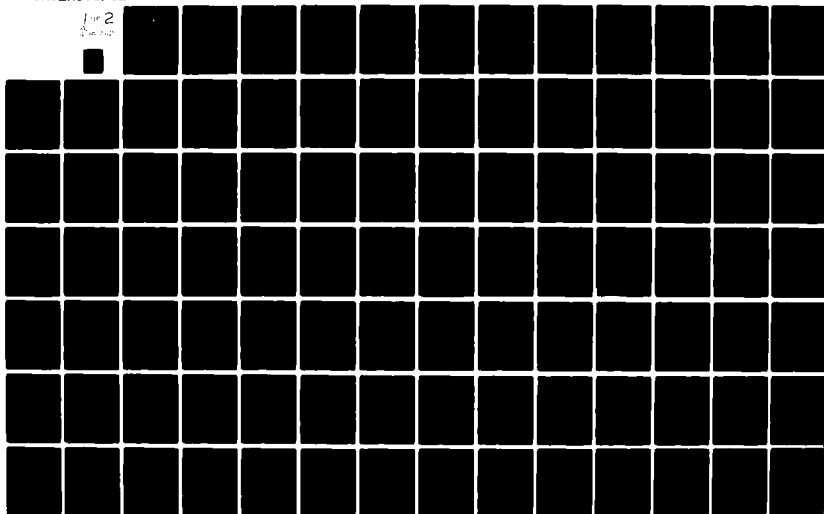


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REPORT NO. NADC-81080-60

AD A115782



REPLACEMENT OF ASBESTOS ABOARD NAVAL AIRCRAFT

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Aircraft and Crew Systems Technology Directorate
NAVAL AIR DEVELOPMENT CENTER
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10 NOVEMBER 1981

PROGRESS REPORT
AIRTASK A512-512C/001-4/0512-000-02
Work Unit AIR-5163-98

Approved for Public Release; Distribution Unlimited

Prepared for
NAVAL AIR SYSTEMS COMMAND
Department of the Navy
Washington, DC 20361

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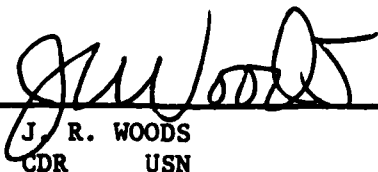
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SUMMARY

INTRODUCTION

Asbestos-containing materials have been widely used in Naval aircraft. However, the availability of asbestos is now limited. This developing shortage is already affecting the Navy in the area of replacement parts for some aircraft, and in the design development of new aircraft. The Department of Defense has been directed to reduce its dependence on asbestos wherever possible. In response to this requirement, the Naval Air Development Center has been tasked to coordinate efforts to identify Naval aircraft applications of asbestos and to identify replacement materials.

Information has been coordinated from three sources. A survey was initiated among the Naval Air Rework Facilities (NARFs) of all asbestos-containing parts. Private industry was solicited for materials that can be substituted for asbestos in Naval air applications. Contacts were established with the airframe and engine manufacturers, making them aware of the potential shortage and soliciting their assistance in minimizing asbestos usage.

SUMMARY OF RESULTS

During this phase of the asbestos replacement program a large amount of information was collated on the current uses of asbestos in Naval aircraft. This was obtained from the Naval Air Rework Facilities, airframe and engine manufacturers, and NAVAIRSYSCOM file material, and is summarized in Appendix A.

An initial priority was set by NAVAIRSYSCOM to find a replacement material for MIL-A-7021 asbestos sheet for gaskets. Two products were identified as suitable replacements and now should be commercially available.

A collection of literature on available replacement materials was established. Organic and inorganic fibers which might replace asbestos were identified. Since no single replacement fiber is known to exhibit all of the engineering properties of asbestos, replacement fibers must be carefully selected for each specific application. A summary of some replacement fibers and materials is included in Appendices B through D.

Several analytical methods were evaluated for identification of asbestos and are described in Appendix E.

CONCLUSIONS

Inquiries revealed that many aircraft and engine manufacturers were not aware of the potential asbestos shortage problem, only of the health effects. As a result, asbestos substitution by manufacturers has been limited to areas where human exposure could occur.

Initial contacts with some of the aircraft and engine manufacturers have indicated a willingness to cooperate with the Navy in identifying asbestos-containing parts on the aircraft, and in finding suitable replacements. They also appear to be in the best position to do the initial test and evaluation work on the replacement materials.

RECOMMENDATIONS

Airframe and engine manufacturers should be notified of the shortage aspects and of the need for a replacement program. They should be asked to determine the level of effort required to find substitute materials, with contracts then let to accomplish the work. Along with industry, Naval Air Rework Facilities should be solicited to assist in collecting data on aircraft parts known to contain asbestos, funding to be provided where needed. Data required include reports on asbestos replacement materials already in use, and on-site recommendations or complaints on the use of replacement materials. NAVAIRDEVCON would monitor and review the efforts of industry and the NARFs. NAVAIRDEVCON in-house effort would include limited characterization of replacement materials and a feasibility study with respect to applications. At the conclusion of all phases of the investigation, NAVAIRDEVCON would evaluate the consolidated information and make recommendations to NAVAIRSYSCOM in a final report.

It is further recommended that two replacement materials, Armstrong's Thermo-Tork TN-9000 and Rodgers' Nobestos D-7100, be field tested to determine their suitability for replacement of MIL-A-7021.

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BACKGROUND

The use of asbestos fiber, beginning in the late 1800's, has become widespread in this century due to its exceptional engineering properties and its relative low cost. But in view of increasing regulation of asbestos-related industries (due to asbestos-linked diseases such as asbestosis, lung cancer, and mesothelioma) as well as potential asbestos shortages (as the resource becomes exhausted), the Department of Defense has been directed to limit its dependence on asbestos.

Although the uses of asbestos in many instances do not require the unique combination of properties associated with that fiber, it has often been the material of choice due to its low cost. Table I lists the major applications for asbestos (reference (a)).

The term "asbestos" actually refers to six types of fiber. Chrysotile, which makes up 95 percent of the world asbestos production, is the fibrous form of the mineral serpentine. Amosite, crocidolite, anthophyllite, tremolite, and actinolite are fibrous forms of the mineral amphibole. Table II lists physical and chemical properties of each (reference (a)).

In general, asbestos is used for its heat resistance (to more than 500°C), reinforcement properties (fiber tensile strength is nearly that of steel), flexibility (it can be spun and woven), ability to be subdivided into fine particles, electrical and thermal insulating ability, chemical resistance, low abrasiveness, excellent absorption and filtering properties, and excellent processing characteristics in resinous mixtures.

Table I

Major Applications for Asbestos

Asbestos Friction Materials**Brake Linings**

- Woven, containing asbestos yarn, tape, or cloth
- Molded, including all nonwoven types

Clutch Facing

- Woven, containing asbestos yarn, tape, or cloth
- Nonwoven—clutch lining, transmission lining

Asbestos-Cement Materials

- Flat sheets and wallboard, all thicknesses converted to 1/4-in. basis

Slabs**Corrugated sheets****Pipes**

- Corrugated tiles for roofs in industry, agriculture, and dwellings

- Planks for platforms in buildings under construction

Balcony canopies**Rain gutters****Interior walls****Ventilating shafts****Air conditioning assemblies**

- Pressure piping (for underground drinking water distribution systems, fuel gas, and sewage)

- Cooling towers (electricity-generating stations)

Asbestos felts

- Roofing-asphalt or tar-saturated

Other

- Other asbestos and asbestos-cement products, including millboard and prefabricated housing components

Asbestos Shingles and Clapboard

- Siding shingles and clapboard, including accessories

Roofing shingles**Asbestos Textiles**

- Yarn, cord, and thread

Cloth

- Other asbestos textiles, including roving, lap, wick, rope, tape, carded fibers, etc.

Table I (Continued)
Major Applications for Asbestos

Gaskets and Insulation

Gaskets, all types

Gaskets (for sealing nonmoving parts)

Asbestos, asbestos-metallic, and asbestos-rubber

Packing (except leather, rubber, and metal) and asbestos insulations

Asbestos compressed sheet

Packing (for sealing moving parts)

Asbestos, asbestos-metallic, and asbestos-rubber

Insulation materials containing asbestos pipe insulation (cellular and laminated)

85% magnesite

Diatomaceous silica, calcium silicate, expanded silica, and asbestos fiber

Other block insulation, including cellular and laminated

All other asbestos insulation

Asbestos Boards and Papers

Boards

Filtering and clarifying

Coverings, coatings, casings, and jacketings for all kinds of surfaces

Manufacturing of welders and melters shields

Slideways in the glass industry

Handles and fire doors

Auto parts

Safes

Protective walls

Curtains, etc.

Sheets

Inner/outer linings of furnaces and heating vessels, drying ovens, incubators, heaters, climate-controlled spaces, etc.

Plates

Insulating buildings against vibrations (aluminum-asbestos)

Solar-heat reflecting surfaces (70% of solar heat)

Special Asbestos Papers

Filters

Asbestos Plastics

Flooring tiles (asbestos-asphalt tiles and, increasingly, asbestos-polymers of vinyl)

Pressed or molded (thermal insulation and in electrical machinery)

Resinated asbestos felt (manufacturing of wings and firing of missiles, and expansion cones for nozzles of boost motors). Other uses in aircraft industry: nozzles for motor tubes, missile tailpipes and missile-heat barriers, fuselages for guided missiles, fuel tanks for fighter bombers, cabin floors, etc.

Asbestos Acid-Resistant Compositions

Used mostly in chemical industry

Table II
Physical, Chemical, and Mineralogical Properties of Varieties of Asbestos

Property	Chrysotile	Crocidolite	Amosite	Anthophyllite	Tremolite	Actinolite
Chemical Formula	$Mg_3Si_2O_5(OH)_4$	$Na_2Fe_3Si_3O_{10}(OH)_2$	$(FeMg)_6Si_8O_{22}(OH)_2$	$(FeMg)_7Si_8O_{22}(OH)_2$	$Ca_2Mg_5Si_8O_{22}(OH)_2$	$(CaMgFe)_6Si_8O_{22}(OH)_2$
Essential Composition	Hydrous silicate of magnesia	Silicate of sodium and iron with some water	Silicate of iron and magnesium; higher iron than anthophyllite	Magnesium silicate with iron	Calcium and magnesium silicate with some water	Calcium-magnesium-iron silicate; water up to 5%
pH	9.2-9.8	—	—	Neutral	—	—
Resistance to Acids	Poor	Good	—	—	Good	Good
Veining	Cross and slip fibers	Cross fiber	Cross fiber	Slip, mass fiber unoriented and interfacing	Slip or mass fiber	Slip or mass fiber
Color	Green, gray, amber to white	Blue	Gray, yellow to dark brown	Yellowish brown, grayish white	Gray-white, greenish-yellowish, bluish	Greenish
Texture	Soft to harsh, also silky	Soft to harsh	Coarse but somewhat pliable	Harsh	Generally harsh, sometimes soft	Harsh
Luster	Silky	Silky to dull	Vitreous, somewhat pearly	Vitreous to pearly	Silky	Silky
Hardness ^a	2.5-4.0	4	5.5-6.0	5.5-6.0	5.5	6±
Flexibility	High	Good	Good	Good	Poor	Poor
Spinnability	Very good	Fair	Fair	Poor	Poor	Poor
Tensile Strength, lb/in.	824,000 max.	878,000 max.	16,000-90,000	4,000 and less	1,000-8,000	1,000 and less
Fusion Point, °C	1,520	1,195	1,400	1,470	1,315	1,395
Specific Heat, Btu/lb-°F	0.266	0.201	0.193	0.210	0.212	0.217
Electric Charge	Positive	Negative	Negative	Negative	Negative	Negative
Filtration Properties	Slow	Fast	Fast	Medium	Medium	Medium
Specific Gravity	2.4-2.6	3.2-3.3	3.1-3.25	2.85-3.1	2.9-3.2	3.0-3.2
Cleavage	010 perfect	110 perfect	110 perfect	110 perfect	110 perfect	110 perfect
Optical Properties	Biaxial positive, extinction parallel ¹	Biaxial ± extinction inclined	Biaxial positive, extinction parallel	Biaxial positive, extinction parallel	Biaxial negative, extinction inclined	Biaxial negative, extinction inclined
Refractive Index	1.50-1.55	1.7 pleochroic	1.84±	1.61±	1.61±	1.63± weakly pleochroic
Resistance to Destruction by Heat	Good, brittle at high temperatures	Poor, fuses	Good, brittle at high temperatures	Very good	Fair to good	—
Temperature at Ignition Loss, °C	1,000	850	900-1,000	1,000	1,000	—
Magnetite Content, %	0.0-0.5	3.0-5.9	0	0	0	—

