BRITISH STANDARD AEROSPACE SERIES

BS 4F 68:2002

Controlled storage of vulcanized rubbers for use in aerospace applications

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Committees responsible for this British Standard

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British Hydromechanics Research Group (BHR)

British Narrow Fabrics Association (BNFA)

British Rubber Manufacturers' Association Ltd (BRMA)

UK Defence Standardization

Society of British Aerospace Companies (SBAC)

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Foreword

This British Standard has been prepared by Technical Committee ACE/25. It supersedes BS 3F 68:1977, which is withdrawn. It was first published in 1968 under the direction of the Aerospace Standards Committee at the request of the Society of British Aerospace Companies Ltd.

This new edition of BS F 68 incorporates technical changes only. It does not represent a full review or revision of the standard, which will be undertaken in due course.

This standard takes into account accumulated experience since it was first published, reflects changes in the grouping of rubbers and in their storage periods, and refers to the inclusion of stockists in the distribution chain and the steps to be taken to secure agreement on the division of the storage period.

This new edition extends the range of products considered.

Although vulcanized rubbers made to well-controlled specifications, properly packaged and stored under good conditions, will remain in a fully serviceable condition for many years, nevertheless, some rubbers are more susceptible than others to degradation by such factors as heat, light, ozone, oxygen, humidity, etc. Because of these factors a system of storage control is necessary to ensure that such rubbers are issued in a serviceable condition.

For the convenience of users of this standard, the grouping of rubbers specified in BS 2F 68:1973 is given in Annex C.

NOTE This standard is not intended to be used as a design document.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Summary of pages
This document comprises a front cover, an inside front cover, pages i and ii, pages 3 to 9 and a back cover.

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1 Scope

1.1 This British Standard specifies requirements for the storage, and inspection during storage, of vulcanized rubber, whether in the form of materials or as components to be used for aerospace purposes. These requirements also apply to items made from cellular rubber.

1.2 The requirements of this standard do not apply to rubber components contained within mechanical assemblies, e.g. pumps and valves.

NOTE In such cases the recommendations of the assembly supplier for exercising the assembly and lifing of the rubber need to be sought and applied.

1.3 The storage periods quoted apply only if the storage conditions specified in Annex A are complied with and if the packaging complies from the date of cure with the requirements of BS F 69, as far as is practicable, making allowance for subsequent manufacturing operations.

1.4 The storage period comprises the whole period of existence of the rubber from the date of cure. This period will generally be divided between manufacturing (including assembly) and storage (e.g. in manufacture, by stockists, by aircraft constructors and operators) and the division of this period should be mutually agreed between the interested parties.

1.5 These requirements are based on the classification of rubbers into groups as defined in Clause **3**.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS F 69, *Specification for packaging and identification of vulcanized rubber items.*

Defence Standard 81-39, *Packaging of rubber hoses, plastics hoses, and hose assemblies*[1)].

3 Classification of rubbers

Rubbers are classified into three groups of differing sensitivity to ageing as follows:

a) Group A rubbers with a high sensitivity to ageing as listed in Table 1;

b) Group B rubbers with an intermediate sensitivity to ageing as listed in Table 2;

c) Group X rubbers with a low sensitivity to ageing as listed in Table 3.

Any new rubbers introduced which are not listed in Table 1, Table 2, or Table 3 shall be considered as belonging to group A until their storage capabilities have been established.

Table 1 — Group A rubbers

Abbreviation[a]	Chemical name[a]	Common name
NR	Isoprene rubber, natural	Natural rubber
BR	Butadiene rubber	Polybutadiene
IR	Isoprene rubber, synthetic	Polyisoprene
AU	Polyester urethane rubber	Polyurethane[b]
EU	Polyether urethane rubber	Polyurethane[b]
SBR	Styrene-butadiene rubber	SBR
PNR	Polynorbornene rubber	Polynorbornene
PS	Polysulfide rubber	Polysulfide

[a] In accordance with BS ISO 1629 (with the exception of PNR and PS).
[b] Owing to the extreme susceptibility of some types of polyurethane to degradation by moisture, special care and/or inspection in storage may be required.

[1)] Available from: UK Defence Standardization, Kentigern House, 65 Brown Street, Glasgow G2 8EX.

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Table 2 — Group B rubbers

Abbreviation[a]	Chemical name[a]	Common name
NBR	Acrylonitrile-butadiene rubber	Nitrile rubber
HNBR	Hydrogenated NBR	Hydrogenated nitrile rubber
NBR/PVC	Blend of acrylonitrile-butadiene rubber and polyvinyl chloride	Nitrile PVC
ECO	Copolymer of ethylene oxide and chloromethyloxirane	Epichlorohydrin rubber
ACM	Copolymer of ethyloacrylate (or other acrylates) and a small amount of a monomer which facilitates vulcanization	Acrylic rubber
CR	Chloroprene rubber	Chloroprene
IIR	Isobutene-isoprene rubber	Butyl rubber
[a] In accordance with BS ISO 1629.		

