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AEROSPACE RECOMMENDED PRACTICE

SAE ARP5316 REV. A

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Superseding ARP5316

Storage of Elastomer Seals and Seal Assemblies Which Include an Elastomer Element Prior to Hardware Assembly

1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) addresses the general requirements for data recording procedures, packaging, and storing of elastomeric seals and seal assemblies which include an elastomeric element prior to the seal being assembled into hardware components.

The requirement for packaging is an integral part of the controlled storage procedure and provides a means of positive product identity from the time of manufacture to the time of assembly into a component.

1.1 Disclaimer:

This document does not establish limitations or storage times for assembled components nor the operating life of said components.

The information contained in this ARP is intended to be utilized by those organizations who do not have specific requirements or recommendations already in place for the control of elastomeric seals and seal assemblies. This ARP can be specified in control, storage, and procurement documents. However, when the requirements of this document are in conflict with the customer's requirements or specifications, the requirements of the customer's detailed specification shall govern.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS1933A Age Controls for Hose Containing Age-Sensitive Elastomeric Material

2.1.2 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

AFML-TR-67-235	Literature Survey on the Effects of Long-Term Shelf Aging of Elastomer Materials
ANA Bulletin 438	Age Control of Age-Sensitive Elastomeric Items
DOD 4140.27.M	Shelf Life Management Manual
MIL-HDBK-695	Rubber Products: Recommended Shelf Life
MIL-STD-1523	Age Control of Age-Sensitive Elastomeric Materials

2.1.3 ASTM Publications: Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1418 Standard Practice for Rubber and Rubber Latices - Nomenclature

2.1.4 Electric Power Research Institute Publications: Available from EPRI, 3412 Hillview Avenue, Palo Alto, CA 94304.

NP-6608 Shelf Life of Elastomeric Components

3. BACKGROUND:

3.1 MIL-STD-1523:

Age control was imposed on elastomers used in critical sealing devices of aircraft hydraulic, lubricating, and fuel systems after World War II. Several different requirements and specifications were implemented in the years following the war until 1958 when ANA Bulletin 438 was released. This bulletin's purpose was to collect all previous requirements for age control in one document and to make it easier for various agencies and contractors to effectively implement age control. However, confusion in interpretations resulted in abuses, cost increases and inconsistently imposed exceptions.

Many other programs were then undertaken to study age control. The results of many of these were summarized in the Air Force report, AFML-TR-67-235. The conclusion of the studies summarized in this report and others that were in progress was that the overall properties of elastomeric materials were much improved over the materials initially evaluated and age control should be made less restrictive. As a result of this information, MIL-STD-1523 was released in 1973 and superseded ANA Bulletin 438. One of the basic requirements of the new document was to provide a cure date limitation of twelve quarters from cure date to acceptance of the seals by the original procuring activity, whether a government agency, a first or second contractor or a kitter. In all cases, the use of cure date was intended to provide for good FIFO (First In - First Out) warehousing procedures.

3.1 (Continued):

On February 1, 1984, MIL-STD-1523A was issued to supersede MIL-STD-1523. This revision was targeted at eliminating the confusion in interpretation of the previous document. It also extended cure date requirements from 12 quarters to 40 quarters.

MIL-STD-1523A controlled the age of elastomers only at time of acceptance by the government. This meant that the cure date of each elastomer had to be known at the time a system was accepted by the government.

Even with the clarifications of MIL-STD-1523A, confusion still existed and the discussion regarding the need for age control continued.

3.2 EPRI NP-6608:

In June, 1989, Bruce Boyum and Jerral Rhoads presented an IEEE Paper: "Elastomer Shelf Life: Aged Junk or Jewels" - IEEE Transactions on Energy Conversion, Vol.4, No.2, pp 191-203, June, 1989. After a detailed review of the information from previous studies and the age control documents including MIL-HDBK-695C, they concluded that age control limits were very conservative and shelf life could be extended as long as proper storage conditions were maintained.

