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COMPATIBILITY OF MATERIALS WITH LIQUID OXYGEN

by C. F. Key and W. A. Riehl

George C. Marshall Space Flight Center
Huntsville, Ala.

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SUMMARY

The test instrument and procedure developed by Lucas and Riehl (Ref. 1) was used to determine the compatibility of a wide variety of materials with liquid oxygen (LOX). This method is based upon the tendency of materials to react with LOX on impact and is commonly known as the "ABMA Tester". Within the past eight years' use, over 100,000 individual test drops have been made on approximately 1,000 different materials.

Pertinent data from these tests have been compiled, and the findings are presented in this report. Recommendations are made for the guidance of designers and others in the selection of safe materials for use in oxygen systems. Materials are discussed according to the following classifications: (1) Lubricants, (2) Sealants and Threading Compounds, (3) Thermal and Electrical Insulation, (4) Elastomers, Plastics and Adhesives, (5) Gaskets and Packing, (6) Metals, Alloys, and Solders, (7) Dye Penetrants, and (8) Solvents, Cleaning Solutions, and Miscellaneous.

SECTION I. INTRODUCTION

Liquid oxygen is one of the most important oxidizers in missiles and space vehicles and is the only propellant common to all of the "building block" stages of the Saturn I, Saturn IB, and Saturn V space vehicles (S-I, S-IV, S-IB, S-IC, S-II, S-IVB). It is well known that many materials in contact with liquid oxygen (LOX) are capable of exploding and/or igniting when subjected to mechanical shock or some other sudden energy surge. Organic materials of the type conventionally used as fuels, lubricants, gaskets, etc., are particularly hazardous. The environmental and structural demands imposed on space vehicle systems make it impossible to rigidly exclude all materials that fall within these categories. Accordingly, a LOX impact test device (Fig. 1) was developed to provide information on the relative hazard presented by these materials. This instrument has been in use for over eight years on a continuous basis to assess the hazard associated with products and materials contemplated for use in space vehicle LOX systems at the George C. Marshall Space Flight Center (MSFC). The development of this method and device was described by Lucas and Riehl (Ref. 1).

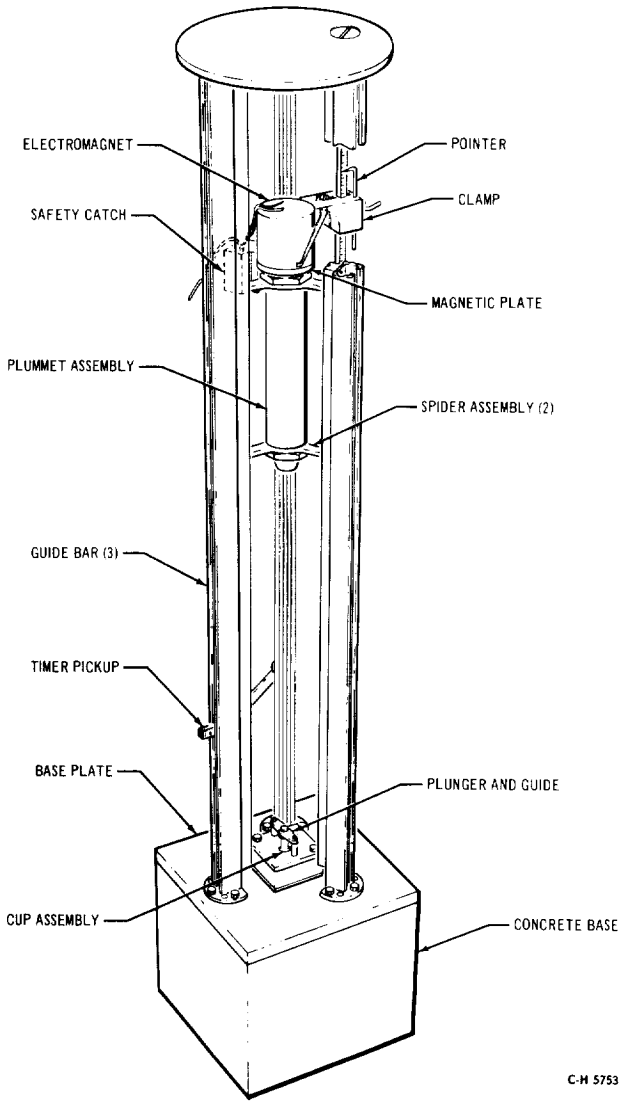


FIGURE 1. LOX IMPACT SENSITIVITY TESTER

A previous report listed data accumulated over the first several years of testing and presented general conclusions and/or indications (Ref. 2). At this writing, over 100,000 individual tests have been made on approximately 1,000 different materials at this Center (or its organization predecessor).* The object of this report is to provide the results of over eight years of testing and general information gained therefrom. Recommendations are made for guidance of designers and others in the selection of safe materials for use in oxygen systems. These recommendations generally apply also to systems containing other gases (air, helium, nitrogen, etc.) that are intended for purging or pressurizing LOX systems. Any impact sensitive lubricant, sealant, or other material employed in a purging or pressurizing system could possibly be swept into the LOX equipment and might introduce a serious hazard.

This report supersedes that of Curry and Riehl (Ref. 2).

SECTION II. TEST METHOD

A. EQUIPMENT

The apparatus used for all of the tests reported herein was the "ABMA Tester".

The mechanical features and operations of the ABMA LOX impact tester have been described comprehensively in other reports and will not be stated herein (Ref. 1 and MSFC-SPEC-106 [Appendix]). It should be noted, however, that experience gained throughout this program has confirmed consistently the absolute necessity of guarding against contamination in the test equipment if meaningful results are to be obtained. Special cleaning practices are followed in preparing the test equipment, and it has been found that any deviation from these procedures usually is reflected in anomalous results during subsequent tests.