^aWorking Scale of Hardness: 1, very easily scratched by fingernail, and has greasy feel to the hand; 2, easily scratched by fingernail; 3, scratch by brass pin or copper coin; 4, easily scratched by knife; 5, scratch with difficulty with knife; 6, easily scratched by file; 7, little touched by file, but will scratch window glass. All harder than 7 will scratch window glass.

ASBESTOS SURVEY RESULTS

No replacement material for asbestos can be expected to have its unique combination of physical properties. The goal in finding suitable replacements is to duplicate as closely as possible those properties of asbestos that are necessary to the individual application. For example, an asbestos replacement candidate for use in a clutch lining should have high heat and abrasion resistance, and excellent tensile strength, but electrical insulating and chemical resistance properties may not be important.

For this reason, the first priority was to identify all uses of asbestos in Naval aircraft, to determine the properties necessary for each part. A parts survey form was developed for this purpose in which information was organized according to the individual aircraft. The following information was requested from aircraft manufacturers and rework facilities.

- a. Aircraft/ground support equipment for which part is used
- b. Part name, part number, manufacturer
- c. Location of installed part
- d. Applicable military or other specification
- e. Reason for use
- f. Part environment: maximum part temperature
fluid exposure
stress level
other factors — abrasion, vibration, etc.
- g. Recommendations for replacement
- h. Permanent or replaceable part: if permanent, do fiber emissions exceed exposure limits
if replaceable, what is repair frequency

The parts survey form was first used to organize parts information from the many correspondences in the original NAVAIRSYSCOM files. At the same time a listing was made of all the military specifications that contain asbestos.

Contacts with several airframe and engine manufacturers have indicated that they had been unaware of the potential shortage of asbestos. Their previous replacement efforts had been directed towards replacing asbestos only in areas where human exposure could occur. The manufacturers have indicated a willingness to cooperate, especially if they were to receive funding to find and test substitute materials. Two manufacturers have responded to the parts survey.

Appendix A represents the data obtained from NAVAIRSYSCOM combined with parts surveys received from the NARFs, and the airframe and engine manufacturers.

IDENTIFICATION OF ASBESTOS REPLACEMENTS

MATERIALS

Since the use of asbestos fiber has been a direct result of not only its excellent thermal properties but also its relative low cost, many asbestos substitutes already exist, although they may be somewhat more costly.

Carbon or graphite fibers are an outstanding substitute for asbestos in high temperature gasket and packing applications. Graphite fibers can be used to 3000° C in nonoxidizing atmospheres, are resistant to nearly all fluids except strong oxidizing acids, are self-lubricating, and conduct heat rapidly. Two drawbacks are 1) shorting of electrical equipment in the event of a gasket or packing blowout (preventable with antiextrusion rings) and 2) dissimilar metal corrosion caused by graphite/aluminum or graphite/steel couples (reference (b)). In addition, high modulus graphite fibers are an excellent substitute for asbestos fibers in high strength composites where thermal insulation is not important.

Man-made inorganic fibers, however, do possess good insulating capabilities. The following table lists the more important materials, their compositions, and temperature limitations.

Table III

Inorganic (Non-Metal) Fibers

	SiO ₂	Al ₂ O ₃	Other	Loss of Flexibility at (°C)
Nextel (3M)	24	62	14 (B ₂ O ₃)	1425
Fiberfrax (Carborundum)	48	52	—	1260
Refrasil (Hitco)	98	—	—	1000
"Irish" Refrasil (Hitco)	97	—	1-3 (Cr ₂ O ₃)	1260
Astroquartz (J.P. Stevens)	99	—	—	1000
"E" Glass (Owens Corning)	54	14	20 (CaO) 10 (B ₂ O ₃)	370
"S" Glass (Owens Corning)	65	25	10 (MgO)	540

The first five fibers listed above are several times more expensive than glass, and all are rather brittle and abrasive. Such materials are well-suited to static applications (see Appendix B for technical and product information) and as fillers in composite compositions.

High performance organic fibers are being promoted for many former asbestos applications, such as packings, gaskets, and fire protection fabrics. The following table compares properties of the important high temperature fibers.

Table IV
Organic Fibers
(Reference (c))

	Tensile Strength (10 ³ psi)	Decomposition or Melt Temperature (°C)	Moisture Pickup (%) at 21 °C/65% R.H.
Kevlar (Du Pont)	400	499	4.5 (55% R.H.)
Nylon 6.6	86-134	249	4.0
Nomex (Du Pont)	90	400	6.5
Dacron (Du Pont)	50-99	250	0.4
Teflon (Du Pont)	25-31	288	0

Teflon and Kevlar (Appendix B) are useful in many dynamic applications. PV ratings (pressure in psi multiplied by velocity in feet per minute) for Teflon and Kevlar are 275,000 and 450,000, with maximum service temperatures of 260°C and velocities of 1900 feet per minute. Both can be used as gasketing materials as well, but Teflon has a tendency to cold flow resulting in significant creep relaxation, and Kevlar has exhibited rather low compressive strengths when used as composite reinforcement (reference (b)). All of these fibers are useful as insulating sleeving and electrical cable insulation.

APPLICATIONS

Of the many federal, military, and industry specifications for asbestos materials or materials which might contain asbestos, the following have been identified as coordinated or prepared by the Naval Air Systems Command:

MMM-A-132	AMS-3839
MMM-A-134	AMS-3840
MIL-A-7021	AMS-3842
MIL-P-19918	AMS-3858
MIL-P-25770	

At the start of the program, MIL-A-7021 (Asbestos Sheet, Compressed, for Fuel, Lubricant, Coolant, Water, and High Temperature Resistant Gaskets) was a first priority item for asbestos replacement due to its importance to depot-level maintenance organizations. A survey of nearly a dozen gasket manufacturers revealed that almost the entire industry was in the process of developing such a material, and that it was only a matter of time before such products would be available. Two products are now being promoted for high temperature applications which possess properties similar to MIL-A-7021: Armstrong's Thermo-Tork TN-9000 and Rodgers' Nobestos D-7100 (see preliminary data sheets in Appendix C).

Included in Appendix D are possible sleeving substitutes (for fuel, hydraulic lines, etc.) manufactured by Santa Fe Textiles, Inc.

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- (b) Graner, W.R., "Non-Asbestos Alternatives for Asbestos Compression Packings and Gaskets," David W. Taylor Naval Ship R & D Center Contract Report N00600-76-D-0511, 15 December 1979.
- (c) Santa Fe Textiles, Inc., "Braiding Material Chart."
- (d) Schelz, J.P., "The Detection of Chrysotile Asbestos at Low Levels in Talc by Differential Thermal Analysis," *Thermochimica Acta*, 8, 197-204 (1974).
- (e) DuPont Thermal Analysis System, Application Brief No. 6: "Binder Content of Asbestos Gasket Material," 1 December 1967.
- (f) Michaels, L. and Chissick, S.S. (eds.), *Asbestos* (Volume 1, Properties, Applications, and Hazards), p. 94-106, John Wiley & Sons, New York (1979).
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APPENDIX A

SURVEY RESULTS:

ASBESTOS-CONTAINING AIRCRAFT MATERIALS

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PARTS SURVEY FORM

AIRCRAFT: A-4
 MANUFACTURER: McDonnell-Douglas
 CFAMARF: Pensacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
5819253-7/9	Insulator Tape Raybestos- Manhattan	Engine	LS-9280 Tape			Cryol glass-filled nylon sheet Johns-Manville	
5814151-17	Asbestos Tape					Refrasil Type I Series UT-96	
E10-7730-5	Pad		AFC 481				
2878769	Marinite 23A					Marinite I Johns-Manville	

PARTS SURVEY FORM

AIRCRAFT: A-8

MANUFACTURER: Grumman

CF/NAF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	EA-9307 Hysol Paste Sealant (A-14%, B-0%)		GA1008D04	High temp liquid shim			
	EC-1128 3M Roping Sealant (15%)		GC118AG1 GC118AG2	Restricted use in areas which do not exceed 121°C; Usually over-coated with GM4107			
	PR1422 CLB2 Products Research Paste Sealant (3%)		MIL-S-8802 Class B-2	General sealant		Not used since 1974	
	Pro-Seal 700 Essex Chem. Co. Paste Sealant (A-6%, B-0%)		MIL-S-38249 Type I	Firewall sealant			
	BR-92 American Cyanamid Paste Adhesive (3-3.5%)		GA1008D05	General purpose adhesive repair of honeycomb structure			
	EA-934 Hysol Paste Adhesive/ Liquid Shim (A-14%, B-0%)	Fishmouth Splice Inboard Wing	GM4004-221 GA1008D08	Liquid shim and general purpose epoxy adhesive			

PARTS SURVEY FORM

AIRCRAFT: A-6

MANUFACTURER: Grumman

CF/NAIRF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Aerobond 2143 Adhesives Engineering Paste-Adhesive/ Liquid Shim		GM4004-221 GA1008D08	Liquid shim and general purpose adhesive		Dexter-Hysol bought out product line and discontinued the product	
	EA-9308.2 Hysol Paste Adhesive (A-3%, B-0%)		GA1008D04	General purpose adhesive			
	Metbond 329 Narmco Materials Film Adhesive (1%)		GM4355-1	Honeycomb bonding			
	Reliabond 368 Reliable Mfg. Film Adhesive (3%)		GM4355-1	Honeycomb bonding			
	LR-7356C (7%) LR-7605C (4%) LR-7606C (6%) Akron Paint & Varnish Co. Coating	Walkways	MIL-W-6044	Walkway coatings			