This was followed up in May, 1994 by EPRI NP-6608, "Shelf Life of Elastomeric Components". The conclusion of this detailed study was that with proper storage, shelf life for elastomer seals could be extended to 32 years.

3.3 AS1933A:

Based upon the data from the numerous studies concerning age control and shelf life, MIL-STD-1523A was canceled on January 30, 1995 - without replacement but reference was made to AS1933A, “Age Controls for Hose Containing Age-Sensitive Elastomeric Materials”. This action, in essence, released aerospace elastomers from age control.

In the time since the cancellation of MIL-STD-1523A confusion has reigned. Contractors are not aware of the history of age control and still insist on it. Quality organizations are not only still insisting on age control but are now using AS1933A for seals or referring to MIL-HDBK-695C.

Some of the insistence for age control is due to the requirement that the latest revision of specifications must be used and if age control or cure date requirements are removed, there is no traceability to specification revisions. In addition, organizations are concerned about FIFO requirements being maintained.

3.4 ARP5316:

To address the needs of contractors and to alleviate the confusion created by the cancellation of MIL-STD-1523A, ARP5316 was issued. This recommended practice addresses elastomeric seal components and offers a control document for those organizations which require one. It includes recommended shelf life limits that are consistent with the data from the cumulative studies on age control. It addresses the need for traceability and proper storage of elastomeric components of seals. It also provides a document that addresses seals not hoses, rubber boots, etc. It provides a reference source for Quality Organizations to work with.

The recommended storage times are based upon industry input regarding practical storage limits based upon FIFO requirements. Most users of the elastomers addressed in this ARP will find that the times listed in the document are beyond the time periods utilized in FIFO programs. More importantly, proper storage and traceability are emphasized since these are the key elements in promoting long shelf life and ensuring that the elastomeric seal components meet the latest revision of a specification.

3.5 MIL-HDBK-695D:

This recently released revision directs the reader to ARP5316 for questions concerning elastomer seal shelf life.

3.6 DOD 4141.27.M:

The DOD Shelf Life Management Manual uses ARP5316 as its key reference for elastomer seal shelf life.

4. DEFINITIONS:

4.1 ELASTOMER:

A material that possesses elastic properties and has undergone vulcanization and/or conversion into a finished product.

4.2 SEAL:

An elastomeric finished product or an assembly with an elastomeric element which prevents the excursion of media on one side of the product from migrating to the other side.

4.3 STORAGE LIFE:

The maximum period of time, starting from the time of manufacture, that an elastomeric seal element, appropriately packaged, may be stored under specific conditions, after which time it is regarded as unserviceable for the purposes for which it was originally manufactured. The time of manufacture is the time of cure for thermoset elastomers or the time of conversion into a finished product for thermoplastic elastomers.

4.4 HARDWARE COMPONENT:

The unit in which the elastomeric seal element is placed.

5. PACKAGING:

5.1 Unless otherwise specified by the customer at the time of order, the elastomeric seal or seal assembly shall be packaged:

a. in individually sealed envelopes by the manufacturer, or

b. in individually sealed packets in multiple envelopes by the manufacturer provided that individually packaged elastomeric seals or assemblies can be removed without affecting the seal integrity of the other packets.

The packaging shall be carried out in an atmosphere in which the relative humidity is not greater than 65%. Contamination by oil, grease, etc. shall be avoided.

Seal assemblies (all components) shall be packaged in the same sealed envelope so that all elements of the assembly are present when the package is opened.

5.2 Packaging Materials:

All packaging materials shall be free of copper naphthenates or creosote preservatives which can degrade rubber.

Suitable materials include Kraft bags and polyethylene bags more than 0.075 mm thick and UV resistant. Opaque packaging is preferred but certified UV resistant materials can be used if available. Metal foil bags can be used provided they are salt free.

5.3 Labeling:

Each package or container shall be labeled with the following information which shall be visible from the outside of the package without breaking the seal:

a. Manufacturers' part number;
b. Specification number and Revision level;
c. Customer's part number and/or contract number (if requested);
d. Quantity in package;
e. Manufacturer's name and/or identity number (such as CAGE Code);
f. Quarter and Year of cure or manufacturer of the rubber component (e.g., July to September 1997 = 3Q97);
g. Manufacturer's batch number;
h. Rubber class designation per ASTM D 1418.