In principle, this test procedure involves dropping a standard plummet of known weight (9.04 Kg) from known heights (up to 1.1 meters) under near-frictionless conditions. This plummet strikes a plunger which is resting on a layer of the material being tested in the bottom of an expendable aluminum alloy cup. The remainder of the sample cup is filled with liquid oxygen. Details of striker cup and sample are shown in Figure 2. During a series of such tests, a material capable of reacting with LOX under these conditions will explode and/or flash brillantly. The highest energy level withstood by a given material without an indication of sensitivity in twenty trials is considered an indication of hazard associated with the material under test.

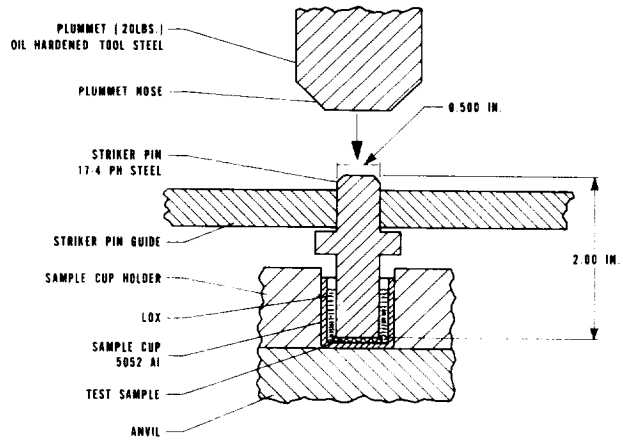


FIGURE 2. DETAILS OF STRIKER, SAMPLE CUP, AND SAMPLE (IMPACT SENSITIVITY TESTER)

B. SAMPLE PREPARATION

It has been found in previous work (Ref. 1 and 2) that sample preparation is a very important factor if reproducible test results are to be obtained. With all samples tested, LOX impact sensitivity varies with thickness. Reactivity generally increases as the sample thickness is decreased. However, this relationship cannot be assumed to be directly proportional and may actually reverse with some materials. For example, with some sheet titanium samples, there appeared to be a trend toward increased reactivity with thicker samples (Ref. 3). It is quite difficult to ascertain the inherent relationship of thickness and sensitivity to impact because multiple factors usually are involved, such as sample hardness, flexibility, ductility, etc., at LOX temperatures.

* Prior to July 1, 1960, this Center was the Development Operations Division of the Army Ballistic Missile Agency. As the test method and instrument were developed several years ago under the cognizance of the Army, and since the instrument has since become widely known as the "ABMA Impact Sensitivity Test Instrument," it will be referred to as such in this report, even though this instrument is now used under cognizance of Marshall Space Flight Center.

Another factor of importance is the state of the materials which are frozen by the LOX, especially liquid samples. The state of subdivision of the sample also is important. For example, even stainless steel will react with LOX if it is in the form of fine wool.

1. Solid Materials

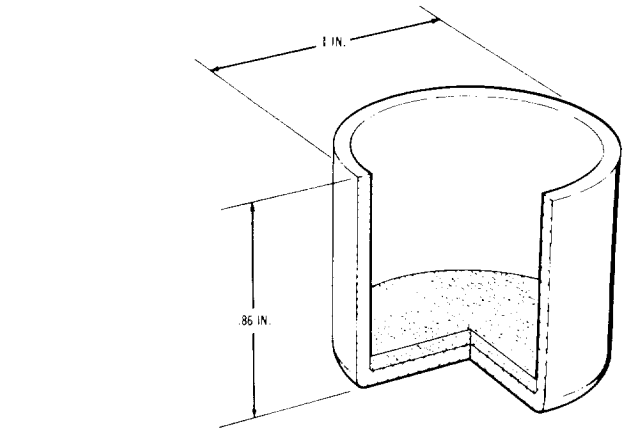
All solid materials (metals, gaskets, plastics, etc.) are tested in the form of 11/16-inch diameter discs in the specific thickness intended for use. Pressure sensitive tapes, coatings, surface treatments, etc., are tested after applying them to test discs of the metal or other substrate upon which they will be used in service. When hard or granular materials are to be tested, a type 347 stainless steel insert is placed as a false bottom in each sample cup. This technique was necessitated by the early discovery in the program that some hard materials (silica, carborundum, etc.) could give a false indication of impact sensitivity under the conditions imposed by this test procedure. Such hard materials are driven into the aluminum sample cup by the plunger, causing extreme local deformation of the metal. The heat liberated at microscopic points of contact between the aluminum and the granular material is in some cases sufficient to trigger a detectable reaction between the fresh aluminum surface and the LOX. (Data showing this effect were reported in Ref. 1 & 2).

2. Liquids

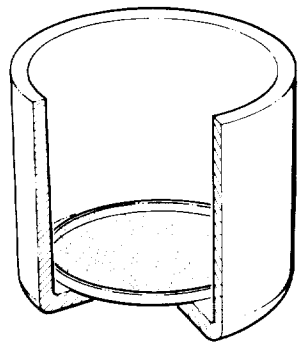
Materials such as lubricants, sealants, etc., whose thickness is not dictated by the intended application, are normally tested in thicknesses of 0.050 inch. This thickness was selected on the basis of providing a condition to which test results are most sensitive to variations in materials (Ref. 1). This thickness can be attained readily in the case of liquid materials by metering individual samples into the test cups from a burette. It has been ascertained that 0.50 cc of liquid will produce a 0.050 inch (± approximately 0.005 inch) layer in the bottom of the test cups (Fig. 3).