PARTS SURVEY FORM

AIRCRAFT: A-6

MANUFACTURER: Grumman

CFANARF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Asbestos Fire Shield R4622 Resistoflex Sleeve (99%)	Power Plant Flex Hoses	GS630E	Cover power plant flex hoses			
	Asbestos Fire Shield 96040 Titerflex Sleeve (99%)	Power Plant Flex Hoses	GS630AD	Cover power plant flex hoses			
	PR-1436G Ty. I PR-1436G Ty. III Products Research Type I - Brush Type III - Spray (2%)	Cockpit Floors	MIL-S-81733 GC-116AP01	Overcoat cockpit floors Steel fastener overcoat			
	Prestite 591.1 Interchemical Co. Paste Sealant (30-40%)		GSS14300	Channel groove sealant		Replaced by 094-011 in 1964	
	Metaset A-4 Smooth-On Paste-Adhesive/ Liquid Shim (A-1%, B-1%)	Wing to Fus- lage Fittings	GM4004121	Used primarily as liquid shim on wing to fuselage fittings			

PARTS SURVEY FORM

AIRCRAFT: A-6
 MANUFACTURER: Grumman
 CFN/ARF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Adhesive & Sealant	Fishmouth Splice Inboard Wing	GS27001-2				
	EA930 Adhesive & Sealant	Fishmouth Splice Inboard Wing					
	Seal	Aft Turbine Exhaust Outlet on Train & Train Provisioned A/C					
	Power Plant Flex Hoses (99% Asbestos Braided Sleeve) Resistoflex R4522 Titelflex 96040	Installed Over Fuel Oil and Hydraulic Flex Hoses in Power Plant Area		Fire shield			
	Asbestos Filled Epoxy Resin Hysol EA834			Fill and repair panels		ADX938 wood fiber (cellulosic fiber) and cabasil to make thixotropic	
1128EC41163-19	Gasket		MIL-A-7021				
128810813-1	Sleeve		AMS-3940				
128810813-3	Sleeve		AMS-3940				

PARTS SURVEY FORM

AIRCRAFT: EA-6B

MANUFACTURER: Grumman

CFWABF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	EA-9307 Hysol Paste Sealant (A-14%, B-0%)		GA1008D04	High temp liquid shim			
	EC-1126 3M Roping Sealant (15%)		GC115AG1 GC115AG2	Restricted use in areas which do not exceed 121°C; Usually over- coated with GM4107			
	PR1422 CLB2 Products Research Paste Sealant (3%)		MIL-S-8802 Class B-2	General sealant		Not used since 1974	
	Pro-Seal 700 Essex Chem. Co. Paste Sealant (A-5%, B-0%)		MIL-S-38249 Type I	Firewall sealant			
	BR-92 American Cyanamid Paste Adhesive (3-3.5%)		GA1008D05	General purpose adhesive repair of honeycomb structure			

PARTS SURVEY FORM

AIRCRAFT: EA-68

MANUFACTURER: Grumman

CFANAF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	EA-934 Hysol Paste Adhesive/ Liquid Shim (A-14%, B-0%)		GM4004-221 GA1008D08	Liquid shim and general purpose epoxy adhesive			
	Aerobond 2143 Adhesives Engineering Paste-Adhesive/ Liquid Shim		GM4004-221 GA1008D08	Liquid shim and general purpose adhesive		Dexter-Hysol bought out product line and discontinued the product	
	EA-9309.2 Hysol Paste Adhesive (A-3%, B-0%)		GA1008D04	General purpose adhesive			
	Matbond 328 Narmco Materials Film Adhesive (1%)		GM4355-1	Honeycomb bonding			
	Reliabond 388 Reliable Mfg. Film Adhesive (5%)		GM4355-1	Honeycomb bonding			

PARTS SURVEY FORM

AIRCRAFT: EA-68

MANUFACTURER: Grumman

CFANARF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	LR-7358C (7%) LR-7605C (4%) LR-7608C (6%) Akron Paint & Varnish Co. Coating	Walkways	MIL-W-5044	Walkway coatings			
	Asbestos Fire Shield R4522 Resistoflex Sleeve (99%)	Power Plant Flex Hoses	GSS30E	Cover power plant flex hoses			
	Asbestos Fire Shield 96040 Titeflex Sleeve (99%)	Power Plant Flex Hoses	GSS30AD	Cover power plant flex hoses			
	PR-1438G Ty. I PR-1438G Ty. III Products Research Type I - Brush Type II - Spray (2%)	Cockpit Floors	MIL-S-81733 GC-115AP01	Overcoat cockpit floors Steel fastener overcoat			
	Prestite 691.1 Interchemical Co. Paste Sealant (30-40%)		GSS14300	Channel groove sealant		Replaced by Q94-011 in 1964	

PARTS SURVEY FORM

AIRCRAFT: EA-6B

MANUFACTURER: Grumman

CFANAF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	HP-954 Hexcel Corp. Film Adhesive (1%)	AN/ALO-98 Pod Radome	GA100AG				
1128EC41163-11	Gasket		MIL-A-7021				
1128EC41163-13	Gasket		MIL-A-7021				
1128EC41163-17	Gasket		MIL-A-7021				
1128EC41163-19	Gasket		MIL-A-7021				
1128EC42028-11	Gasket		MIL-A-7021				
1128P40021-11	Gasket		MIL-A-7021				

PARTS SURVEY FORM

AIRCRAFT: A-7

MANUFACTURER: Vaught

CFR/NARSF: Jacksonville

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
	Asbestos-Filled Sealant (Asbestos Fibers in an Elastomeric Matrix) (A-7E)			Used in vibration damping applications			
202-22000	Asbestos/Steel Laminated Washers			Used as seals in the bleed duct V-band coupling	A small gap at the seal interface exposes the washer to the incoming bleed air; however, since the laminations are oriented parallel to the flow of air, there is no direct contact between it and the asbestos	Provided the exposed steel portion of the laminata is not damaged, this should not result in any asbestos contamination	
	Asbestos Spacers	Between the Exterior of the Bleed Air Ducts and the Support Structure (Only on A-7A)				Have not been used on subsequent airplanes	

PARTS SURVEY FORM

AIRCRAFT: AV-8A

MANUFACTURER: British Aerospace (28981) Formerly Hawker Siddeley

CFR/NR/F: Cherry Point

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
(K9042)75-01-0 601 (28981)A301691	120 Gal Drop Tank (Aux Fuel) In Outer Shell of Asbestos Phenolic Composite	Attached under Aircraft		Inexpensive filler for shell (binder phenolic) These are sanded Shop 93105	Outdoor conditions	Metal (Al) tanks	Replaceable (1)
(28981)C287737	Insulation	Battery Cooling Duct		Provides insulation	Heat of reaction nozzle	(2) Refrasil AR-100-98 Fabric coated (3) DC3145	Replaceable (1)
(28981)E292840 -1 thru -8	Insulating Gasket	Between Heat Shield and Fuselage		Insulates reaction blast from fuselage	Heat from reaction nozzles	(4) TN8000, 1/32 in.	
(28981)C274238 -3, -5	Insulation Rear Yaw Nozzle Ducting	Area of Rear Yaw Nozzle		High temp insulation	Heat of reaction nozzle	(2) Refrasil coated one side with DC3145(3)	Replaceable
(28981)B279969-1	Lagging, Front Reaction Nozzle	Fwd Nose Area		Insulate nearby mechanisms from reaction nozzle heat	Heat of reaction nozzle	(2) Refrasil fabric coat with (3) DC3145, Put Al foil one side	Replaceable (1)
(28981)C274238 -4	Lacing Cord for Insulation	Rear Yaw Nozzles		High temp resistance	Heat of reaction nozzle	(2) Refrasil cordage, 1/8" dia, UC - 100-B	Replaceable (1)
SEE NA 01-AVBA 2-3.3	Asbestos Muff	Over Connec- tions in Reaction Duct		Detect leaks by dis- coloring from hot gases at leaks	High heat	Indicator fabric - fiber- glass painted white inserted in fiberglass envelope	Replaceable (1)

NOTES: (1) COVERED BY ENGINEERING DIRECTIVE
 (2) REFRASIL - CERAMIC FABRIC, MADE BY HITEC PRODUCTS CO., DIV. OF ARMCO STEEL DISTRIBUTED BY
 TAYLOR PARKER CO. NORFOLK, VA AND UNITED SEAL AND RUBBER CO. SCOTTTDALE, GA
 (3) DC 3145 - ONE PART SILICONE RUBBER, DOW CORNING CO. MIDLAND, MICH
 (4) TN 8000 - GASKET MATERIAL RESISTS TEMPERATURES TO 1000°F MADE BY ARMSTRONG CORK CO.
 DISTRIBUTED BY CHEMELEC PRODUCTS, EASTERN MANUFACTURING SERVICES,
 22 SPRINGDALE RD., CHERRY HILL, NJ

PARTS SURVEY FORM

AIRCRAFT: C-98

MANUFACTURER: McDonnell Douglas Corp.

CFR/NABF: Commercial

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
9635162	Insulator (molded part)	Brake Piston					
9635668	Insulators (molded part)	Brake Heat Shield					
AE 102	Sleeving, Fire Retardant (Aeroquip)	Fuel Hoses in Engine Nozzles				In the process of being changed	

PARTS SURVEY FORM

AIRCRAFT: E-2

MANUFACTURER: Grumman

CFAMARF: North Island

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	EA-9307 Hysol Paste Sealant (A-14%, B-0%)		GA1008D04	High temp liquid shim			
	EC-1128 3M Roping Sealant (15%)		GC115AG1 GC115AG2	Restricted use in areas which do not exceed 121°C; Usually over-coated with GM 4107			
	PR1422 CLB2 Products Research Paste Sealant (3%)		MIL-S-8802 Class B-2	General sealant		Not used since 1974	
	Pro-Seal 700 Essex Chem. Co. Paste Sealant (A-5%, B-0%)		MIL-S-38249 Type I	Firewall sealant			
	BR-92 American Cyanamid Paste Adhesive (3-3.5%)		GA1008D06	General purpose adhesive repair of honeycomb structure			
	EA-934 Hysol Paste Adhesive/ Liquid Shim (A-14%, B-0%)		GM4004-221 GA1008D08	Liquid shim and general purpose epoxy adhesive			

PARTS SURVEY FORM

AIRCRAFT: E-2

MANUFACTURER: Grumman

CF/ANAF: North Island

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Aerobond 2143 Adhesives Engineering Paste-Adhesive/ Liquid Shim		GM4004-221 GA1008D08	Liquid shim and general purpose adhesive		Dexter-Hysol bought out product line and discon- tinued the product	
	EA-9309.2 Hysol Paste Adhesive (A-3%, B-0%)		GA1008D04	General purpose adhesive			
	Metibond 329 Nemco Materials Film Adhesive (1%)		GM4365-1	Honeycomb bonding			
	Reliabond 398 Reliable Mfg. Film Adhesive (3%)		GM4365-1	Honeycomb bonding			
	LR-7366C (7%) LR-7605C (4%) LR-7608C (6%) Akron Paint & Varnish Co. Coating	Walkways	MIL-W-5044	Walkway coatings			

