instructions are needed.

Between 15 x 2 mm and 100 x 10 mm
These rings are most of the time too small to prepare exact test pieces out of them. However in this case well defined testing is possible on complete rings or sections of complete rings.

- Hardness is measured in micro-IRHD on the rings. Care should be taken to place the device on top of the ring. Normally the highest values are the most accurate as a small misplacement of the device always will lead to a lower value for the hardness.
- Tensile tests can be done on complete rings with the devices mentioned in ISO 37. Most dimensions are best tested using the small clamps. At least 5 rings should be tested.
- Tear resistance is possible with those rings where the cross section is 7 mm or more. In those cases the test pieces can be prepared according to ISO 23529 with only small deviations from the prescribed dimensions. For smaller rings the tear strength has to be carried out on test sheets.
- Compression set can be measured on complete rings or in case the rings are too large for the clamps on sections of the rings. Method is further as given in ISO 815. A small higher value (3 to 5 %) can be the result but normally there will be enough distance of the limits.
- Stress relaxation at compression. Here goes the same as for compression set although here no higher values are found.
- Ozone resistance test can be done by either stretching the cut open parts of the rings or by stretching the complete rings by mounting them on a thorn in such a way that the required elongation is obtained.
- Resistance to liquids can be done on complete rings or on section in those cases that the complete rings are too big.

Exceptions in case of rings with a flexible protective surface coating

- Ozone resistance, resistance to thermal load and resistance to liquids or vapours shall be tested on rings with the coating in any case.

ANNEX I

Nomenclature and abbrevations of the most common rubber types according to ISO 1629 : 1996

ACM	Copolymer of ethyl or other acrylates and a small amount of a monomer which facilitates vulcanization
AEM	Copolymer of ethyl or other acrylate and ethylene
AU	Polyester urethane
BIIR	Bromo-isobutene-isoprene rubber (brominated butyl rubber)
BR	Butadiene rubber
CIIR	Chloro-isobutene-isoprene rubber (chlorinated butyl rubber)
CM	Chlorinated polyethylene
CO	Epichlorhydrin rubber
CR	Chloroprene rubber
CSM	Chlorosulphonated polyethylene
ECO	Ethylene oxide and epichlorhydrin copolymer
EAM	Ethylene-vinyl acetate copolymer
EPDM	Terpolymer of ethylene, propylene and a diene with the residual unsaturated portion of the diene in the side chain
EPM	Ethylene-propylene copolymer
EU	Polyether urethane
FFKM	Perfluoro rubber of the polymethylene type having all substituent groups on the polymer chain either fluoro, perfluoroalkyl or perfluoroalkoxy groups
FKM	Fluororubber of the polymethylene type having substituent fluoro and perfluoroalkoxy groups on the main chain
FVMQ	Silicone rubber having fluorine, vinyl and methyl substituent groups on the polymer chain
IIR	Isobutene-isoprene rubber (butyl rubber)
IR	Isoprene rubber (synthetic)

MQ	Silicone rubber having only methyl substituent groups on the polymer chain
NBR	Nitrile-butadiene rubber (nitrile rubber)
NR	Natural rubber
PMQ	Silicone rubber having both methyl and phenyl groups on the polymer chain
PVMQ	Silicone rubber having methyl, phenyl and vinyl substituent groups on the polymer chain
Q	Rubber having silicon in the polymer chain
SBR	Styrene-butadiene rubber
T	Rubbers having sulphur in the polymer chain (excluding copolymers based on CR)
VMQ	Silicone rubber having both methyl and vinyl substituent groups in the polymer chain
XNBR	Carboxylic-nitrile butadiene rubber (carboxynitrile rubber)
XSBR	Carboxylic-styrene butadiene rubber