3. Semi-Solids

Greases, caulking compounds, and other semi-solid materials are tested at a thickness of 0.050 inch by use of special cup inserts. These inserts are fabricated from type 5052 aluminum and have an internal depth of 0.050 ± 0.005 inch (Fig. 4). A series of twenty of these are placed in a special holder (Fig. 4). Sufficient material is pressed into the cups with a clean stainless steel spatula until a smooth surface, flush with the top, is obtained. The insert cups then are removed and placed in the bottom of the regular specimen cups with tweezers (Fig. 3).



(a) TEST CUP WITH LIQUID SAMPLE (0.050 ± 0.005 in. THICK)



(b) TEST CUP WITH GREASE SAMPLE SHOWING INSERT CUP

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FIGURE 3. SAMPLES IN TEST CUPS

A freezing technique has been developed which provides uniform frozen samples of both liquids and semi-solids. The test cups, containing the samples, are placed in a special freezing box (Fig. 5). LOX is poured into the bottom, and the samples are slowly frozen by the vapors. After freezing, sufficient LOX is introduced to overflow and fill the test cups. Any samples that crack and float in the LOX are discarded.

C. ACCEPTANCE CRITERIA

In order to acceptance-test a material for use in LOX systems, twenty separate samples of the material submerged in LOX are subjected to 10 kg-m (72 ft-lbs) impact energy delivered through a 1/2-inch diameter area. More than one indication of sensitivity is cause for immediate rejection. A single explosion, flash, or other indication of sensitivity during the initial series of twenty tests requires that an additional forty samples be tested without incident to insure acceptability of the material.

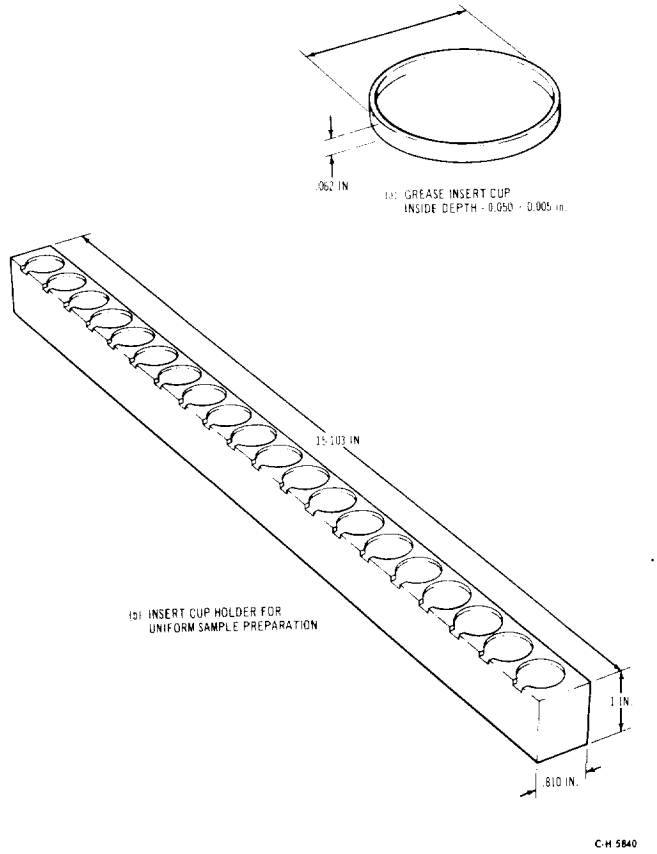

FIGURE 4. GREASE INSERT CUP HOLDER

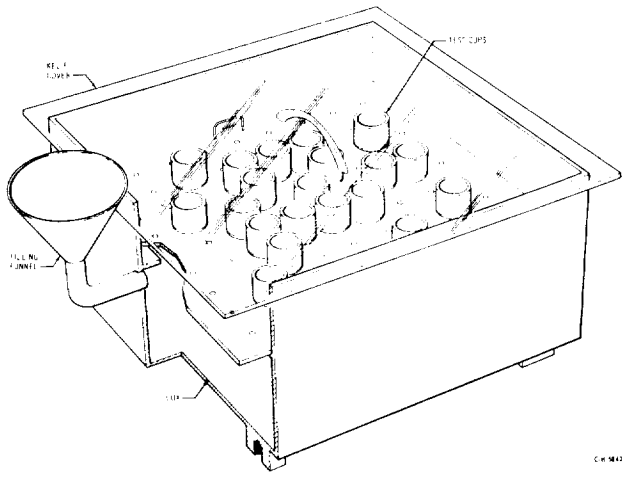

FIGURE 5. SAMPLE FREEZING BOX

The results obtained by application of the foregoing test procedure to a wide variety of proprietary products are tabulated according to categories in Tables 1 through 8. The materials are rated according to the test results as follows:

S - Satisfactory for LOX service if cleaned and/or processed by applicable MSFC standards

BT - Satisfactory as stated above, with the provision that each manufacturer's batch of the product must be individually tested and found acceptable

C - Conditional, insufficient test experience to rate sample adequately

U - Unacceptable, capable of vigorous burning or exploding in contact with LOX

Two notes of caution are in order. (1) Wherever possible, a complete identification is made of the materials tested. Although some general conclusions can be drawn relative to certain classes or chemical families of materials, it is definitely unsafe to predict the behavior of any totally new product on this basis. Even materials normally inert to LOX can be rendered unsafe by minute amounts of processing additives, pigments, etc., that may be favored by one manufacturer or processor. It is equally unsafe to define a material for a specific application in liquid oxygen solely on the basis of a military or other specification for a general purpose product, since most of such specifications do not limit sufficiently the chemical constitution of the product. (2) Assuming there is freedom from deleterious additives or contaminants, the chemical nature of the product primarily governs its behavior toward LOX. For these reasons, the tabulated test data are applicable only to the specific proprietary products mentioned and may not apply to other similar materials or to other products meeting the same specification.