5.3 (Continued):

Expiration date will be added to the label for direct military procurement. It is not required to be on the label and will be added only when Purchaser specifically requests the addition because of direct military procurement.

6. STORAGE:

6.1 Temperature:

The storage temperature shall be below 100 °F (38 °C), except when higher temperatures are caused by temporary climate changes, and articles shall be stored away from direct sources of heat such as boilers, radiators, and direct sunlight.

NOTE: If the storage temperature is below 59 °F (15 °C), care should be exercised during the handling of stored articles as they may have stiffened and become susceptible to distortion if not handled carefully.

The temperature of articles stored below 59 °F (15 °C) shall be raised to approximately 68 °F (20 °C) throughout their mass before being installed into a component.

6.2 Humidity:

The relative humidity shall be such that given the variations of temperature in storage, condensation does not occur. In any event, if the elastomers are not stored in sealed moisture proof bags, the relative humidity of the atmosphere in storage shall be less than 75% r h, or if polyurethanes are being stored, shall be less than 65% r h.

6.3 Light:

Elastomeric seals shall be protected from light sources, in particular direct sunlight or intense artificial light having an ultraviolet content. The individual storage bags offer the best protection as long as they are UV resistant.

NOTE: It is advisable that windows of storage rooms where elastomers are stored in bulk be covered with a red or orange coating or screen.

6.4 Radiation:

Precautions shall be taken to protect stored articles from all sources of ionizing radiation likely to cause damage to stored articles.

6.5 Ozone:

As ozone is particularly deleterious to some elastomeric seals, storage rooms shall not contain any equipment that is capable of generating ozone such as mercury vapor lamps, high voltage electrical equipment giving rise to electric sparks or silent electrical discharges. Combustion gases and organic vapor shall be excluded from storage rooms as they may give rise to ozone via photochemical processes.

6.6 Deformation:

Elastomeric seals shall be stored free from superimposed tensions and compressive stresses or other causes of deformation. Where articles are packaged in a strain-free condition, they shall be stored in their original packaging. In case of doubt, the manufacturer's advise shall be sought.

Rings of large inside diameter shall be formed into three equal superimposed loops so as to avoid creasing or twisting.

NOTE: It is not possible to achieve this condition by forming just two loops.

6.7 Contact With Liquid and Semi-Solid Materials:

Elastomeric seals shall not be allowed to come into contact with liquid or semi-solid materials (for example, gasoline, greases, acids, disinfectants, cleaning fluids) or their vapors at any time during storage unless these materials are by design an integral part of the component or the manufacturer's packaging. When elastomeric seals are received coated with their operational media, they shall be stored in this condition.

6.8 Contact With Metals:

Certain metals and their alloys (in particular, copper, manganese, and iron) are known to have deleterious effects on elastomers. Elastomeric seals shall not be stored in contact with such metals (except when bonded to them) but shall be protected by individual packaging.

6.9 Contact With Dusting Powder:

Dusting powders shall only be used for the packaging of elastomeric items in order to prevent blocking. In such instances, the minimum quantity of powder to prevent adhesion shall be used.

6.10 Contact Between Different Elastomers:

Contact between different polymeric elastomers and elastomers of different seals shall be avoided. They shall not be packaged together in the same envelope.

6.11 Elastomeric Seals With Metal Parts Bonded to Them:

The metal part of bonded elastomeric seals shall not come in contact with the elastomeric element of another seal. The bonded seal shall be individually packaged. Any preservative used on the metal shall be such that it will not affect the elastomeric element or the bond to such an extent that the seal will not comply with the product specification.

6.12 Stock Rotation:

Elastomeric seal stock should be rotated on the FIFO principle (First In - First Out) so that the most recent manufactured parts remain in inventory.