PARTS SURVEY FORM

AIRCRAFT: E-2
 MANUFACTURER: Grumman
 CFANARP: North Island

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Asbestos Fire Shield R4522 Reistoflex Sleeve (99%)	Power Plant Flex Hoses	GS530E	Cover power plant flex hoses			
	Asbestos Fire Shield 96040 Titeflex Sleeve (99%)	Power Plant Flex Hoses	GS530AD	Cover power plant flex hoses			
	PR1436G Ty. I PR1436G Ty. III Products Research Type I - Brush Type III - Spray (2%)		MIL-S-81733 GC-116AP01	Steel fastener overcoat			
	Asbestos Cloth (100%)	Bleed Air Lines 123 EC 100023 100024 100053 100282 50020	GC100013 SS-C-1783	Duct clamp insulation on bleed air lines (1 sq. ft.) Clamp cushions on hot ducting		Discontinued use of asbestos in 1978	
123EC16043-11	Gasket		MIL-A-7021				
123EC16043-13	Gasket		MIL-A-7021				

PARTS SURVEY FORM

AIRCRAFT: E-2

MANUFACTURER: Grumman

CFANAF: North Island

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
123EC16043-15	Gasket		MIL-A-7021				
123P10603-15	Gasket		MIL-A-7021				
123P11440-15	Seal		GC110AP1				
123P11440-17	Seal		GC110AP1				
123P11506-11	Gasket		MIL-A-7021				
123P11506-17	Gasket		MIL-A-7021				

PARTS SURVEY FORM

AIRCRAFT: F-4

MANUFACTURER: McDonnell Douglas (76301)

CFANAF: North Island

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
32-50155	Gasket Insulating Bleed Air	Bleed Air System	MIL-A-17472 Superseded by MIL-A-7021 Type I	Resistance to high temperature	Very hot air	(2) TN 9001, 1/32 in. thick sheet	Replaceable (1)
320380065-93	Seal For Air Inlet Screen	Seal Over Air Inlet to Engines	MIL-R-3085	Prevent ingestion of foreign objects	Heat around engine	MIL-R-3085 SC-710A, E3 thickness 1/8 in.	Replaceable (1)

NOTES: (1) Covered by Engineering Directive

(2) TN 9001 - Gasket Material Resists Temp to 583°C. Made by Armstrong Cork Co.

PARTS SURVEY FORM

AIRCRAFT: F-14

MANUFACTURER: Grumman

CFAMARF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	EA-8307 Hysol Paste Sealant (A-14%, B-0%)		GA1008D04	High temp liquid shim			
	EC-1128 3M Roping Sealant (15%)		GC115AG1 GC115AG2	Restricted use in areas which do not exceed 121°C; Usually over- coated with GM4107			
	PR1422 CLB2 Products Research Paste Sealant (3%)		MIL-S-8802 Class B-2	General sealant		Not used since 1974	
	Pro-Seal 700 Essex Chem. Co. Paste Sealant (A-5%, B-0%)		MIL-S-38249 Type I	Firewall sealant			
	BR-92 American Cyanamid Paste Adhesive (3-3.5%)		GA1008D05	General purpose adhesive repair of honeycomb structure			
	EA-934 Hysol Paste Adhesive/ Liquid Shim A-14%, B-0%		GM4004-221 GA1008D08	Liquid shim and general purpose epoxy adhesive			

PARTS SURVEY FORM

AIRCRAFT: F-14

MANUFACTURER: Grumman

CFA/NARF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Aerobond 2143 Adhesives Engineering Paste-Adhesive/ Liquid Shim		GM4004-221 GA1008D08	Liquid shim and general purpose adhesive		Dexter-Hysol bought out product line and discon- tinued the product	
	EA-9309.2 Hysol Paste Adhesive (A-3%, B-0%)		GA1008D04	General purpose adhesive			
	Metibond 329 Narmco Materials Film Adhesive (1%)		GM4355-1	Honeycomb bonding			
	Reliabond 398 Reliable Mfg. Film Adhesive (3%)		GM4355-1	Honeycomb bonding			
	LR-7358C (7%) LR-7606C (4%) LR-7608C (6%) Akron Paint & Varnish Co. Coating	Walkways	MIL-W-5044	Walkway coatings			

PARTS SURVEY FORM

AIRCRAFT: F-14

MANUFACTURER: Grumman

CFR/NARS: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Asbestos Fire Shield R4622 Resistoflex Sleeve (90%)	Power Plant Flex Hoses	GSE30E	Cover power plant flex hoses			
	Asbestos Fire Shield 98040 Titriflex Sleeve (90%)	Power Plant Flex Hoses	GSE30AD	Cover power plant flex hoses			
	AF-130 3M Film Adhesive (10%)	Radome	GMA355-6	Radome applications			
	Insulator Asbestos Base, Phenolic Rein Laminate	Radome Assembly	AS1817018- 11, -13 MIL-P-25770 MIL-M-14F Type GPI-100			USPE-720E/7781	
	Block, Fire Shield Phenolic-Asbestos Molding Compd GR41RPD Type 9579		AS18191697 MIL-P-25770 Type 2 GRH- H			Unsanitized sheet 41RPD type 9579 Raybestos-Manhattan Inc.	

PARTS SURVEY FORM

AIRCRAFT: F-14

MANUFACTURER: Grumman

CFA/NARF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Power Plant Flex Hoses (99% Asbestos Braided Sleeve) Resistoflex R4522 Titeflex 96040	Installed over Fuel Oil and Hydraulic Flex Hoses in Power Plant Area		Fire shield			
	Asbestos Filled Epoxy Resin EA834					ADX839 wood fiber (cellulose fiber) and cabasil to make thixotropic	
	Teflon impregnated asbestos sheet		AMS 3840				
AMS3840 062X40X48	Extrusion		AMS 3840				
A51B36001-17	Insulator		MIL-A-7021				
A51E20103-11	Insulator		AMS 3840				
A51E20103-13	Skid		AMS 3840				
A51E20119-13	Gasket		MIL-A-17472				
A51E20119-17	Gasket		MIL-A-17472				
A51H20121-11	Gasket		MIL-A-17472				

PARTS SURVEY FORM

AIRCRAFT: F-14

MANUFACTURER: Grumman

CFE/NARF: Norfolk

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
A51H20124-11	Gasket		MIL-A-17472				
A51H20128-11	Gasket		MIL-A-17472				
A51K10001-13	Seal		MIL-P-17303				
A51K10001-15			MIL-P-17303				
A51K10001-17			MIL-P-17303				
A51K10001-19			MIL-P-17303				
A51K10001-21			MIL-P-17303				
A51L92038-413	Block		MIL-P-25770				
A51L92038-415	Block		MIL-P-25770				
A51L92044-411			MIL-P-25770				
A51L92044-413			MIL-P-25770				
A51P60350-13	Gasket		MIL-A-17472				

PARTS SURVEY FORM

AIRCRAFT: F-18

MANUFACTURER: McDonnell-Douglas

CF/MARF: North Island

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Hot Spotz Tape Insulated Tape (90-95% Asbestos) (26 oz used)	Electrical Connections		Used to insulate electrical connections			
	Presite 590.5 "Dum-Dum Tape" (1 lb used)			Used to attach fiber backing boards			
	FM404 Foaming Adhesive (1%)						
	MMS348 Liquid Shim (5%)			Liquid shim, repair material			
	EA934 Adhesive Hynol (10%)			Liquid shim, repair material			
	EA9309 Adhesive Hynol			Liquid shim, repair material			

PARTS SURVEY FORM

AIRCRAFT: H-1
 MANUFACTURER: Bell
 CF/MARP: Pensacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
204-060-815-159	Seal					Thermo Sil Garlock	

PARTS SURVEY FORM

AIRCRAFT: H-2

MANUFACTURER: Kaman

CFANAF: Pensacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
(84955) K611670-1	Main Rotor Blade - from EA834 Epoxy Adhesive Hysol	Main Rotor Blade - Doubler		Used as a structural adhesive in shops 83401 83402, 83403 in wet mode for attaching doubler	Outdoor conditions	Have nonasbestos alternate EA834NA	Replaceable
KAT-K682785-11	Gasket		MIL-A-7021C			30 mil paper Nomex Type 410	

PARTS SURVEY FORM

AIRCRAFT: H-3

MANUFACTURER: Sikorsky

CF/MARF: Pensacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
78288 mfg code 56115-20201-1 -2 -3	Main Rotor Blade - from EA934 Epoxy	Main Rotor Blade		Used as filler in shop 93403 in wet mode, then wet sanded		Have nonasbestos alternate EA934NA	
EFS-10	Asbestos Jacket	Battery Cable					
8122-82413-13, -14	Gasket		MIL-A-7021				
8135-20702-2	Gimbal Ring	Transmission					
SDI E36910-80	Brake Block	Transmission Stand					
56115-20201-1 -2 -3	Rotor Blade EA934 Filler Hysol	Main Blade		Build up leading edge for fitting abrasion strip	Under abrasion strip	EA934NA (nonasbestos) Hysol	Replaceable (covered by engineering objectives)

PARTS SURVEY FORM

AIRCRAFT: H-46

MANUFACTURER: Boeing Vertol (77272)

CFANAME: Cherry Point

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
BV Dwg A02DS100	Goodyear No. 9310862	Rotor Brake Pucks					
BV Dwg A15113511	Sheet - Johns - Marville JM-219 Sheet	Engine Exhaust IR Suppressor - Gasket		Long fiber asbestos felt for heat resistant binder; Elastomers wouldn't hold up here		Has no replacement (contact Ed Gallagher 9-223-9030 & 2581); Elastomers wouldn't hold up here	
BV Dwg 107S3308-182	Sheet - Johns - Marville JM-98	Synch Shaft Shield - Sta. 410					
BV Dwg A02S3104-18	Sheet - Johns - Marville JM-98	Engine Shaft Shield - Sta. 477					
BV Dwg A02S3105	Sheet - Johns - Marville JM-98	Synch Shaft Shield - Sta. 477					
BV Dwg A02S3106-2	Smoke Shield	Aft Fuselage		Insulates from engine heat	Engine heat	Refrasil ceramic fiber (Hitec) coated on both sides with DC3145 one part silicone rubber (Dow Corning)	Replaceable - covered by engineering directive
BV Dwg A02S3107-3 -4	Sheet - Johns - Marville JM-98 (Fluoroelastomer)	Engine Shaft Shield, Sta. 477					

*Elastomeric type cloth impregnated with neoprene

PARTS SURVEY FORM

AIRCRAFT: H-46
 MANUFACTURER: Boeing Vertol (77272)
 CFAMARK: Cherry Point

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
BV Dwg A0255808-1	Thermoprene Binder - Johns- Manville General Purpose Grade C	Engine Exhaust IR Suppressor					
Elano Dwg EL-131002-704	Asbestos Yarn - CEP 0920; Rev 36 (Omega Eng. Inc.)	Engine Exhaust IR Suppressor					
VFR 10753303-164 -165 -184 -161 -163	Engine Shaft Shields: Shop 93105, Cut and Sewn	Engine Shaft Station 410		Insulates from engine heat	Engine heat	Refrasil ceramic fiber (Hitco) coated on both sides with DC3145 one part silicone rubber (Dow Corning)	Replaceable - covered by engineering directive
A02R1502-7 -8 -9 -10 -11 -12	Main Rotor Blade - from EA834 Epoxy Mfg Code 77272	Main Rotor Blade		Used as filler in shop 93403 in wet mode, then wet sanded; Provides correct properties for cracking and transmitting warnings of failure immin- ent	Outdoor conditions	Have a nonasbestos alternate EA934NA (Hysol)	Replaceable - covered by engineering directives
A16S3016-2	Synch Shaft Seal	Engine Shaft		Insulates from engine heat	Engine heat	Refrasil ceramic fiber (Hitco) coated on both sides with DC3145 one part silicone rubber (Dow Corning)	Replaceable - covered by engineering directives