An additional factor that must be kept in mind in evaluating the data is only the chemical compatibility of the material with oxygen systems is reported herein. This criterion will apply to all materials which may contact oxygen. However, many other factors usually must be considered before a final material selection can be made. For example, if a lubricant were to be used on an O-ring in a valve in an oxygen system at low temperature, at least four additional factors must be investigated as follows:

1. Corrosivity of the lubricant and metal

components which it may contact during storage and use

2. Compatibility of the lubricant and elastomer O-ring or other seals

3. Low temperature behavior of the lubricant

4. Lubricity of the material under operating conditions

Naturally, the factors to be considered in final selection of any material are dependent upon the service intended. Selection and evaluation of these factors will vary widely. Thus, it is not feasible to attempt to provide in this report all of the information necessary to assess fully the adequacy of a material for specific applications. However, unless extenuating circumstances exist, this Center will not approve the use of any material listed as "Unsatisfactory" in the attached tables in oxygen systems.

The selection of the specific material to use among those rated as satisfactory will depend upon the particular application intended. This Center should be consulted directly for such assistance.

SECTION IV. DISCUSSION

A. LUBRICANTS

Lubricants tested for impact sensitivity in LOX are shown in Table 1. It is realized that none of the fluids or greases that withstood the impact test would actually function as lubricants at LOX temperature (-297°F). However, all materials withstanding this test are considered safe for use in gaseous oxygen, which also is a hazardous environment. The only type of lubricant capable of functioning at LOX temperature would be a solid or solid film lubricant. Although a number of these appear insensitive to impact, their adhesion and functional characteristics at LOX temperature have not yet been proven through use at this Center.

All petroleum-derived lubricants tested to date have proven to be impact sensitive, as expected. The conventional silicone greases and fluids constitute a similar hazard.

All completely fluorinated and/or chlorinated fluids and greases tested to date have proven satisfactory for LOX service from the standpoint of impact sensitivity. This includes materials now being marketed under the trade names of "Fluorolube," "Kel-F," and "Halocarbon."* However, any specific flourocarbon lubricant for which no data are tabulated should be tested prior to use to insure that its inherent compatibility will not be affected adversely by additives that may be present.

Chlorofluorocarbon oils and greases ("Fluorolubes," "Kel-Fs," and "Halocarbons") are not sensitive to impact in LOX (at 72 ft.-lbs). However, under conditions of high shear involving aluminum in the presence of these agents, explosions can occur in the absence of liquid oxygen. These conditions have been created experimentally by forcing a rotating aluminum or steel rod, chucked in a drill press, into contact with an aluminum plate which has been smeared with the chlorofluorocarbon under investigation. Explosions have been triggered in this manner with a number of aluminum alloy-chlorofluorocarbon combinations. These conditions may appear more stringent than normally would be encountered in lubricant or thread sealant applications. However, the availability of other materials not subject to this behavior is believed to warrant the exclusion of chlorofluorocarbons from lubricant or sealant applications involving shear loading with aluminum. It is interesting to note that no explosions have been produced with fully fluorinated hydrocarbons. Apparently, chlorine substitution is required to render the fluorocarbon susceptible to reaction with aluminum under shear conditions.

There are indications that fluorination of organic groups attached to silicones decreases the sensitivity of the parent silicone to impact in LOX. Two particular materials of this type, Dow Corning FS 1280 and 1281 (formerly manufactured as "QC-2-0026" and "QC-2-0093"), appear to be less impact sensitive than conventional silicone fluids. Since the impact sensitivity of these two greases has been found to vary batchwise, each manufacturer's lot should be tested prior to use. In many cases, these materials are insensitive in twenty trials (at 10 Kg-m) impact at the normal test thickness of 0.050 inch. However, when thin smears (approximately 0.005 in. thick) are tested under the same conditions, reactions frequently occur. Such is not usually the case with fluorocarbon materials.

On the other hand, the fluorosilicones (FS 1280 and 1281) did not explode or react when tested under high shear loading in contact with aluminum.

Perfluoro-trialkyl amine based lubricants generally were LOX compatible. Some lubricants based on

* The names of the manufacturers of all proprietary products mentioned in the text of this report are provided in Tables 1 through 8.

these base fluids have been reported compatible with a wide variety of propellants (Ref. 4). Two in particular, "PD-817" and "PD-788," were tested also with respect to lubricity, corrosivity, and compatibility with elastomers. These materials appear particularly promising as "universal" lubricants for use in a wide variety of applications in different propellant systems. However, they usually dry out to a powdery Teflon residue within several weeks' exposure to the air.

B. SEALANTS AND THREADING COMPOUNDS

Sealants and threading compounds listed in this category are those materials which are applied to connections or threaded fittings for the dual purpose of preventing seizing or galling during assembly, and minimizing leakage in use. "Sealants" are defined herein as materials which do not normally harden or set and are employed in non-permanent applications. "Threading compounds" are those which harden and and for use on permanent type joints. Until recently, efforts to locate a consistently satisfactory LOX thread sealant from a proprietary source have not been successful. Most commercial sealants formulated specifically for LOX service are mixtures of commercial-purity graphite and chlorinated aromatic compounds. Early experience with sealants having this basic composition indicated that trace impurities in graphite may render the final product impact sensitive. Only a special grade of graphite purified by acid treatment was found to give consistently satisfactory results when formulated into a sealant and tested as described. For several years, a LOX sealant for use at this Center (designated "AR-1F" sealant) was formulated internally, and each batch was tested on an individual basis to insure conformity to our requirements.

Recently, a thread sealant manufactured by the Acheson Colloids Company (EC 1730) has become available. A number of batches of this product have been tested thus far, and all were approved for LOX use. This material is recommended as a replacement for "AR-1F" LOX sealant. However, batchwise acceptance testing by MSFC-SPEC-106 is still necessary to insure product quality.