7. RECORDING OF DATA DURING STORAGE:

7.1 Recording:

A record shall be kept of the initial physical properties and the dimensional characteristics of the elastomeric seal elements placed in storage. The records shall include the actual numerical results of the physical property tests for that batch of seals and the range of properties observed during testing. This record shall be maintained by the customer's Quality Organization until such time that the stock of seals has been depleted.

In addition to the inspection and testing reports, a record shall be maintained of the label information so that all information can be cross referenced.

8. DISCARDING OF SEALS:

8.1 After Storage Life Has Been Exceeded:

Once the storage life has expired, the elastomeric seals should be removed from inventory and destroyed per internal company procedures for the destruction of such materials.

9. STORAGE PERIOD:

9.1 Duration of Storage:

Unless otherwise specified in the product specification or Purchase Order notes, the maximum storage periods for unassembled elastomeric seal elements shall be those described in Tables 1 and 2. This presupposes that the stored elastomers meet the current specification revisions. If they do not, they must be discarded since only those elastomeric seals that meet the current specification revision should be used in applications to provide the highest integrity seal for the current system requirements.

TABLE 1 - Aerospace Material Specifications

Specification	Title	Polymer	Maximum Storage Life (Years)
AMS 3200	Butadiene-Acrylonitrile (NBR) Rubber Petroleum-Base Hydraulic Fluid Resistant (55-65)	NBR	15
AMS 3202	Butadiene-Acrylonitrile (NBR) Rubber Dry Heat Resistant (55-65)	NBR	15
AMS 3209	Chloroprene Rubber, Weather Resistant (65-75)	CR	15
AMS 3210	Chloroprene Rubber, Electrical Resistant (65-75)	CR	15
AMS 3212	Acrylonitrile Butadiene (NBR) Rubber Aromatic Fuel Resistant (55-65)	NBR	15
AMS 3213	Acrylonitrile Butadiene (NBR) Rubber Aromatic Fuel Resistant (75-85)	NBR	15
AMS 3215	Acrylonitrile Butadiene (NBR) Rubber Aromatic Fuel Resistant (65-75)	NBR	15
AMS 3216	Fluorocarbon (FKM) Rubber, High Temperature - Fluid Resistant Low Compression Set (70-80)	FKM	Unlimited
AMS 3218	Fluorocarbon (FKM) Rubber, High Temperature - Fluid Resistant Low Compression Set (85-95)	FKM	Unlimited
AMS 3227	Acrylonitrile Butadiene (NBR) Rubber, Hot Oil and Coolant Resistant, Low Swell (55-65)	NBR	15
AMS 3228	Acrylonitrile Butadiene (NBR) Rubber, Hot Oil and Coolant Resistant, Low Swell (65-75)	NBR	15
AMS 3229	Acrylonitrile Butadiene (NBR) Rubber, Hot Oil and Coolant Resistant, Low Swell (75-85)	NBR	15
AMS 3238	Butyl (IIR) Rubber, Phosphate Ester Resistant (65-75)	IIR	Unlimited
AMS 3239	Butyl (IIR) Rubber, Phosphate Ester Resistant (85-95)	IIR	Unlimited
AMS 3241	Chloroprene (CR) Rubber Weather Resistant (55-65)	CR	15
AMS 3242	Chloroprene (CR) Rubber Weather Resistant (75-85)	CR	15
AMS 3243	Chloroprene (CR) Rubber Flame Resistant (55-65)	CR	15
AMS 3244	Chloroprene (CR) Rubber Flame Resistant (65-75)	CR	15

TABLE 1 - Aerospace Material Specifications (Continued)