PARTS SURVEY FORM

AIRCRAFT: H-46

MANUFACTURER: Boeing Vertol (77272)

CFARAF: Cherry Point

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
	Fire Sleeves	Various Fluid Lines		Insulation of fluid from engine heat	Engine heat	Tubing made from ceramic fiber, coated with silicone RTV rubber if required	Replaceable

PARTS SURVEY FORM

AIRCRAFT: CH-53

MANUFACTURER: Sikorsky

CFANARF: North Island (Pensacola)

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Firewall Bulb-Type Seals (CH-53E)						
	Controls, Fire			In-flight protection for hydraulic fuel lines			
58137-91302	Clutch Lining	H-53 APP					
65370-4114-101	Clutch Lining	H-53 APP					

PARTS SURVEY FORM

AIRCRAFT: OV-10

MANUFACTURER: Rockwell International

CF/MARF: Cherry Point

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
305-533320	Gasket - HBY Sys. Hot Air Shut Off, Asbestos Rubber Sht.	1/AC	HH-P-46			Contract	
*8C78X-XX	Electrical Conduit; Neoprene Coated Asbestos Fabric		AS0135-008 Type 10			Contract	
305-470012	Gasket - Engine Oil Supply Line; Asbestos Rubber Sht.	2/AC	MIL-A-7021 Class 1			Contract	
305-470016	Gasket - Oil Tank Filler; Asbestos Rubber Sht.	2/AC	MIL-A-7021 Class 1			Spares	

*Rockwell International Standard Part - Used throughout aircraft - numerous applications of various diameters and lengths.

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CFANARF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
LS9338-7	Gasket; 2/AC	Pneumatic High Temp. & Pres. (Bleed Air & Starter Sys.)					
LS9338-7	Gasket; 1/AC	Pneumatic High Temp. & Pres. (Anti-icing Sys.)					
LS9338-21	Gasket; 1/AC	APU To Air Multiplier (Bleed Air Duct Assy.)					
AN900-10	Gasket; 1/AC	Box Assy. - Temp. Bulb (Air Distribution Sys.)					
AN900-10	Gasket; 1/AC	Bulb (Engine Oil Tank)					
AN900-9	Gasket; 1/AC	Sensing Starting Hose (Bleed Air & Starter Sys.)					
AN900-8	Gasket; 1/AC	Engine Oil Tank Sump					

PARTS SURVEY FORM

AIRCRAFT: P-3
 MANUFACTURER: Lockheed
 CF/MARF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
AN600-7	Gasket; 2/AC	Bleed Air Pres. Trans. (LH Center Wing Anti-Icing Sys.)					
AN600-3	Gasket; 4/AC	Check Valve Housing (Anti-Icing Sys.)					
803438-11	Seal; 1/AC	Access Door, Fwd. Tailpipe (No. 1 & 4 Nacelle Access Doors)					
803438-15	Seal; 1/AC	Access Door, Fwd. Tailpipe (No. 1 & 4 Nacelle Access Doors)					
803438-37	Seal; 2/AC	Access Door, Fwd. Tailpipe (No. 1 & 4 Nacelle Access Doors)					

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CFA/NARF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
816244-21	Seal; 1/AC	Fireshield Lower Panel (No. 1 & 4 Nacelle)					
816244-106	Seal; 1/AC	Fireshield Lower Panel (No. 1 & 4 Nacelle)					
816464-1	Seal; 1/AC	Fireshield (No. 1 Nacelle)					
816464-1	Seal; 1/AC	Fireshield (No. 4 Nacelle)					
816269-1	Seal; 1/AC	Cable, Fireshield (No. 1 Nacelle)					
816260-1	Seal; 1/AC	Cable, Fireshield (No. 4 Nacelle)					
816261-1	Seal; 1/AC	Cable, Fireshield (No. 4 Nacelle)					
816269-7	Seal; 1/AC	Access Door (No. 1 Nacelle)					

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CF/MARF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
817046-1	Seal; 23/AC	Stringer, Fire-shield (No. 1 & 4 Nacelle)					
817046-1	Seal; 16/AC	Stringer, Fire-shield (No. 2 & 3 Nacelle)					
816674-1	Seal; 1/AC	Inboard Side, Fireshield (No. 1 Nacelle)					
822705-1	Retainer; 1/AC	Seal, Outboard Side Fireshield (No. 4 Nacelle)					
815235-13	Retainer; 1/AC	Center Fire-shield Panel (No. 2 & 3 Nacelle)					
815235-15	Seal; 1/AC	Center Fire-shield (No. 2 & 3 Nacelle)					
816335-5	Retainer; 1/AC	Lower Fire-shield Panel (No. 2 & 3 Nacelle)					

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CFA/NARF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
816336-13	Seal; 1/AC	Lower Fire-shield Panel (No. 2 & 3 Nacelle)					
816336-14	Seal; 1/AC	Lower Fire-shield Panel (No. 2 & 3 Nacelle)					
816233-11	Retainer; 1/AC	Lower Fire-shield Panel (No. 2 & 3 Nacelle)					
816233-12	Retainer; 1/AC	Lower Fire-shield Panel (No. 2 & 3 Nacelle)					
816233-13	Seal; 1/AC	Lower Fire-shield Panel (No. 2 & 3 Nacelle)					
816233-14	Seal; 1/AC	Lower Fire-shield Panel (No. 2 & 3 Nacelle)					

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CFANAME: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
817037-1	Seal; 1/AC	Fireshield, Outbd. Side (No. 2 Nacelle)					
936871-101	Seal; 1/AC	Fireshield Outbd. Side (No. 3 Nacelle)					
817208-1	Seal; 1/AC	Gueset, Fire-shield (No. 2 & 3 Nacelle)					
902468-1	Seal; 1/AC	Engine Breatherline, Airshield (No. 2 & 3 Nacelle)					
960693-101	Seal; 1/AC	Isolation Shield Leading Edge (No. 1 & 4 Nacelle)					
836086-15	Seal; 1/AC	Tailpipe Shroud (Tailpipe)					
808464-17	Seal; 1/AC	Forward Tailpipe Access Door (No. 2 & 3 Nacelles)					

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CFANAF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
908886-17	Gasket; 1/AC	Augmenter Assy, Air, Oil Cooler Exit Duct (No. 2 & 3 Nacelle)					
907116-17	Seal; 1/AC	Flap, Oil Cooler (Oil Cooler Flap and Actuator)					
908822-11	Strip; 2/AC	Tailpipe Shroud (Tailpipe)					
908823-17	Seal; 2/AC	Bellmouth Half (Tailpipe)					
908884-13	Seal; 1/AC	Tailpipe Shroud (Tailpipe)					
908884-9	Seal; 1/AC	Tailpipe Shroud (Tailpipe)					
923129-3	Seal; 1/AC	Tailpipe Shroud LH (Tailpipe)					
923129-4	Seal; 1/AC	Tailpipe Shroud RH (Tailpipe)					
923202-3	Seal; 1/AC	Tailpipe Shroud (Tailpipe)					

PARTS SURVEY FORM

AIRCRAFT: P-3
 MANUFACTURER: Lockheed
 CFANAF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
923202-4	Seal; 1/AC	Tailpipe Shroud (Tailpipe)					
811332-9	Seal; 1/AC	Drip Pan, Bottom Cowl (Bottom Cowl Panel)					
836336-23	Seal; 1/AC	Corner, Drip Pan (Bottom Cowl)					
936417-101	Insulation Cover - Therm Blanket	APU; 1/AC					
936418-101	Insulation Boot - Therm Blanket	APU; 1/AC					
936419-101	Insulation Cover - Therm Blanket	APU; 1/AC					
936422-101	Insulation Cover - Therm Blanket	APU; 1/AC					
936425-101-103	Insulation Boot - Therm Blanket	1 ea.					
936480-101	Insulation Cover - Therm Blanket	APU; 1/AC					

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CFAN/AF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
936242-101 -105	Cover	Hydraulic Lines, Sta. 288 Fire Barrier; 1 ea.					
936252-101	Cover	Hydraulic Lines, Sta. 323 Fire Barrier; 1/AC					
937664-101	Insulation Blanket	Left Side, Pres- sure Deck; 1/ AC					
937666-101	Insulation Blanket	Right Side, Pressure Deck; 1/AC					
937666-101	Insulation Blanket	Center Pressure Deck; 1/AC					
937668-101 -105	Insulation Blanket	Left Side, Sta. 288; 1 ea.					
937669-101	Insulation Blanket	Right Side, Sta. 288; 1/AC					
937670-101	Insulation Blanket	Center Sta. 288; 1/AC					
937672-101	Insulation Blanket	Center, Sta. 323					

PARTS SURVEY FORM

AIRCRAFT: P-3

MANUFACTURER: Lockheed

CF/MARF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
937673-101	Insulation Blanket	Upper R.H., Sta. 323; 1/AC					
937674-101	Insulation Blanket	Lower, Sta. 323 1/AC					
937675-101 -106	Insulation Blanket	Center, L.H., Sta. 323; 1 ea.					
937676-101	Insulation Blanket	Upper, L.H., Sta. 323; 1/AC					
937677-101	Insulation Blanket	Lower, L.H., Sta. 323; 1/AC					
937678-107 -109	Fire Barrier Installation	Sta. 323; 1 ea.					
937678-111 -113	Fire Barrier Installation	Sta. 323; 1 ea.					

PARTS SURVEY FORM

AIRCRAFT: S-3A

MANUFACTURER: Lockheed

CFMARP: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	USONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
1288704-101	Insulation	Wing; 2/AC		Thermal insulator between bleed air duct mount bracket & structure			
SS-C-466 (Bulk Mat)	Tape, Asbestos	Engine Pylon; Isolation Mount; De-ice Duct; 2/AC					
SS-C-466 (Bulk Mat)	Tape, Asbestos	Wing; 2/AC		Thermal insulator between de-ice duct & mount			
1288631-103	Gasket ¹	Engine Pylon; Thermostat & Anticipator Gasket; 4/AC					
LS9336-1	Gasket ²	Engine; Tenth Stage Port Gasket; 2/AC					
LS9336-10	Gasket ²	ECS Compartment; Bleed Duct Flange Gasket; 1/AC					

¹Bolted Flange Gasket - is being replaced by a metal gasket on an attrition basis²Bolted Flange Gasket - comprised of spiral wound laminations of cres and asbestos

PARTS SURVEY FORM

AIRCRAFT: S-3A

MANUFACTURER: Lockheed

CFMAREF: Alameda

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
LS9338-11	Gasket ²	ECS Compartment; 4/AC		Cross bleed check valves & bypass valve flange joint gaskets, APU Duct			
LS9338-16	Gasket ²	ECS Compartment; 1/AC		Flow control & shutoff valve flange gasket			
400686-103 (LCC 741443)	Firewall Assy	APU Compartment; 1/AC		Heat shield			

² Bolted Flange Gasket - comprised of spiral wound laminations of cres and asbestos