One other proprietary sealant, "Anderol X-133," is available which is satisfactory from the standpoint of LOX compatibility. It has not been recommended for use at this Center because it is highly corrosive to aluminum alloys 5086, 6061, and 2024, which are used widely in LOX piping.

A number of threading compounds are cited in Table II as being satisfactory for LOX service. These are primarily inorganic silicate cements.

C. THERMAL AND ELECTRICAL INSULATION (TABLE III)

A number of thermal insulations have been tested although they would not normally be in direct contact with LOX. All foam plastic and mastic types of insulation investigated have been impact sensitive with the exception of Dynatherm D-65. The latter is an intumescent coating containing approximately 66% inorganic filler materials. Dynatherm D-65 should be tested batchwise (in the use thickness) prior to any application where it may ultimately contact liquid oxygen. The moisture protective overcoating for Dynatherm D-65 (i.e., D-904) has been found impact sensitive.

Several bulk fiberglass insulations also appear unsatisfactory, due probably to additives employed to control fiber or matt properties. Subsequent heat treating frequently renders these materials satisfactory. Two bulk fiberglass insulation materials appear satisfactory for LOX service (Glass Fiber "B" 621, J. M. Microfiber Felt No. 108). It is stressed that each batch of these materials should be tested for LOX compatibility. Two varieties of cellular glass, Foamsil and Foam Glass, have proven satisfactory when tested for LOX compatibility.

A study currently is underway to investigate the LOX compatibility of organic insulation materials used in liquid hydrogen systems. This occurs because air usually is condensed on the surface from the atmosphere by the extreme low temperature. Re-evaporation and re-condensation processes probably will occur to varying degrees within external insulation thereon. Upon evaporation, liquid air becomes enriched in oxygen content.

Consequently, impact sensitivity of thermal insulation materials used externally in liquid hydrogen systems is being investigated as a function of LOX concentration in LN_2. Results of these tests will be reported subsequently.

A number of Teflon and Kel-F type electrical insulations were tested and proved satisfactory. Any insulation which actually contacts liquid oxygen should be tested to insure safe use. A word of caution is in order concerning the pigments used to color-code electrical insulation. Tests have shown that addition of organic pigments to Teflon may transform a normally acceptable material to one which is highly sensitive to impact in LOX.

D. ELASTOMERS, PLASTICS, ADHESIVES (TABLE IV)

Elastomers - All natural and non-fluorinated synthetic rubbers tested to date, including a number of silicone elastomers, have proven impact sensitive to varying degrees. The most generally satisfactory elastomers tested to date have been plasticized Kel-F, Fluorel, and Viton A. However, the impact sensitivity of these materials varies markedly with the nature and extent of plasticizer and additives used. Thus, batchwise testing per MSFC-SPEC-106 is necessary to insure LOX compatibility of these elastomers.

Plastics - Most common plastics are impact sensitive to varying degrees. All phenolic plastics tested to date have proven impact sensitive. Polyethylene, Nylon and Tedlar are not recommended.

During the past six years, thirty-one various types and thicknesses of Mylar have been tested for compatibility with LOX by the procedure described in MSFC-SPEC-106. Sample thicknesses ranged from 0.001 to 0.010 inch. Aluminum vapor coated Mylar and Mylar tapes also were tested. By summarizing the results of a combined total of 559 individual impact tests on these materials, the following conclusions are made:

a. All samples were impact sensitive at the acceptance level specified in MSFC-SPEC-106, i.e., 10 Kg-m.

b. Of thirteen samples that were tested at 5 Kg-m impact energy, eight were still sensitive. This shows that over 60 per cent of the samples were in a class of reactivity considered highly sensitive to impact.

c. Of those samples tested over a range of impact energies, the following average per cent reactions (No. Fires/No. Tests X 100) were obtained:

At 10 Kg-m - 28%
5 Kg-m - 25%
3 Kg-m - 10%

The above data are plotted in Figure 6, along with similar test results for Nylon, Buna-N, cotton, titanium, and polyethylene. This figure clearly illustrates that Mylar is in the same category of LOX reactivity as materials which reportedly have caused major catastrophies in the missile and space industry.

The sensitivity of two new Du Pont plastic films, types ML, & H, appears to vary directly with thickness. Therefore, the actual thickness proposed for application should be tested for sensitivity to impact in LOX.

Of all materials tested thus far, Teflon TFE, (tetrafluoroethylene), Teflon FEP, (fluorinated ethylpropylene), Aclar, and unplasticized Kel-F are the most insensitive to impact in LOX. One or more of these materials usually will suffice where a plastic is needed for engineering use. However, these materials normally are inert to LOX only as long as they are free of contamination, pigmentation, or fillers for reenforcement. Glass or asbestos fillers usually do not render such fluorocarbon materials sensitive to LOX.

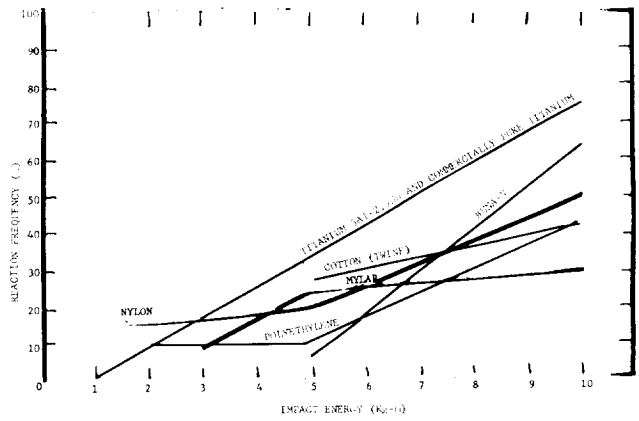

FIGURE 6. LOX IMPACT REACTIVITY OF MYLAR, NYLON, AND TYPICALLY HAZARDOUS MATERIALS

Adhesives & Tapes—No fully satisfactory adhesive has been found for LOX use. All organic adhesives tested were incompatible.