Specification	Title	Polymer	Maximum Storage Life (Years)
AMS 3248	Ethylene Propylene (EPM) Rubber Phosphate Ester Resistant 55-65	EPDM	Unlimited
AMS 3249	Ethylene Propylene (EPDM) Rubber, Hydrazine-Base-Fluid Resistant, 75-85	EPDM	Unlimited
AMS 3260	Rubber, Ethylene-Propylene-Diene EPDM Type	EPDM	Unlimited
AMS 3302	Silicone Rubber, General Purpose (45-55)	Q	Unlimited
AMS 3303	Silicone Rubber, General Purpose (55-65)	Q	Unlimited
AMS 3304	Silicone Rubber, General Purpose (65-75)	Q	Unlimited
AMS 3305	Silicone Rubber, General Purpose (75-85)	Q	Unlimited
AMS3306	Rubber, Silicone 1200 psi (8.27 MPa) High Modulus (55-65)	VMQ	Unlimited
AMS 3307	Silicone (VMQ) Rubber, Low Compression Set Non-Oil Resistant (65-75)	VMQ	Unlimited
AMS 3325	Fluorosilicone (FVMQ) Rubber, Fuel & Oil Resistant (55-65)	FVMQ	Unlimited
AMS 3327	Fluorosilicone (FVMQ) Rubber, High Temperature Fuel & Oil Resistant (70-80)	FVMQ	Unlimited
AMS 3328	Fluorosilicone (FVMQ) Rubber, Fuel and Oil Resistant (35-45)	FVMQ	Unlimited
AMS 3329	Fluorosilicone (FVMQ) Rubber, Fuel and Oil Resistant, High Strength, 45-55	FVMQ	Unlimited
AMS 3330	Fluorosilicone (FVMQ) Rubber, Fuel and Oil Resistant (45-55)	FVMQ	Unlimited
AMS 3331	Fluorosilicone (FVMQ) Rubber, Fuel and Oil Resistant (65-75)	FVMQ	Unlimited
AMS 3336	Silicone (PVMQ) Rubber, Extreme Low Temperature - Resistant (55-65)	PVMQ	Unlimited
AMS 3337	Silicone (PVMQ) Rubber, High & Extreme Low Temperature Resistant (65-75)	PVMQ	Unlimited
AMS 3338	Silicone (PVMQ) Rubber, Extreme Low Temperature Resistant (75-85)	PVMQ	Unlimited
AMS 3345	Silicone Rubber, 1000 psi (6.90 MPa) Tensile Strength, 45-55	Q	Unlimited
AMS 3346	Silicone Rubber - 1000 psi (55-65)	Q	Unlimited
AMS 3347	Silicone Rubber - 1200 psi, High Modulus (45-55)	Q	Unlimited
AMS 3348	Silicone (VMQ) Rubber 1150 psi (7.93 MPa) Tensile Strength, High Resiliency 25-35	VMQ	Unlimited

TABLE 1 - Aerospace Material Specifications (Continued)