PARTS SURVEY FORM

AIRCRAFT: T-2

MANUFACTURER: Rockwell International

CF/MARF: Penacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
*8C7BX-XX	Electrical Conduit; Neoprene-Coated Asbestos Fabric		AB0135-008 Type 10			Contract	
249-22423	Beam-Elevator Trailing Edge Extend- ed (Machining); Phen Sht Asbestos Base	2/AC	MIL-P-8059 Grade AA			Ship No. 1-292	
249-22424	Beam Elevator Trim Tab Trailing Edge Extension (Machining) Phen Sht Asbestos Base	2/AC	MIL-P-8059 Grade AA			Ship No. 1-292	
249-24420-5	Beam-Rudder Trailing Edge (Machining); Phen Sht Asbestos Base	1/AC	MIL-P-8059 Grade AA			Ship No. 1-316	
249-25020	Beam-Bullet Fairing Trailing Edge (Mach- ining); Phen Sht Asbes- tos Base	1/AC	MIL-P-8059 Grade AA			Ship No. 1-316	

*Rockwell International Standard Part - Used throughout aircraft - numerous applications of various diameters and lengths

PARTS SURVEY FORM

AIRCRAFT: T-2

MANUFACTURER: Rockwell International

CFANAF: Pensacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
263-31852-15	Filler - Windshield Cockpit Enclosure, Asy of; Phen Sht. Asbestos Base	2/AC	MIL-P-8059 Grade AA			Ship No. 1-316	
249-48733	Fairlead - Fuel Dump Valve; Cont Wing Szt. 161.2 Cable; Phen Sht. Asbestos Base	2/AC	MIL-P-8059			Ship No. 1-316	

PARTS SURVEY FORM

AIRCRAFT: T-28

MANUFACTURER: Rockwell International

C/FANAF: Pensacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
168-31018	Seal	Fire Wall Access Door					
200-63414-3, -5	Gasket		MIL-C-10316 MIL-C-4117				

PARTS SURVEY FORM

AIRCRAFT: T-33

MANUFACTURER: Lockheed

CFR/NRIF: Persepolis

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
LH-461198	Air Tube						

PARTS SURVEY FORM

AIRCRAFT: T-38
 MANUFACTURER: Northrop
 CFAN/ARF: Kelly AFB

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
	Gasket Material with an Asbestos Fabric Covered by an Elastomer					These materials have been specifically excluded by OSHA as having a potential for asbestos exposure	
	Epoxy Resin System Sealants, Etc. with Small Amounts of Asbestos Fillers					These materials have been specifically excluded by OSHA as having a potential for asbestos exposure	

PARTS SURVEY FORM

AIRCRAFT: T-30
 MANUFACTURER: Rockwell International
 CF/ANAF: Pensacola

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
265-523055	Fairlead	Lateral Control Cable	MIL-P-8059			MIL-P-15035 Type FBG L-P-508 Type II Grade CE	
270-522008	Fairlead	Control Cable	MIL-P-8059			MIL-P-15035 Type FBG L-P-508 Type II Grade CE	
265-520022	Fairlead	Control Cable	MIL-P-8059			MIL-P-15035 Type FBG L-P-508 Type II Grade CE	
517830	Asbestos Packing Material	Diffuser Case Struts-J60 Engine			85 psia, air temp of 288°C		

PARTS SURVEY FORM

AIRCRAFT: Various

MANUFACTURER: Sikorsky

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Hysol Paste Adhesive EA834 - Adhesive Contains Asbestos as Filler Material			Repair adhesive, all aircraft			
	Hysol Paste Adhesive EA8309 - Adhesive Contains Asbestos as Filler Material			Repairs: blades and airframe application, all aircraft			
	Firewall Bulb-Type Seals All S-61 Models & CH-53E					The asbestos used in the seals, control protection, and gaskets is contained by a binder and should not present a health hazard during handling and use	
	Brakes All Models Except SH-608	Rotor Brake, Wheel Brake APU Clutches					

PARTS SURVEY FORM

AIRCRAFT: Various

MANUFACTURER: Sikorsky

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
	Controls HSS-2, S-61, CH-53 A/D			Fire in-flight protection for hydraulic and fuel lines		The asbestos used in the seals, control protection, and gaskets is contained by a binder and should not present a health hazard during handling and use	
	Gaskets All Models		C7637B G126038 Type 1 A7021C			The asbestos used in the seals, control protection, and gaskets is contained by a binder and should not present a health hazard during handling and use	

PARTS SURVEY FORM

AIRCRAFT: Various
MANUFACTURER: Grumman

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Asbestos Fire Shield R4622 Resistoflex Sleeve (99%)	Power Plant Flex Hoses	GS530E	Cover power plant flex hoses			
	Asbestos Fire Shield 98040 Titeflex Sleeve (99%)	Power Plant Flex Hoses	GS530AD	Cover power plant flex hoses			
	Butyl Asbestos Fire Sleeve Resistoflex 1/4"-1"	Medium and High Pressure Hose Assemblies	GS530E			Resistoflex will replace with silicone/fiberglass fire sleeve qualified to FAA tests TS0-CS3, TS0- C75 and SAE AS1055 fire tests	
	Silicone Asbestos Fire Sleeve Titeflex	"Hi-Pac" Hose High Pressure, Medium Pressure	GS530AD			Titeflex will replace with silicone/fiberglass fire sleeve or integral silicone extruded fire sleeve	
	Silicone Asbestos Fire Sleeve Aeroquip		GS530AY			Silicone/fiberglass fire sleeve is being developed	

PARTS SURVEY FORM

AIRCRAFT: Various

MANUFACTURER: Grumman

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
		"Hi-Pac" Hose High Pressure				Integral extruded silicone fire sleeve	
		Medium Pres- sure Hose	GH12AV			Integral extruded silicone fire sleeve	
1128EC41183-19	Gasket		MIL-A-7021				
128810813-1	Sleeve		AMS 3940				
	Wittaker, Clark & Daniels Talc #387	Fuel Cells				Smith Chemical ACS Talc	
E-2	GC1000 Asbestos Blanket Insulation	Bleed Air Ducts				Refrasil 300-86 Cloth (Silicone) Hitco Defense Ind. Division	
	Johns-Manville Marinite 45 Marinite 23 Marinite 36 Marinite 65	Tooling Insulation Board				Johns-Manville Marinite XL	
	Products Research Corp. PR 1422 CLA			MIL-S-8802 Sealant		Products Research Corp. PR 1741	
	Inmont Corp. Prestite 591.1			Sealant		Dow Corning DC 094 011	

PARTS SURVEY FORM

AIRCRAFT: Various
MANUFACTURER: Grumman

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	3M Co. EC 760			Sealant		Proseal EP 711	
	Dexter Corp. Hysol Div. ADX 3103		GA1008K	Adhesive			
	EA-9307 Hysol Paste Sealant (A-14%, B-0%)		GA1008D04	High temp liquid shim			
	EC-1128 3M Roping Sealant (15%)		GC115AG1 GC115AG2	Restricted use in areas which do not exceed 121°C; Usually over-coated with GM4107			
	PR1422 CLB2 Products Research Paste Sealant (3%)		MIL-S-8802 Class B-2	General sealant		Not used since 1974	
	Pro-Seal 700 Essex Chem. Co. Paste Sealant (A-5%, B-0%)		MIL-S-38249 Type I	Firewall sealant			

PARTS SURVEY FORM

AIRCRAFT: Various

MANUFACTURER: Grumman

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	BR-92 American Cyanamid Paste Adhesive (3-3.5%)		GA1008D05	General purpose adhesive repair of honeycomb structure			
	EA-934 Hysol Paste Adhesive/ Liquid Shim (A-14%, B-0%)		GM4004-221 GA1008D08	Liquid shim and general purpose epoxy adhesive			
	Aerobond 2143 Adhesives Engineering Paste Adhesive/ Liquid Shim		GM4004-221 GA1008D08	Liquid shim and general purpose adhesive		Dexter-Hysol bought out product line and discon- tinued the product	
	EA-9308.2 Hysol Paste Adhesive (A-3%, B-0%)		GA1008D04	General purpose adhesive			
	Metibond 329 Narmco Materials Film Adhesive (1%)		GM4355-1	Honeycomb bonding			
	Reliabond 398 Reliable Mfg. Film Adhesive (3%)		GM4355-1	Honeycomb bonding			

PARTS SURVEY FORM

AIRCRAFT: Various

MANUFACTURER: Grumman

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEMENT PART
	LR-7356C (7%) LR-7605C (4%) LR-7606C (6%) Akron Paints & Varnish Co. Coating	Walkways	MIL-W-5044	Walkway coatings			

PARTS SURVEY FORM

ENGINE: J29
MANUFACTURER: General Electric

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Asbestos Impregnated Clamps	Throughout Engine					

PARTS SURVEY FORM

ENGINE: J85-GE-4B

MANUFACTURER: General Electric

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
288C486 (37)	Cushion Clamps, Teflon Impregnated, Wire Reinforced Asbestos						
8418603P6 (2)	Heat Shield Gasket						
8418591P1 (2)	Comb. View Port Gasket						
2007722P01 (6)	Fire Shielding Gasket						
8418708P2 (2)	Gasket						
8418618P1 (1)	Axis B Cover Gasket						
MS9136-01 (2)	Axis C Gasket						
4008T55P01 (1)	Butyl Asbestos Fire Sleeves	External Configuration Hose Assembly				Will remove asbestos when ECP 85E94 is approved	
R1030 (2)	Butyl Asbestos Fire Sleeves	External Configuration Hose Assembly				Will remove asbestos when ECP 85E94 is approved	
R1031 (6)	Butyl Asbestos Fire Sleeves	External Configuration Hose Assembly				Will remove asbestos when ECP 85E94 is approved	

PARTS SURVEY FORM

ENGINE: J85GE 4B

MANUFACTURER: General Electric

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
R 1032 (6)	Butyl Asbestos Fire Sleeves	External Configuration Hose Assembly				Will remove asbestos when ECP 85E94 is approved	
R 1033 (1)	Butyl Asbestos Fire Sleeves	External Configuration Hose Assembly				Will remove asbestos when ECP 85E94 is approved	
37D401588P103 (1)	Asbestos Insulation	Igniter Exciter (Bendix)				Work currently being done to find replacements	

PARTS SURVEY FORM

ENGINE: J86-GE-6J

MANUFACTURER: General Electric

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
209C486 (90)	Cushion Clamp, Teflon Impregnated, Wire Reinforced Asbestos						
2007T84P01 (2)	Gasket						
841B591P1 (2)	Comb. View Port Gasket						
841B708P2 (1)	Gasket						
37B201689P101 (1)	A/I Gasket						
MS9135-01 (1)	Axis B Gasket						
MS9136-01 (1)	Axis C Gasket						
MS9137-01 (1)	Axis D Gasket						
4002T71P01 (1)	Asbestos Insulation	Thermocouple Flex Lead					
4000T23P02 (1)	Asbestos Insulation	Ignition Exciter (Bendix)				Work currently being done to find replacements	

PARTS SURVEY FORM

ENGINE: J85-GE-21

MANUFACTURER: General Electric

TOTAL ASBESTOS PER ENGINE: 0.34 lb

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	External Hose and Tubing Clamps			Fluid and heat resistance		Fluorosilicone	
	Gasket (0.03 lb)	Under Gear Box PTD Pad Cover				Fluorosilicone	
	Seals	Variable Exhaust Nozzle Actuators		High temperature dynamic seals			
	Seals	Power Unit		High temperature dynamic seals			