In particular, epoxy resins and cements are violently sensitive to impact and must be excluded completely from LOX service. All silicone adhesives that have been examined are impact sensitive. Due to this susceptibility of adhesives, all known pressure sensitive tapes are sensitive to impact, including "Teflon" and metal foil backed tapes. This sensitivity is manifested even when the tapes are applied to metal discs which would insure minimal contact between the adhesive and LOX.

Some inorganic cement types of "adhesives," i.e., "Sauereisen," are insensitive. However, these generally are sodium silicate based and provide only comparatively weak bonding, and are quite brittle. A dental cement (CuO, phosphoric acid base) reportedly has been used in some instances but is highly corrosive.

An attempt to develop a satisfactory adhesive for LOX service now is underway by the Narmco Division

of Telecomputing Corporation, under contract NAS8-11068 to this Center . Initial studies will be directed toward consideration of fluorination of common resins while still retaining adhesive characteristics.

E. GASKETS AND PACKING (TABLE V)

Gaskets - A common type of general purpose gasket material is composed of a fibrous or spongy material impregnated with natural rubber or a synthetic elastomer. Asbestos is a popular fiber source and is available in combination with virtually every common rubber or plastic. The inherent impact sensitivity of the particular binder employed thus is conferred to some extent upon the finished material. The impact sensitivity of these asbestos composites varies considerably from batch to batch but is usually significantly less than an equivalent thickness of the binder material. At best, however, these materials range from marginal to unacceptable, depending upon the binder composition and proportion.

The earlier statements on the effect of sample thickness, as originally deduced from tests on thread sealants and lubricants, also apply to these composite materials. "Allpax 500," an asbestos-synthetic rubber mixture as supplied by the manufacturer, gives an average of two fires or detonations per test series in the 1/16-inch thickness as compared with approximately fifteen reactions per series when tested in a 1/64-inch thickness.

It has been found that the impact sensitivity of these products can be lessened by impregnation with one of several chlorofluorocarbon oils. These fluids are highly insensitive to impact in LOX and, apparently, tend to quench the impact sensitivity of other materials capable of absorbing them. The "Allpax 500" product mentioned above is processed routinely at this installation for LOX service by controlled impregnation with a chlorofluorocarbon fluid. Post-treatment impact testing is done on each processed batch to verify the adequacy of the treatment. Details of this process and the circumstances prompting its development are described in another report (Ref. 5). It is interesting to note that Bell Aircraft Corporation employed a similar process to render leather suitable for LOX service. The unprocessed leather is highly sensitive to impact.

The problem of finding a compatible gasket material that will seal at the relatively low flange pressures generally associated with MSFC flight hardware has proven difficult. The most unreactive non-metallic materials, "Kel-F" and Teflon," are difficult to utilize because of low temperature brittleness, cold flow, or other mechanical deficiencies. A wide variety of fluorocarbon based gaskets filled with asbestos, ceramic, or glass fibers for re-enforcement are available commercially. Most of these are LOX compatible and have physical sealing characteristics greatly improved over the parent plastic. However, they still do not provide the sealing capability necessary for MSFC flight hardware. Fluorogreen E-600 appears almost, if not, as good as treated Allpax and tentatively has been approved for use. However, much still is desired to provide a gasket material fully satisfactory with respect to both LOX compatibility and sealing capability in MSFC hardware. The Narmco Division of the Telecomputing Corporation currently has a contract from this branch to develop such a material.

Packing - A large number of braided and solid "Teflon" packings has been found satisfactory. One asbestos type packing, "JM 177J7," generally is compatible and has a satisfactory record of service at this Center. At least one manufacturer, Crane Packing Company, processes and packages certain packings specifically for LOX service when requested. "Flexrock 420" also is used currently by MSFC.

Caution - It is stressed that even the recommended packing and gasket materials vary in acceptability from one batch to another; therefore, samples from each batch intended for LOX service should be tested and qualified prior to use. This is to insure that variations in manufacturer's processing methods do not introduce contamination or adverse chemical compatibility.

F. METALS, ALLOYS, SOLDERS, AND SURFACE TREATMENTS (TABLE VI)

All ferrous and aluminum based alloys tested to date are considered compatible with LOX, provided requisite cleaning procedures and other safeguards are followed. This included a sample of a new maraging steel (Bethlehem heat no. 120D163). Freshly abraded aluminum or aluminum which has been stripped of its protective oxide film is impact sensitive. Thus, although the natural oxide film on aluminum is sufficient to make it impact insensitive, any action which breaks or removes the film from aluminum while submerged in LOX constitutes a hazardous situation. Exactly such conditions are believed to have caused an explosion in a filter in a LOX ground supply line recently (Ref. 6). This was ascribed to the loosening of the mounting fixtures for the filter cartridges, which allowed chattering of the top of the stainless steel filter cartridge and the aluminum support plate. Since this condition was on the upstream side of the filter and small hard particles undoubtedly were present (because of the basic function of the filter), it was deduced that the explosion probably was initiated by abrasion of the surface of the aluminum by such particles while

in contact with LOX. Because of the possibility of reoccurrence of these conditions in such filters, it was recommended that the aluminum components therein be replaced by stainless steel.

It is stressed that the conditions required to cause explosions with aluminum and LOX are extremely severe. These findings do not detract in any way from the proven serviceability of aluminum alloys now in use for missile LOX tankage and piping, provided all such equipment has been cleaned and protected in accordance with applicable MSFC standards and maintained under such conditions. Test results showing that stainless steel wool and ordinary steel wool are impact sensitive reflect the greater amount of active surface available for chemical combination in these cases and do not detract from the proven serviceability of steels in massive shapes for LOX service. However, these results suggest caution in the use of metal wool for cleaning LOX hardware.

