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WAA Sewers and Water Mains Committee: Materials and Standards

Information and Guidance Note

SELECTION, PROPERTIES, STORAGE AND INSTALLATION REQUIREMENTS FOR ELASTOMERIC SEALS AND SEALING RINGS

1. INTRODUCTION

The first evidence of serious deterioration of rubber sealing rings made with natural rubber was noted in the Netherlands in 1949. This was subsequently shown to be caused by bacterial activity. Following the publication of this work, biodeterioration of rubber sealing rings was reported from other countries, notably Australia and New Zealand[1]. In 1960, the Dutch specification for sealing rings was amended to exclude the use of natural rubber (NR) in favour of styrene butadiene synthetic rubber (SBR).

In the UK, the then Ministry of Housing and Local Government Working Party on the Design and Construction of Pipe Sewers set up experiments at 3 sewage works in 1966 to compare the behaviour of natural and synthetic rubber rings for sewer pipe joints. In the 1970s WRc investigated examples of deteriorated rings both in sewers and water mains. The cause of deterioration was microbiological with *Nocardia Asteroides* the responsible organism. This work led to the development of a microbiological deterioration test for inclusion in the revision of BS 2494: 1976. Further work is being carried out by WRc on this test, including an investigation of formulation influences.

2. GENERAL

BS 2494: 1976[2] has now been revised and published as BS 2494: 1986[3] – Specification for elastomeric joint rings for pipework and pipelines. To allow the use of the existing stock of joint rings, both standards will operate concurrently for 9 months from the publication of the revised standard after which BS 2494: 1976[2] will be withdrawn. The use of joint rings complying with the requirements of BS 2494: 1986[3] will be the sole recommendation after the withdrawal of BS 2494: 1976[2].

The revised standard includes water quality requirements for rings in contact with hot or cold potable water, and resistance to microbiological deterioration requirements for all potable water and drainage applications.

This Information and Guidance Note is applicable to elastomeric joint rings, sealings rings, jointing gaskets and similar components used to seal aqueous fluids in pipes and fittings. It is also applicable to all the elastomeric components of composite sealings rings, except for the water quality and microbiological deterioration requirements which only apply to the part of the ring in contact with the contents of the pipeline. This Information and Guidance Note is based upon BS 2494: 1986 which has been drafted on a performance basis and hence does not specify the material to be used, but does specify the physical properties required for any material used to manufacture joint rings.

Examples of rubber polymers that may commonly be used in the formulation of joint rings are: natural rubber; styrene-butadiene rubber; ethylene-propylene-diene terpolymer rubber; acrylonitrile butadiene rubber (nitrile rubber); polychloroprene rubber, **provided that the materials meet the requirements of BS 2494: 1986[3].**

A Kitemark Scheme will operate with the revised standard BS 2494: 1986[3]. It is recommended that only Kitemarked rings are purchased, when they become available, in line with the policy of the Water Industry to purchase products produced within an approved third party quality assurance certification scheme.

Joint rings complying with the Water Industry requirements of BS 2494: 1986[3] are designated by type and application in Table 1:

Table 1. Ring designations

Type	Intended Application
W (Water)	Potable water.
D (Drainage)	Drainage (including drains, sewers, sewage pumping mains, soil, waste, ventilating pipes and fittings and rain water pipes).
H (Hot, potable)	Hot water and low pressure steam up to 110° C for potable purposes.
S (Hot, non-potable)	Hot water and low pressure steam up to 110° C for non-potable purposes.

N.B. BS 2494: 1986 also refers to Type G (Gas and Hydrocarbon fluids) which is not relevant to this Information and Guidance Note.

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Each type of sealing ring is sub-divided into six hardness ranges between 36° IRHD and 91° IRHD. Physical properties are specified for each hardness range and type classification in Tables 3 to 6 of BS 2494: 1986[3].

Normally pipes and fittings are supplied with the necessary sealing rings and only when replacement rings are required will they be ordered separately. Although the sealing rings are a relatively low cost item, they are essential in maintaining the water tightness of the pipeline. It is recommended that all rings supplied including those supplied with pipes and fittings comply with the requirements of the revised British Standard, identifiable by their markings, which will be in accordance with clause 3.7 of BS 2494: 1986[3], and as outlined in 3.6 of this Information and Guidance Note.

To comply with the revised standard, the rubber sealing rings are subject to Type Tests and Product Control Tests summarised in Table 2. Type Tests are carried out annually, with the exception of those for microbiological deterioration, or whenever the manufacturing technique is changed. All type tests are carried out whenever the rubber formulation is changed.

As part of the quality assurance procedure for the Kitemark, manufacturers are required to demonstrate that the formulations used in production are those that have been approved by the Type Tests in addition to meeting the product control test requirements.

3. PROPERTIES, STORAGE AND INSTALLATION REQUIREMENTS

Rubber sealing rings should comply with BS 2494: 1986[3]. The following simplified guidance is provided for the properties, storage and installation requirements of rubber sealing rings.