Table 3 — Group X rubbers

Abbreviation[a]	Chemical name[a]	Common name
CSM	Chlorosulfonylpolyethylene	Chlorosulfonated polyethylene
EPM	Ethylene-propylene copolymer	EPM or EPR
EPDM	Ethylene-propylene diene modified	EPDM
FKM	Fluoro rubber having substituent fluoro, perfluoroalkyl or perfluoroalkoxy groups on the polymer chain	Fluorocarbon rubber
FVMQ	Fluorosilicone rubber	Fluorosilicone
VMQ/PVMQ	Silicone rubber	Silicone
[a] In accordance with BS ISO 1629.		

4 Storage

4.1 Requirements

4.1.1 *Storage*

Materials and unassembled components shall be packaged in accordance with the requirements of BS F 69 and stored under the conditions specified in Annex A.

4.1.2 *Inspection in storage of group A and group B rubbers*

When packaged and stored in accordance with the requirements of **4.1.1**, materials and unassembled components of group A or group B rubbers should remain in good condition for at least the appropriate initial period given in Table 4 reckoned from the date of cure. (Some items of group A rubbers in thicknesses of less than 1.5 mm, or group A cellular rubbers, may need more frequent inspection.)

Inspection during storage shall follow either procedure A [see **4.1.2**a)] or procedure B [see **4.1.2**b)]. Batches which fail inspection and/or testing shall be considered as unserviceable.

a) *Procedure A.* Not later than the expiry of the initial periods as given in Table 4, representative samples of a batch shall be inspected and/or tested in accordance with Annex B and, if found to be satisfactory, the batch shall then be considered suitable for the stated extension period (see Table 4). Further renewals of the extension period may be made, subject to satisfactory further inspection and/or testing.

b) *Procedure B.* Components may be maintained in store without periodic inspection. After the expiry of the initial periods given in Table 4, representative samples of a batch shall be inspected and/or tested in accordance with Annex B before use or issue to a customer.

Subsequently all remaining items of the inspected batch should remain fully serviceable without further inspection until at least the expiry of the extension period given in Table 4.

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Table 4 — Initial and extension periods for materials and unassembled components in storage

Group	Initial period[a] years	Extension period(s)[a] years
Group A rubbers	5	2
Group B rubbers	7	3
Group X rubbers	See **4.1.3**, **4.3** and **1.2**	
[a] See also **1.4**.		

4.1.3 *Inspection in storage of group X rubbers*

No periodic inspection is required for materials or unassembled components of group X rubbers.

4.2 Repackaging

All samples withdrawn for testing and/or inspection and found to be satisfactory shall be repackaged to the original specification before being returned to storage.

4.3 Inspection before final assembly

Items of all groups shall be inspected and/or tested immediately prior to final assembly.

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Annex A (normative)
Storage conditions

A.1 General requirements

NOTE The storage requirements specified in **A.1** are based on the guidelines given in BS ISO 2230.

A.1.1 *Temperature*

The temperature of the store shall be between 5 °C and 25 °C.

A.1.2 *Humidity*

Moist conditions shall be avoided. Storage conditions shall be such that condensation does not occur. The relative humidity shall be below 75 %.

A.1.3 *Light*

Vulcanized rubber shall be protected from light, in particular direct sunlight and intense artificial light with a high ultraviolet content. Unless the articles are packaged in opaque containers, it is advisable to cover any windows of storage rooms with a red or orange coating or screen.

A.1.4 *Ozone*

As ozone is particularly deleterious, storage rooms shall not contain any equipment that is capable of generating ozone, such as mercury vapour lamps, high voltage electrical equipment, electric motors or other equipment giving rise to electric sparks or silent electrical discharges.

A.1.5 *Deformation*

Vulcanized rubber shall, wherever possible, be stored in a relaxed condition free from tension, compression or other deformation. If it is impossible to avoid deformation it should be kept to a minimum, since deformation can lead to deterioration and to permanent changes of shape. Where articles are packaged in a strain-free condition they shall be stored in their original packaging. In case of doubt the manufacturer's advice shall be sought. High stacking should be avoided, and heavy packages should not be stacked vertically.