PARTS SURVEY FORM

ENGINE: T58

MANUFACTURER: General Electric

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Hose Clamps						
	T5 Harness						
	Insulation Blanket	#3 Pump					
	Flow Divider Gasket	-10 Engine					

PARTS SURVEY FORM

ENGINE: T64
MANUFACTURER: General Electric

PART NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
	Hose Clamps						
	Gasket	Fuel Nozzle					

PARTS SURVEY FORM

ENGINE: T700-GE-401

MANUFACTURER: General Electric

DRAWING NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
4042T58	Tube Clamp		AMS 3839				
289C488P05/P11	Clamp		AMS 3839				
6038T02	Particle Separator Scroll Case		A50TF88 A50TF94				

PARTS SURVEY FORM

ENGINE: TF34-400

MANUFACTURER: General Electric

DRAWING NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
3034T18			AMS 3839				
4047T17			AMS 3839				
4047T20			AMS 3839				
4059T68			AMS 3839				
5026T05			AMS 3839				
289C486			AMS 3839				
6036T40			A50TF74				
6020T24			A50TF88				
6020T25			A50TF88				
6020T26			A50TF88				
6020T27			A50TF88				
6020T28			A50TF88				
6020T29			A50TF88				
3034T18	Strap Bracket		A50TF94				
4029T28	Spray Nozzle		A50TF94				

PARTS SURVEY FORM

ENGINE: TF34-400
 MANUFACTURER: General Electric

DRAWING NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
4037T62	Link		A50TF94				
4037T78			A50TF94				
4047T17	Strap Assembly		A50TF94				
4047T20			A50TF94				
4047T58			A50TF94				
4059T68			A50TF94				
5041T09			A50TF94				
6018T65			A50TF94				
6018T71	Control Panels		A50TF94				
6020T24			A50TF94				
6020T25	Control Panels		A50TF94				
6020T26	Control Panels		A50TF94				
6020T27	Control Panels		A50TF94				
6020T28			A50TF94				
6020T29			A50TF94				

PARTS SURVEY FORM

ENGINE: TF34-400

MANUFACTURER: General Electric

DRAWING NUMBER	NOMENCLATURE	LOCATION	SPEC. NO.	REASONS FOR USE	REAL ENVIRONMENT	RECOMMENDATIONS FOR REPLACEMENTS	PERMANENT OR REPLACEABLE PART
6020T35			A50TF94				
6020T94			A50TF94				
6020T95			A50TF94				
6020T86			A50TF94				
6020T97			A50TF94				
6020T98			A50TF94				
6021T32			A50TF94				
6031T13			A50TF94				
6031T18			A50TF94				
6031T19			A50TF94				

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APPENDIX B
FIBER REPLACEMENTS

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FIBERFRAX

Fiberfrax* ceramic fibers are manufactured from a very high purity alumina-silica composition. Fiberfrax is manufactured in several forms: bulk fiber, blanket, cloth, sleeving, tape, coating cements, and moldable insulation products.

TYPICAL CHEMICAL ANALYSIS

	<u>Bulk Fiber</u>	<u>Blanket</u>	<u>Cement</u>
Al_2O_3	51.9%	48.0%	41.0%
SiO_2	47.9%	51.8%	57.0%
Fe_2O_3	0.1%	0.04%	0.04%
Na_2O	0.08%	—	0.8%
Na_2O_3	—	0.1%	—
MgO	—	0.01%	0.4%
CaO	—	0.02%	—
TiO_2	—	0.002%	—
B_2O_3	—	—	0.6%
Leachable Chlorides	< 10 ppm	< 10 ppm	—
Trace Inorganics	—	—	0.2%

TYPICAL PHYSICAL PROPERTIES

Color	White
Continuous Use Limit	1260°C
Melting Point	1790°C (bulk fiber) 1760°C (blanket)
Fiber Diameter	2-3 microns
Specific Gravity	2.73 g/cm ³
Fiber Tensile Strength	4 x 10 ⁵ psi

Fiberfrax exhibits good resistance to attack from most corrosive agents. Fiberfrax also resists oxidation and reduction. If wet by water or steam, thermal and physical properties are restored upon drying. Fiberfrax contains no water of hydration.

*A product of the Carborundum Company

Additional properties include:

- High temperature stability
- Low thermal conductivity
- Low heat storage
- Thermal shock resistance
- Light weight
- Corrosion resistance

Fiberfrax bulk fiber is used as a high temperature fill or packing material in a variety of high temperature applications.

Fiberfrax Durablanket is a strong, light weight, flexible-needled blanket made from long Fiberfrax ceramic fibers. The fibers are cross-locked through a unique forming process to produce a blanket with good handling strength. There are no binders added. Durablanket is a highly efficient insulator.

Fiberfrax textile products are high temperature fabrics. All textiles contain 20-25% organic fiber added during the carding process to produce roving. The roving is further processed into two-ply yarn for weaving into Fiberfrax cloth, tape, and sleeving. Fiberfrax textiles have good insulating ability to 1260°C. In addition, they have resistance to breakdown due to mechanical vibration and stress. Insert materials are incorporated into the yarn to increase fabric tensile strength. Nichrome wire inserts are available for obtaining maximum strength at elevated temperatures (to 1093°C). Glass filament inserts are used in applications where metal is undesirable, as is the case when using Fiberfrax textiles as a dielectric (to 650°C). In applications where tensile strength is important, temperature limits of insert materials should be considered.

Fiberfrax cloth, tape, and sleeving may be heat treated prior to shipment to remove 97% of the volatile portion of the organic carrier fiber. Heat treating turns the product a charcoal gray color. Double heat treating removes the remaining organic and returns the product to its original white color. Each heat treat decreases the thickness and strength of the product slightly.

Applications of Fiberfrax textiles include gasket material, cable and wire insulation, and fuel line insulation.

Fiberfrax coating cements contain fibers blended with inorganic additives to form air-setting refractory coatings or bonding agents. Dried cements form a hard surface which is resistant to erosion and flame abrasion. They are efficient insulators and help prevent substrate materials from spalling. They have good thermal reflectance and dielectric strength. Above 871°C these materials increase in strength due to the formation of a ceramic bond. Fiberfrax coating cements vary in thickness of application (.25 mm to 1.52 mm), and are available as a paste (suitable for troweling), or a paint (applied by brushing, rolling, dipping, or spraying). These cements are mildly alkaline, and are insoluble in water. A small amount of organic material is added to permit shipment during winter months.

Fiberfrax moldable insulation product is used for cast shapes, coatings, linings, and for general refractory repairs. It consists of ceramic fibers dispersed in a sticky water-based refractory silica binder. Drying produces a hard-surfaced, low thermal conductivity insulation.

Custom die-cut parts provide an economical means of meeting gasket, spacer, and seal requirements. Textile-covered products are used for applications requiring repeated use, or ease in handling and installation. Durablanket encased in high temperature alloy wire mesh can be custom-made to solve unique engineering problems.

NEXTEL 312

Nextel 312* ceramic fibers are manufactured in several forms, including woven fabrics, braided-sleeving hose coverings, tapes, wire insulation, furnace linings, blankets, gaskets, and seals.

CHEMICAL ANALYSIS

Al_2O_3	62%
SiO_2	24%
B_2O_3	14%

PHYSICAL PROPERTIES

Color	White
Short-Term Use Limit	1650°C
Extended Use Limit	1427°C
Melt Temperature	1800°C
Fiber Diameter	10-12 microns
Specific Gravity	2.70 g/cm ³
Tensile Strength	2.5 x 10 ⁵ psi
Tensile Modulus	2.2 x 10 ⁷ psi

The manufacturer reports that Nextel withstands the combined effects of flexing and high temperature better than asbestos, quartz, or amorphous silica textiles.

Additional characteristics are:

- High temperature textile
- Good tensile strength
- Strength and flexibility at high temperatures
- Low thermal conductivity
- Good dielectric strength
- Good abrasion resistance
- Resistance to chemicals
- Nonoxidizing
- Dimensionally stable
- Nonhygroscopic

*A product of 3M/Ceramic Fiber Products

REFRASIL

Refrasil* textiles are continuous filament, amorphous silica products, with the thermal performance of a refractory material. They are produced by the chemical leaching of glass fibers, resulting in almost pure silica. Refrasil is available as woven cloth, tape, sleeving, yarn, cordage, bulk fiber, batt, and rope gasket. Refrasil products are available with various pretreatments, yielding different properties.

CHEMICAL ANALYSIS

SiO ₂	97.9%	Fe ₂ O ₃	0.017%
TiO ₂	0.55%	ZrO ₂	0.017%
Al ₂ O ₃	0.29%	SrO	0.021%
MgO	0.13%	CuO	trace
B ₂ O ₃	0.41%	NiO	trace
CaO	0.71%	Cr ₂ O ₃	trace

PHYSICAL PROPERTIES AND CHARACTERISTICS

Color	Tan, white, or green depending on pretreatment
Continuous Use Limit	982°C (1260°C for "Irish" Refrasil)
Melting Point	1704°C
Fiber Diameter	8-10 microns

Refrasil textiles insulate continuously and retain their strength and flexibility to 982°C. Beyond this temperature embrittlement and shrinkage occurs, but thermal protection continues to 1704°C. Embrittlement is caused by the amorphous silica converting to a crystalline form (devitrification). When various impurities are present (especially alkalies and alkaline earths), brittleness occurs as low as 704°C.

Refrasil resists oxidation and is chemically compatible with most materials. The manufacturer considers Refrasil a superior alternative for asbestos, claiming it protects at higher temperature and exhibits minimal dusting and fly-off of fiber particles.

Other characteristics:

- Resistant to thermal shock
- Hygroscopic (but does not degrade in presence of water)
- Resistant to abrasion (treated product)
- Good fabrication characteristics, toughness, and durability (treated product)

*A product of Armco/Hitco Materials Division

Refrasil Pretreatments:

"Standard" product — hydrocarbon finish.

"Treated" product — provides tough, sacrificial coating that improves abrasion resistance, durability, and handling, and facilitates stitching, sewing, and grommeting.

"Adhesive" — standard product with adhesive backing.

"Preshrunk" product — weaker in strength and lower in abrasion resistance than standard product. Useful only where shrinkage cannot be tolerated.

"Irish" Refrasil — standard product treated with 1-3% Cr_2O_3 which extends the temperature stability, flexibility, and reuse capability to higher performance temperatures. Operates continuously at 1260°C , and has 10% lower thermal conductivity.

"Treated Irish" Refrasil — treated for ease of handling and physical integrity during fabrication.

KEVLAR

Kevlar* is an aramid fiber used primarily as a reinforcement material in asbestos-free friction materials, gasket sheeting, and plastic products. It is available as continuous filament yarn (used in clutch facings), yarn impregnated with Teflon (used for pump packing), staple fiber, chopped fiber, and pulp.

PHYSICAL PROPERTIES

Fiber diameter typically 12 microns

High tensile strength

High toughness

Long term durability with high wear resistance

Temperature stability to 232°C

Dimensional stability

Good frictional performance

Nonabrasive

Life exceeding common binders

Thermal and electrical insulation inferior to the refractory materials

Low density

The manufacturer claims that Kevlar can give product performance superior to asbestos-based materials. Less Kevlar is required than asbestos for reinforcement. The balance of the asbestos is replaced with inexpensive inorganic fillers. They claim that a Kevlar-reinforced product can be cost effective with the comparable asbestos-containing product, and that Kevlar can give product performance superior to asbestos.