3.1 Materials

The rings should be manufactured from compounds that are free from reclaimed rubber, vegetable oils, factice and vulcanised waste. There are no other

Table 2 - Summary of type tests and product control tests in BS 2494: 1986

Test	Type Tests		Product Control Tests	
	Ring designation			
	W and D	H and S	W and D	H and S
Tensile strength	✓	✓	✓	✓
Elongation at break	✓	✓	✓	✓
Hardness	✓	✓	✓	✓
Compression set at 23°C 70 hours	✓	✓		
Compression set at 70°C 22 hours	✓		✓	
Compression set at 125°C 22 hours		✓		✓
Stress relaxation	✓	✓		
Water absorption	✓	✓		
Low temperature hardness change	✓			
Ozone test	✓	✓		
Splice test - where applicable	✓	✓	✓	✓
Accelerated ageing 70°C 168 hours	✓			
Accelerated ageing 125°C 168 hours		✓		
Tensile strength change	✓	✓		
Elongation at break change	✓	✓		
Hardness change	✓	✓		
Microbiological deterioration	✓	✓		
Effects on water quality	W only	H only		

limitations on the type of rubber used provided it can meet the performance requirements of the Standard.

3.2 Hardness

Within each Type category, rubber sealing rings are classified into six hardness ranges. The hardness should be within 3° IRHD of the specified nominal when measured in accordance with the microtest described in BS 903: Part A26[4]. This normally limits the microtest to the hardness range 30° to 85° IRHD. However, for joint rings, the microtest is considered to be suitable for measurements up to 91° IRHD.

The hardness required for the sealing ring is determined by the design of the joint and the material from which the pipe is made and is usually specified by the manufacturer of the joint for which it is to be used. The nominal ring hardness for composite rings containing more than one rubber compound refers to the part of the ring providing the sealing function, usually the softest part of the ring. It is advisable to use sealing rings with hardness of 76° IRHD or above in flange joints as softer rings may be distorted as the joints are tightened. If replacement rings are required, the manufacturer of the joint should be consulted to ensure that rings of suitable hardness and design are ordered.

3.3 Appearance and Finish

To provide an adequate seal, rubber sealing rings should be smooth and free from air marks and other blemishes. The material forming the rings should also be homogeneous and free from porosity as judged without magnification on the surface or on any cut section.

The moulding flash should not impair the sealing properties of the ring. The maximum dimensions of the flash are detailed in Table 3.

3.4 Dimensional Tolerances

Rubber sealing rings may be produced either by moulding or by cutting and joining vulcanised lengths of extruded section. The dimensional tolerances for all rubber sealing rings should be in accordance with BS 3734[5]. The tolerances on all dimensions of moulded rings and on the diameter of rings made from cut and joined extruded section should be to class M2 of BS 3734[5]. The tolerance on the section of the extruded lengths should be to class E 1 of BS 3734[5]. These are detailed in Tables 4 and 5 of this Information and Guidance Note.

3.5 Splice joined rings

Rings manufactured from cut and joined lengths of extruded section should show no signs of separation at the splice joint. The two ends of the section at the joint should not be displaced relative to each other and any excess solution should have been carefully trimmed off the joint by the manufacturer.

Full details of the splice test are given in Appendix E of BS 2494: 1986[3].

3.6 Marking

Each ring, or parcel of rings where the marking of each ring is not practicable, should be marked clearly and durably, as listed below, such that the sealing capability of the ring is not impaired.

(a) Nominal size
(b) Manufacturer's identification
(c) British Standard with the ring type as a suffix e.g. BS 2494: W
(d) The quarter and year of manufacture.

The following information is also desirable:

(e) The British Standard abbreviation for the rubber, e.g. EPDM - Ethylene-Propylene Diene Terpolymer
(f) The type of joint for which the ring is intended.

3.7 Effects on Water Quality

For ring types W and H in contact with potable water, the rings should meet the requirements of the United Kingdom Water Fittings Byelaws Scheme Information and Guidance Note No. 5-01-02[6]. When an equivalent British Standard is available, BS 2494: 1986[3] will be amended to quote the new standard. Materials and products that have been tested to

Table 3 - Maximum dimensions of moulding flash

Nominal dimension of section		Maximum flash thickness and/or width (mm)
Above (mm)	Up to (mm)	
–	5	0.10
5	10	0.20
10	16	0.40
16	25	0.50
25	40	0.60
40	65	0.70
65	–	0.80

comply with the requirements of specification 5-01-02, are listed in the Water Fittings and Materials Directory[7].

3.8 Microbiological Deterioration

When tested as outlined in Appendix A, the rings should comply with the following:

(a) The average loss in mass of the test set of test pieces should not exceed 3.5%

(b) There should be no greater release of carbon black or other fillers from the test set than from the control set when the surfaces of the specimens are lightly rubbed.

For composite rings, the above requirements do not apply to the components that will not be exposed to the contents of the pipework or pipeline.