The inherent compatibility of the common aluminum alloys is not affected adversely by anodizing or by two proprietary surface treatments ("Iridite" and "Alodine"). However, some samples of aluminum which have been anodized and dyed have proven to be impact sensitive. This sensitivity was traced to improper sealing during the dyeing process. Any dyed aluminum or new processes of dyeing and/or conversion coating aluminum should be tested to insure LOX compatibility.

All titanium alloys tested have been extremely sensitive to impact. Because of a special interest in this material, the reactivity of titanium with oxygen was studied by several test methods and under a variety of conditions associated with space vehicles. The impact sensitivity method was used to study the effects of surface treatments, coatings, and numerous other factors upon the reactivity. Punctures resulting from bullets, darts, pins, or artificial meteoroids usually caused explosions. Coatings which reduced titanium reactivity in impact or shock tests were not beneficial under puncture conditions. Aluminum and stainless steel failed to react on impact or puncture.

The shock stimuli produced by small detonator caps alone were sufficient to initiate explosive reaction of titanium in contact with oxygen. An extremely heavy shock was necessary to cause aluminum to react under the same test conditions, and stainless steel did not react under the most drastic shock conditions employed. The titanium/oxygen combination is considerably more susceptible to spark initiation than aluminum/oxygen. A detailed report on the "Reactivity of Titanium with Oxygen" has been issued separately (NASA-TR-R-180), (Ref. 3).

Table VI shows results obtained by testing 1/16-inch thick magnesium alloys in accordance with MSFC-SPEC-106. Limited tests also have been made to investigate the tendency of magnesium (HK-31) alloy to react with oxygen upon puncture and when subjected to shock. Taken overall, these data indicate that magnesium alloys generally are somewhat more susceptible to reaction with oxygen than aluminum but far less than titanium. It cannot be stated categorically that magnesium alloys should not be used in LOX systems. However, the alloy composition, surface treatment, and application intended must be evaluated carefully prior to assuming the somewhat greater degree of risk than would occur under similar conditions with aluminum alloys.

Electrodeposited coatings on steel generally are LOX compatible (cadmium, copper, nickel, chrome). However, tin plated materials have been impact sensitive.

All high melting silver solders tested have proven satisfactory. Any soft solders intended for application on LOX hardware should be tested individually.

G. DYE PENETRANTS (TABLE VII)

Dye penetrants are widely used for detection of cracks and other surface defects in materials. Normally, these are applied in liquid form and the excess wiped or washed off. Residual penetrant entrapped in defects renders these visible by normal or ultraviolet illumination.

1. Qualitative Studies

When evaluating such materials for compatibility with LOX systems, the penetrant is tested first in the form as received, and as recommended by the manufacturer for application, such as various dilutions with water. This is done by placing a 1/2-cc of the liquid directly into the test cup. As mentioned previously, this produces a 0.050 inch thick layer in the specified cup. Since in use the thickness probably will be less than 0.050 inch, those samples passing this test are subjected to impacts at a thickness of only 0.025 inch (1/4-cc).

Almost all penetrants, emulsifiers, and developers have been tested initially by this procedure. Penetrants, emulsifiers, and developers which have been found unacceptable in this initial screening test, and others, are listed in Table VIIA.

In order to evaluate the potential hazard of surface residues resulting from dye penetrants, 1/2-cc samples of those materials passing the initial screening

test were evaporated just to dryness (or constant volume) at 100° C prior to impacting in LOX. Because it was unknown whether this treatment would thermally decompose some of the test materials, duplicate sets of samples also were prepared by vacuum drying at room temperature. Based on results of these tests (Table VIIB), four promising penetrants were selected; Shannon Glo P-236 and P-505, and Magnaflux ZL42 and SKL-4 (3:1 use dilution).

Four batches of Shannon-Glo P-236 were impact tested in both the liquid form and in various amounts of residues on drying. All passed MSFC-SPEC-106. However, this penetrant was found severely corrosive to aluminum alloys, types 5052, 2219, 6061, and 5456, and, consequently is not approved for use on aluminum components in either LOX or fuel system hardware. Thus, no further evaluation tests were made on this material with respect to LOX compatibility.

In evaporating the liquid samples in vacuum, it is extremely difficult to prevent mechanical loss of sample by eruptions occurring at the start of evaporation. Furthermore, whether oven or vacuum drying is used, an appreciable and somewhat varying amount of sample is deposited on the sides, rather than the bottom, of the cup during evaporation.

The most realistic means of testing probably would be by intentional entrapment in metal inserts with reproducible cracks in the surface. However, because of the difficulty in obtaining such sample "carriers" and the large amounts that would be necessary for testing, this method was not considered feasible. As a substitute, a porous inert material was chosen. A proprietary asbestos fiber paper, 0.020 inch thick, "Novabestos" 7511T, was selected as a carrier. One-half inch squares of this material were soaked in the penetrant for one hour, drained three hours, and tested before and after drying at 60° C (140.0° F) for 30 minutes.

Results of tests on samples prepared by the carrier technique are shown in Table VIIC and reconfirm the compatibility of Magnaflux ZL42, SKL-4 (3:1 use dilution), and Shannon P-505.

Tests on Shannon Glo P-505 currently are inconclusive. Only a limited amount of this material has been tested thus far, and one fire was obtained in twenty trials on the vacuum dried residue. An additional sample is being requested for complete evaluation.

Both Magnaflux ZL42 and Shannon Glo P-505 require the use of an emulsifier and developer for effectively determining surface defects in materials. Magnaflux ZL43 emulsifier and ZP45 developer are recommended by the manufacturer for use with ZL42. Emulsifier E-159 and D-498 are recommended by Shannon Glo for use with P-505 Penetrant. SKL-4 is a water base penetrant and needs only a developer, SKD-W, in use. The developers of all three penetrants are LOX compatible (Table VIIB). However, emulsifiers (ZL43 and E-159) were sensitive to impact in LOX in the wet form, 0.025 inch thick (Table VIIA), residues (Table VIIB), and gave 20 fires in 20 trials by the carrier method (Table VIIC).