Specification	Title	Polymer	Maximum Storage Life (Years)
AMS 3349	Silicone (VMQ) Rubber, 1100 psi (7.58 MPa) Tensile Strength, High Resiliency, 65-75	VMQ	Unlimited
AMS 3356	**Silicone (VMQ) Rubber, Lubricating Oil and Compression Set Resistant, Electrical Grade (55-65)**	VMQ	Unlimited
AMS 3357	Rubber, Silicone (VMQ), Lubricating Oil and Compression Set Resistant, 65-75	VMQ	Unlimited
AMS 3382	**Tetrafluoroethylene/Propylene Rubber (FEPM) Hydraulic Fluid and Synthetic Oil Resistant 70 to 80 and 85 to 95**	FEPM	Unlimited
AMS 7255	Rings, Sealing, Tetrafluoroethylene/Propylene Rubber (FEPM) Hydraulic Fluid and Synthetic Oil Resistance 70 to 80	FEPM	Unlimited
AMS 7256	**Rings, Sealing, Tetrafluoroethylene/Propylene Rubber (FEPM) Hydraulic Fluid and Synthetic Oil Resistance 85 to 95**	FEPM	Unlimited
AMS 7257	**Rings, Sealing, Perfluorocarbon (FFKM), Rubber, High-Temperature-Fluid Resistant (70-80)**	FFKM	Unlimited
AMS 7258	**Rings, Sealing, Acrylonitrile Butadiene (NBR) Rubber Fuel Resistant, Low Shrinkage (65-75)**	NBR	15
AMS 7259	**Rings, Sealing, Fluorocarbon (FKM) Rubber High-Temperature-Fluid Resistant, Very Low Compression Set (85-95)**	FKM	Unlimited
AMS 7260	Rings, Butadiene-Acrylonitrile (NBR) Rubber, Molded Fuel and Low Temperature Resistant 70-80	NBR	15
AMS 7264	Rings, Sealing, Silicone Rubber, High Temperature Resistant, Low Compression Set, 65-75	Q	Unlimited
AMS 7266	Rings, Sealing, Fluorosilicone Rubber, General Purpose, High Temperature, Fuel and Oil Resistant 65-75	FVMQ	Unlimited
AMS 7267	**Rings, Sealing, Silicone (VSI) Rubber Heat Resistant, Low Compression Set (70-80)**	VSI	Unlimited
AMS 7268	**Rings, Sealing, Silicone Rubber, Low Compression Set, Non-Oil Resistant (65-75)**	Q	Unlimited
AMS 7269	**Rings, Sealing, Silicone (PVMQ) Rubber, Low Outgassing, Space and Vacuum Service (45-55)**	PVMQ	Unlimited
AMS 7270	**Rings, Sealing, Butadiene-Acrylonitrile (NBR) Rubber, Fuel Resistant (65-75)**	NBR	15
AMS 7271	**Rings, Sealing, Butadiene-Acrylonitrile (NBR) Rubber Fuel and Low Temperature Resistant (60-70)**	NBR	15
AMS 7272	Rings, Sealing, Butadiene-Acrylonitrile (NBR) Rubber Synthetic Lubricant Resistant 67-75	NBR	15

TABLE 1 - Aerospace Material Specifications (Continued)

Specification	Title	Polymer	Maximum Storage Life (Years)
AMS 7273	Rings, Sealing, Fluorosilicone (FVMQ) Rubber, High Temperature Fuel and Oil Resistant 70-80	FVMQ	Unlimited
AMS 7274	Rings, Sealing, Butadiene-Acrylonitrile (NBR) Rubber Oil Resistant (65-75)	NBR	15
AMS 7276	Rings, Sealing Fluorocarbon (FKM) Rubber High-Temperature - Fluid Resistant Very-Low Compression Set (70-80)	FKM	Unlimited
AMS-P-5315	Packing, Preformed, Hydrocarbon Fuel Resistant	NBR	15
AMS-P-5510	Packing, Preformed, Straight Thread Tube Fitting Boss, Type Hydraulic (-65° to 160°F)	NBR	15
AMS-P-5516	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 160°F	NBR	15
AMS-P-25732	Packaging, Preformed, Petroleum Hydraulic Fluid Resistant, Limited Service at 275°F (135°C)	NBR	15
AMS-P-83461	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275°F (135°C)	NBR	15
AMS-R-6855	Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes		
	Class 1 - All Grades	NBR	15
	Class 2 - All Grades	CR	15
	Class 3 - All Grades	SBR	3
	Class 4 - All Grades	CR	15
	Class 5 - All Grades	SBR	3
AMS-R-7362	Rubber, synthetic, solid, sheet, strip and fabricated parts, synthetic oil resistant	NBR	15
AMS-R-25988	Rubber, Fluorosilicone Elastomer, Oil and Fuel Resistant, Sheets, Strips, Molded Parts and Extruded Shapes	FVMQ	Unlimited
AMS-R-83248	Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant	FKM	Unlimited
AMS-R-83285	Rubber, Ethylene-Propylene, General Purpose	EPDM	Unlimited
AMS-R-83412	Rubber, Ethylene-Propylene, Hydrazine Resistant	EPDM	Unlimited
AMS-R-83485	Rubber, Fluorocarbon Elastomer, Improved Performance at Low Temperature	FKM	Unlimited
NAS1613	Seal Element, Packing, Preformed, Ethylene Propylene Rubber	EPDM	Unlimited