Full details of the test are given in BS 2494: 1986[3]. Further work is being carried out by WRc on this test, including an investigation of formulation influences.

3.9 Resistance to chemicals

For rings to be used in drainage applications, the effect of chemicals that may be present in trade effluents on the rubber sealing rings should be considered. For guidance, the relative acid and solvent resistance of polymers commonly used for rubber sealing rings is shown in Table 6. For specific applications, the manufacturer of the joint should be consulted and given full details of any chemicals likely to be present in the effluent.

Table 4 - Dimensional tolerances for moulded rings

Nominal dimension		Tolerance Class M2
Above (mm)	Up to (mm)	(± mm)
0	6.3	0.15
6.3	10	0.20
10	16	0.20
16	25	0.25
25	40	0.35
40	63	0.40
63	100	0.50
100	160	0.70
160	–	0.5%

NOTES
(1) For rings produced by compression moulding, refer to BS 3734[5] for a detailed explanation of the dimensional tolerances.
(2) The tolerances in Table 4 are also applicable to the diameter of rings made from cut and jointed lengths of vulcanised material.

Table 5 - Dimensional tolerances of extruded section

Nominal dimension		Tolerance Class E1
Above (mm)	Up to (mm)	(± mm)
0	2.5	0.20
2.5	4.0	0.25
4.0	6.3	0.35
6.3	10	0.40
10	16	0.50
16	25	0.70
25	40	0.80

3.10 Storage

At all stages between manufacture and use, the rings should be stored in accordance with BS 3574[8]. The following points should be noted:-

(a) The storage temperature should be below 25°C and preferably below 15°C.

(b) They should be protected from light, in particular strong sunlight and artificial light with a high ultra-violet content.

(c) The rings should not be stored in a room with any equipment capable of generating ozone e.g. mercury vapour lamps, high voltage electrical equipment, electric motors or any equipment, which may give rise to electric sparks or silent electrical discharges.

(d) The rings should be stored in a relaxed condition free from tension, compression or other deformation. For instance, they should not be suspended from any part of the circumference.

(e) The rings should be maintained in a clean condition.

3.11 Installation

Special care should be taken to ensure that the sealing rings are not displaced or distorted during the jointing operation. It is advisable to lubricate the rings evenly with a lubricant suitable for use with the rubber compound from which the rings are made. The manufacturer should be contacted for his recommendations. For all potable water applications, the lubricant must comply with Information and Guidance Note No. 5-01-02[6].

Table 6 - Guidance to the relative acid and solvent resistance of polymers

	NR	SBR	EPDM	NBR	CR
Acids	2	2/3	3	2/3	2/3
Aliphatic hydrocarbons	1	1	1	3	3
Aromatic hydrocarbons	1	1	1	2	1
Animal and vegetable oils	1	1	1/2	4	3
Oxygenated organics	2/3	2/3	3	1	1

NOTES Key to ratings:
1 - Poor
2 - Moderate
3 - Good
4 - Outstanding

NR - Natural rubber
SBR - Styrene-Butadiene rubber
EPDM - Ethylene-propylene-diene terpolymer rubber
NBR - Acrylonitrile-butadiene rubber
CR - Polychloroprene

4. REFERENCES

1. P C KIRBY, K J NORTH. The resistance to biodegraduation of a number of alternative natural and synthetic rubber sealing ring formulations. WRc Engineering Report No. 0006E. November 1980.
2. BS 2494: 1976 Materials for elastomeric joint rings for pipework and pipelines.
3. BS 2494: 1986 Specification for elastomeric joint rings for pipework and pipelines.
4. BS 903 - Methods of testing vulcanised rubber. Part A26 Determination of hardness.
5. BS 3734: Specification for dimensional tolerances of solid moulded and extruded rubber products.
6. United Kingdom Water Fittings Byelaws Scheme. Information and Guidance Note No. 5-01-02. Requirements for the testing of non-metallic materials for use in contact with potable water.
7. Water Fittings and Materials Directory published annually for the UK Water Fittings Byelaws Scheme.
8. BS 3574 Recommendations for the storage of vulcanised rubber.

APPENDIX A - OUTLINE OF THE TEST METHOD FOR MICROBIOLOGICAL DETERIORATION

Full details of the test are given in Appendix A of BS 2494: 1986[3].

Eight test pieces cut from a sample test sheet are individually weighed. Four are sealed in an opaque envelope to be used as control test pieces, and the remaining four, under tensile strain, are immersed in raw river water. The river water is maintained at 23 ± 2°C, inoculated with rubber degrading organisms and maintained at a high dissolved oxygen concentration.

After six months, the test pieces plus control pieces are ultrasonically cleaned, dried and weighed. The average percentage weight losses for the test and control pieces are calculated. To pass the test, the difference between the two average percentage weight losses must not exceed 3.5%.

Each test piece is then lightly rubbed with a tissue. To pass the test, the carbon black or filler release from the test pieces must not be greater than that from the control pieces.