A.1.6 *Contact with liquid and semi-solid materials*

Vulcanized rubber shall not be allowed to come into contact with liquid or semi-solid materials (in particular, solvents, oils and greases) at any time during storage, unless so packaged by the manufacturer.

A.1.7 *Contact with metals*

Certain metals (in particular, copper, manganese and iron) are known to have deleterious effects on vulcanized rubber. Vulcanized rubber shall not, therefore, be stored in contact with metals except when bonded to them but shall be protected by wrapping or by separation with a layer of suitable material, e.g. paper or polythene, as specified in BS F 69. Plasticized PVC film shall not be used for wrapping.

A.1.8 *Contact with dusting powder*

Any dusting powder used shall be free from constituents having a deleterious effect on vulcanized rubber.

A.1.9 *Contact between various rubbers*

Contact between vulcanized rubbers of different composition shall be avoided.

NOTE This applies particularly to vulcanized rubbers of different colours.

A.1.10 *Articles with rubber-to-metal bonds*

The metal part of bonded metal items shall not come into contact with the vulcanized rubber of other metal parts. Any temporary protective used on the metal shall be such that it will not adversely affect the rubber or bond.

A.1.11 *Containers, wrapping and covering materials*

The materials of any containers, wrappings and coverings shall be free from substances deleterious to vulcanized rubber, e.g. copper naphthenate, creosote, sulfur-containing compounds.

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A.1.12 *Rotation of stocks*

Vulcanized rubber shall remain in store for as short a time as possible. Therefore articles shall be issued from stores in strict rotation so that the articles remaining in store are those of latest manufacture or delivery.

A.1.13 *Cleaning*

Great care shall be taken in cleaning vulcanized rubbers. Cleaning with soap and water is generally the least harmful but should not be used for polyurethane rubbers or fabric composites with exposed fabric. Organic solvents (such as trichloroethylene, carbon tetrachloride, or petroleum spirit), abrasives and sharp objects shall not be used.

Articles that have been cleaned shall be dried at room temperature.

NOTE Vulcanized rubber accidentally contaminated, however cleaned, will not be as satisfactory as uncontaminated rubber.

A.2 Requirements for the storage of specific items

A.2.1 *Tyres*

A.2.1.1 *General*

Where tyres are delivered wrapped, the wrappers shall be left on during storage.

A.2.1.2 *Preferred method*

Tyres shall be stored vertically in special racks embodying support tubes so that each tyre is supported at two points. Two-thirds of the tyre shall be above the support tubes and one-third below. By this method the tyre is supported by its tread and distortion is reduced to a minimum. The tyres shall be turned to new positions as specified in Table A.1.

Table A.1 — Periods for rotation of tyres in storage

Outside diameter	Period for rotation of tyre
Over 1.5 m	3 months
0.5 m to 1.5 m	6 months
Under 0.5 m	9 months

A.2.1.3 *Alternative method*

Tyres shall be stacked by laying them flat one on top of the other on a clean, level floor. The height of the stack shall be limited to four tyres, which shall all be of the same size, and care shall be taken to ensure that they are accurately centred.

Unwrapped tyres shall not be stacked directly on concrete floors or similar rough surfaces. The sequence of the tyres in the stack shall be changed every 2 or 3 months. No other articles shall be stored on top of the stack.

A.2.2 *Inner tubes*

Inner tubes shall be stored in the cartons in which they were received wherever possible. Where this is not possible, damage can be prevented if the tubes are lightly inflated and stored inside covers of appropriate sizes. Tubes shall not be secured in a fixed position (such as a tight roll) by rubber bands or tapes, as this can cause thinning or cracking of the rubber.

A.2.3 *Hose assemblies, hoses and tubing*

Hose assemblies, hoses and tubing shall be stored in straight lengths (or in their moulded shape) wherever possible. If coiling is unavoidable, the coils or rolls shall be loose, and sharp bends and kinks shall be prevented.

The minimum coil size shall conform to the individual product specification and/or Defence Standard 81-39.

The ends of hose assemblies shall always be blanked with suitable caps and the cut ends of hoses and tubing shall always be sealed.

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A.2.4 *Flexible fuel tanks, dinghies and other inflatable items*

Flexible fuel tanks, dinghies and other inflatable items shall be stored in the sealed containers in which they were received. They shall not be dusted with powders of the kaolin type.

A.2.5 *Seals (including door seals) and extrusions*

A.2.5.1 *Lip-type seals*

Lip-type seals shall always be stored in such a way as to prevent the sealing edges being damaged. On no account shall identity labels be tied to the actual components.

A.2.5.2 *Extrusions and large components*

Coils of extruded items shall be protected by suitable rigid material so that each coil is not distorted by its own weight or that of others upon it. Large mouldings, especially door seals, shall be supported on hardboard or thick card.