A major disadvantage of Kevlar has been poor processing characteristics. The cut ends of the Kevlar fibers entangle with each other during mixing operations, producing clumping. This results in poor dispersion of the Kevlar in the product. The manufacturer has partially solved this problem by recommending special mixing procedures, and by using Kevlar pulp, which is 2-4 mm long and does not produce clumping problems. It is recommended that the development of a product be built around the use of Kevlar, as opposed to making a direct substitution for asbestos. Kevlar is an organic fiber, and does not approach the high temperature use limits that the inorganic alumina and silica fibers have.

*A product of the Du Pont Company

APPLICATIONS FOR KEVLAR

The manufacturer describes the applications of Kevlar in several major areas. Their evaluations of Kevlar's performance follow:

Clutch facings can be reinforced with 20 percent by weight Kevlar yarn or short fiber, combined with inorganic fillers and binder. These formulations offer a number of advantages over one which is 50 percent asbestos, including longer wear.

Properly constructed brake pads require less than 5% short fibers of Kevlar by weight, combined with inorganic fillers and binder to achieve performance characteristics equal to or better than asbestos.

Sheet gasketing can be reinforced with less than 6% Kevlar pulp by weight combined with other fibers, fillers, and rubber binders. These formulations match the performance specification of asbestos gasketing used at temperatures over 177°C.

Fiberglass has proven to be a very effective substitute for asbestos in many high temperature phenolic plastic applications. However, in certain applications where sliding contact, thermal dimensional stability, or damage tolerance is required, fiberglass has been deficient. In these phenolic plastics applications, Kevlar is demonstrating advantages over fiberglass as a replacement for asbestos.

Other applications include fabrics, caulk, sealants, and coatings.

ZETEX

Zetex* fabric is made from a highly texturized form of silica, and coated on one side with a proprietary treatment. Zetex is manufactured in many forms: blankets, tape, tubing, sleeving, rope, yarn, and wire-reinforced textile.

PHYSICAL PROPERTIES

Continuous Use Limit	593°C
Tensile Strength	5.0 x 10 ⁵ psi (22°C) 2.5 x 10 ⁵ psi (538°C)
Specific Gravity	2.54 g/cm ³

Zetex resists most acids, alkalies, and solvents. Exceptions are hydrofluoric acid and corrosive environments at elevated temperatures.

Additional properties include:

Five times stronger than comparable asbestos fabric
Better thermal insulating properties than asbestos of same weight
Dimensional stability

*A product of Newtex Industries, Inc.

Abrasion resistance

Good cutting, sewing, handling characteristics

Bonds well with resins and elastomers

Accepts a variety of treatments to suit specific applications

Applications of Zetex include thermal insulation (pipes, hydraulic lines, cables), gaskets, seals, braided tubing, and sleeving.

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NAVAL AIR DEVELOPMENT CENTER WARMINSTER PA AIRCRAFT --ETC F/G 1/3

REPLACEMENT OF ASBESTOS ABOARD NAVAL AIRCRAFT.(U)

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APPENDIX C
GASKET REPLACEMENTS

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Temporary Data Sheet

ARMSTRONG THERMO-TORK GASKET MATERIALSTypical Values*

<u>Product</u>	<u>TN-9000**</u>	<u>TN-9001***</u>
Thickness	.031"	.031"
Density	90	85
Tensile Strength, AMD, PSI	4000	2500
Compressibility, %	11	22
Recovery, %	70	45
Immersion:		
ASTM Oil #3		
Thickness Increase, %	10	10
Compressibility, %	13	25
Tensile Loss, %	15	20
ASTM Fuel B		
Weight Increase, %	12	16
Thickness Increase, %	7	8
Creep Relaxation, %	20	30

*Average values determined in accordance with ASTM F 104 testing methods for Type 1 materials and should not be used as a basis for material specifications.

**Replacement for MIL-A-7021

***Replacement for AN-892; higher compressibility than MIL-A-7021

Rodgers Corporation
NOBESTOS/DUROID D7100

Preliminary Data Sheet

Physical Properties — NOBESTOS D-7100

<u>Physical Test</u>	<u>Typical Values</u>	<u>ASTM Method</u>
Tensile Strength, psi/MPa	4000/27.6	F152
Compressibility at 5000 psi (34.5 MPa), %	12.5	F36
Recovery, %	68.0	F36
ASTM Oil #3, 5 hours at 150° C		F146
Tensile Loss, %	20.0	
Compressibility, %	15.3	
Thickness Change, %	7.2	
Fuel B, 5 hours at 70° F		F146
Weight Change, %	12.4	
Thickness Change, %	7.2	

APPENDIX D
SLEEVING REPLACEMENTS

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TEXTILE YARN FOR COVERING CABLES AND INSULATING SLEEVING
(Reference (c))

Type	Abrasion Resistance	Flexibility	Fire Resistance	Dielectric	Yarn Size	Heat Tolerance °C
ASTRO QUARTZ	Poor	Good	Excellent	Excellent	300 2/2	982° +
BETA GLASS	Good	Good	Excellent	Good	225 2/2	427°
CERAMIC	Good	Excellent	Excellent	Excellent	as required	1427° +
COTTON PLAIN	Good	Good	Poor	Good	30/2	149°
DACRON	Excellent	Excellent	Good	Good	1100/1	232°
FIBERGLASS "E"	Good	Good	Excellent	Excellent	225 1/2	371°
FIBERGLASS "S"	Good	Good	Excellent	Excellent	150 1/2	538°
GRAPHITE	Poor	Good	Excellent	Excellent	CY2	1649° +
KEVLAR	Excellent	Excellent	Excellent	Excellent	900/1	232°
NOMEX	Excellent	Excellent	Excellent	Excellent	200 1/2	316° +
NYLON MONO	Excellent	Poor	Good	Excellent	900/1	232°
NYLON REGULAR	Excellent	Excellent	Good	Excellent	840/2	232°
PRE-PREG	Good	Ridged	Good	Excellent	Roving	454°
RAFRASIL	Poor	Excellent	Excellent	Good	UC100-2	982°
SARAN	Excellent	Poor	Excellent	Good	2750 R	121°
PURE TEFLON	Excellent	Excellent	Excellent	Excellent	400 1/2	288°
TEFLON BLEACHED	Excellent	Excellent	Excellent	Excellent	400 1/2	288°
TEFLON "E" GLASS	Good	Good	Excellent	Excellent	150 1/2	464°
VINYL	Excellent	Poor	Good	Good	2700 R	149°

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APPENDIX E

METHODS FOR

ASBESTOS IDENTIFICATION

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METHODS FOR ASBESTOS IDENTIFICATION

Many analytical methods can be used for identifying asbestos:

Transmission electron microscopy is useful for identifying particles that are too small to be seen by optical microscopy, or are present in subpicogram quantities.

X-ray diffraction is good for quantitative measurement, but the technique cannot differentiate well between the fibrous and nonfibrous varieties of asbestos, nor can it identify amorphous materials such as glass. When x-ray is used, the concentration of fibers present should be confirmed by optical microscopy.

Infrared is useful for samples containing a high concentration of asbestos.

Chemical composition can be used to differentiate between the asbestiform minerals, depending on the presence or absence of Fe, Ca, and Na, but it is often difficult due to the closely similar chemical composition of the different types of asbestos. Again, optical microscopy should be used to confirm an identification.

NAVAIRDEVGEN has chosen to use two other methods of testing samples for the presence or absence of asbestos. These are thermal analysis (differential thermal analysis and thermogravimetric analysis) and polarized light microscopy (using dispersion staining).

DETECTION BY THERMAL ANALYSIS

Identification of asbestos fibers is often complicated by the presence of other nonasbestos fibers or particles, or impregnated matrix. Microscopic examination may then be difficult. The use of differential thermal analysis (DTA) or thermogravimetric analysis (TGA) has been shown to be a reliable technique in such instances (references (d), (e), and (f)).

A DTA curve for chrysotile asbestos (serpentine) exhibits a dehydroxylation endotherm at about 650°C followed by an exotherm at 820°C resulting from conversion to forsterite and silica. These reactions are independent of the test atmosphere. A TGA curve shows only the weight loss associated with dehydroxylation (~ 13 percent) above 600°C but does allow a quantitative estimate of asbestos content for significant concentrations.

Figure 1 is a TGA curve for a gasket material conforming to HH-P-46. The weight loss due to dehydroxylation is estimated to be 9 percent. Asbestos (chrysotile) content is then estimated to be $9/13 = 0.69$ or about 70 percent.

Date: 22-Jul-80 Time: 14:12:28
 File: GAS.01
 Operator: KGC
 Plotted: 22-Jul-80 15:14:47

Sample: HH-P-46
 Size: 12.53 mg
 Rate: 20 DEG/MIN IN N2
 Program: Advanced Playback V1.0

TGA



Figure 1. Sample Thermogram Showing Dehydroxylation

Other types of asbestos fiber exhibit the following transitions in DTA (reference (f)):

	<u>T₁ (°C)</u>	<u>T₂ (°C)</u>	<u>T₃ (°C)</u>
Crocidolite (in argon)	610 endotherm	800 endotherm	820 exotherm
Crocidolite (in oxygen)	420 exotherm	900 endotherm	930 exotherm
Amosite (in argon)	780 endotherm	1080 endotherm	
Amosite (in oxygen)	640 exotherm		
Anthophyllite (in argon)	700 endotherm	930 endotherm	1160 endotherm
Anthophyllite (in oxygen)	940 endotherm		
Tremolite (in argon)	1030 endotherm		
Tremolite (in oxygen)	1060 endotherm		
Actinolite (in argon)	720 endotherm	1050 endotherm	
Actinolite (in oxygen)	280 exotherm	1140 exotherm	

IDENTIFICATION BY POLARIZED LIGHT MICROSCOPY/DISPERSION STAINING

Polarized light microscopy using dispersion staining is a very versatile technique. With it a variety of fibers can be identified, including chrysotile and the other types of asbestos, and asbestos substitutes. References (g) and (h) discuss these methods in detail.

Fibers are selected from the sample, placed on a slide in a high density refractive index liquid, and a coverslip placed on top. The sample is first examined in polarized light by simply rotating the microscope stage. If the fiber color does not change as the stage is rotated, the fiber is isotropic, meaning it has only one index of refraction (fiberglass and mineral wool are examples, and are thus easily differentiated). Other fibers exhibit a color change when the stage is rotated, have more than one index of refraction, and are called anisotropic. These fibers are readily identified since the colors seen in different refractive index liquids are peculiar to a certain material. This information is available in published dispersion staining curves. Reference (h) contains curves for some of the more common materials often associated with asbestos.

Asbestos, if it is present, will most likely be chrysotile. It is easily identified by dispersion staining. Chrysotile is characterized by distinctive, fine fibrils (often curly) plus straight bundles of fibrils. Under the proper microscope conditions, and when placed in a refractive index liquid of 1.55, chrysotile fibers show a distinctive magenta color when oriented parallel to the fiber axis and blue when oriented perpendicular to it.

If the fibers are too strongly embedded in the sample matrix for the identification to be made, the sample can be ashed at 550°C and the residue examined for asbestos.