Annex B (normative)
Methods of inspection and testing

B.1 General

Materials and components shall be carefully examined for:

a) permanent distortion, e.g. creases or flats;

b) mechanical damage, e.g. cuts, tears, abraded areas or separation of rubber-to-fabric plies;

c) surface cracking; this is best seen, using a low power lens (e.g. up to ×5) when the rubber is extended or flexed;

NOTE 1 Such cracking should be distinguished from surface imperfections caused by mould, scratches or grinding marks as found, for example, in centreless ground hoses.

d) changes in surface condition, e.g. hardening, softening or development of tackiness.

NOTE 2 Light surface blooming, which often occurs in storage, should not necessarily be considered detrimental.

B.2 Requirements for the methods of inspection and testing of specific items

B.2.1 *Tyres*

Tyres shall be visually inspected in accordance with **B.1**.

B.2.2 *Inner tubes*

B.2.2.1 *Valves*

Distortion of the valve base rubber can occur owing to faulty packaging and it shall be inspected for cracking or splitting. Such defects, however slight, warrant rejection. Where valve fitments are observed to have been pressed into the tube surface the area shall be inspected for penetration or cutting, which also warrant rejection.

B.2.2.2 *Tubes*

Creasing or a local deformation of the tube due to folding or packaging does not render the tube unserviceable provided that the tube surface is unbroken. The tube shall be inspected in accordance with **B.1** and also as follows.

Mark with chalk two parallel lines 25 mm apart anywhere in the centre line area of the tube. Stretch the tube manually until the lines are approximately 50 mm apart and examine the stretched surface of the rubber. Provided that there are no signs of cracking on the surface of the rubber, and that the tube returns to the previous shape without any appreciable evidence of permanent set in the stretched area, the rubber may be considered to be in good condition.

B.2.3. *Hose assemblies*

B.2.3.1 *Inspection*

The hose of hose assemblies shall be visually inspected, where possible, in accordance with **B.1**, particular attention being paid to areas adjacent to the end fittings. Bores of hoses shall be inspected by the use of introscopes where possible.

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B.2.3.2. *Testing*

Hose assemblies shall be subjected to the normal production tests for finished assemblies given in the relevant specification. Subsequent to testing, they shall be freed as completely as possible from the residues of any test fluid used, blown through with clean air, resealed with the appropriate plugs or caps, and re-identified with suitable tags indicating the test applied and the date thereof.

B.2.4 ***Hoses and tubing***

Hoses and tubing shall be visually inspected in accordance with **B.1**.

B.2.5 ***Flexible fuel tanks***

Flexible fuel tanks shall be visually inspected in accordance with **B.1** prior to assembly in the aircraft by laying out flat on clean cellular rubber sheeting or other suitable surface (not directly on concrete floors or similar rough surfaces).

B.2.6 ***Dinghies and other inflatable items***

Dinghies and other inflatable items shall be visually inspected in accordance with **B.l** and shall be subjected to any pressure maintenance test stipulated in the relevant specification.

B.2.7 ***Seals, extrusions and large components***

Seals, extrusions and large components shall be visually inspected in accordance with **B.1**, special attention being given to the condition of the lip or sealing surface.

B.2.8 ***Braided rubber cords***

The mechanical properties of finished cords shall be tested in accordance with the relevant specification.

B.2.9 ***Rubber-to-metal bonded components***

B.2.9.1 *Rubber*

The rubber parts of rubber-to-metal bonded components shall be visually inspected in accordance with **B.1**.

B.2.9.2 *Bond*

The edge of the bond shall be visually inspected. Where practicable, the rubber shall be in light tension.

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Annex C (informative)
Previous rubber groupings

In BS 2F 68:1973 rubbers were classified into two groups having different rates of deterioration as shown in Table C.1.

Table C.1 — Classification of rubbers according to rate of deterioration

Group 1	Group 2
Natural rubber	Chlorosulfonated polyethylene
Acrylonitrile-butadiene (nitrile)	Ethylene-propylene
Blend of acrylonitrile-butadiene and polyvinyl-chloride (nitrile/PVC)	Fluorocarbon
Butyl	Fluorosilicone
Polyacrylate	Polychloroprene (neoprene)
Polybutadiene	Silicone
Polyisoprene	
Polyurethane	
Styrene-butadiene	

NOTE Rubbers in group 1 have a faster rate of deterioration than those in group 2.

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Bibliography

Standards publications

BS ISO 1629:1995, *Rubbers and latices — Nomenclature.*

BS ISO 2230:2002, *Rubber products — Guidelines for storage.*

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