Thus, as far as LOX compatibility alone is concerned, the Magnaflux SKL-4 (3:1 dilution) Penetrant/SKD-W Developer system appears to be the most nearly satisfactory. However, even this material can introduce a hazard. Residues from 1 cc or more of the 3:1 dilution of SKL-4 are impact sensitive (3 fires/20 tests/10 kgm).

2. Quantitative Studies

Using Magnaflux Penetrant no. 137-115 as an example, an investigation was made of the ease of removal of dye penetrants and the minimum quantity of residue which will present a hazard. Samples of aluminum castings, sheet aluminum with fine scratches (125μ wide x 200μ deep), and sheet aluminum after grinding with an emery wheel were treated with penetrant, emulsifier, and developer in accordance with the manufacturer's directions. Tests also were made without the developer but with thorough water washing. In every case of the latter technique, the samples were still highly sensitive to impact in LOX. Developing before rinsing assisted much in removing residual dye. However, even this treatment did not consistently render the surface impact insensitive to LOX.

This difficulty in cleaning is not surprising. Since the functional design of penetrants is to penetrate the slightest crevice, it is necessary to employ cleaning agents or techniques of even better penetration characteristics in order to effect efficient removal of residues.

By simply placing decreasing amounts of penetrant in the test cup and evaporating to dryness, it was found that residues (from Magnaflux 137-115 Penetrant) containing as little as 7.5 micrograms of dye still were sensitive to impact in LOX.

3. Future Work

On the basis of the preceding tests, three dye penetrant systems have been selected for further evaluation from an overall viewpoint.

a. Magnaflux SKL-4 Penetrant/SKD-W Developer

b. Magnaflux ZL42 Penetrant/ZL43 Emulsifier/ZP45 Developer.

c. Shannon Glo P-505 Penetrant/E-159 Emulsifier/D-598 Developer

A test program recently has been established by the Materials Division to determine the best overall choice of dye penetrant systems. These will be evaluated with respect to the following criteria:

a. Least sensitivity to impact in LOX

b. Good flaw detection sensitivity on metal surfaces

c. Compatibility with aluminum and steel alloys in use

d. Ease of cleaning.

A separate report describing the results of this program will be issued subsequently. No fully satisfactory dye penetrant system is available currently or anticipated in the near future. It is expected that even after the completion of this evaluation program it will only be possible to recommend particular penetrants for specific uses in individual instances. Batchwise testing per MSFC-SPEC-106 and scrupulous monitoring of application and cleaning procedures will be essential.

H. SOLVENTS, CLEANING AGENTS, AND MISCELLANEOUS

A considerable amount of test work has been done on LOX cleaning and degreasing products. The actual solvents generally employed for degreasing are not inherently sensitive to impact. However, it has been demonstrated that the evaporation of a sufficient quantity of a degreasing solvent can leave an impact sensitive residue. This is particularly true of highly stabilized grades of trichloroethylene. A series of samples was prepared by carefully evaporating appropriate aliquots of a solvent of predetermined residue content in order to yield 10, 5, 2.5, and 1 milligram quantities of residues in impact test cups. Results showed that as little as 1 mg. of residue in the test cup (bottom area of approximately 0.4 in.^{2}) is sufficient to cause detonations. Assuming such solvents conform to local requirements of a maximum of 20 milligrams of non-volatile residue per liter, the unrestricted evaporation of only 50 milliliters of solvent per 0.4 in.^{2} (or 125 ml per in.^{2}) of under-lying surface would be sufficient to produce a potentially hazardous condition in LOX service. This figure may vary considerably with the specific chemical nature of the residue. Thus, appropriate precautions should be taken to avoid situations that could give rise to the concentration and deposition of such residues within LOX handling equipment. Rigid quality control of the solvent is essential in minimizing this risk, and the entire degreasing system should be free of materials capable of solution or dispersion in the solvent, which may be later deposited in the equipment being cleaned.

Similarly, most detergents and other cleaning compounds are capable of forming impact sensitive deposits if they are not removed. Adequate rinsing of all LOX equipment after treatment with cleaning agents of this type is essential.

A number of other miscellaneous materials that have been tested for various reasons are summarized in Table VIII. Some of the materials included here, due to incomplete identification or other uncertainties concerning their origin, conceivably would fall within categories surveyed earlier. A substantial number of these items (marked with an asterisk) are experimental products tested during a research program funded by this organization (at Frankford Arsenal), which was aimed at finding a "universal lubricant" (see page 6, first paragraph).

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Aerolon G Dry Film Lubricant	Acheson Colloids Company	4072	Colloidal graphite isopropanol and Freon 11 and 12	Spray coat on stainless steel inserts		0/40	10	Batch Test
Aerolon M Dry Film Lubricant	Acheson Colloids Company	4074	Colloidal molydisulfide Freon 11 and 12, isopropanol and methylene chloride	Spray coat on stainless steel inserts		0/40	10	Batch Test
Anderol Lubricant L-118	Lehigh Chemical Company	1445	Molybdenum disulphide and vehicle	Violent explosion	.050	1/8 1/2 0/10	10 5 2	Unacceptable - -
Anderol Grease L-182		1336			.050	2/5 1/15	10 5	Unacceptable -
Anderol Solvent Resistant Grease L-237		1452			.050	0/20	5	Unacceptable
Anderol Synthetic Multi-Purpose Grease L-278		1446		Test halted because of reaction violence	.050	1/4	10	Unacceptable
Anderol Grease L-419		1338		Violent explosion	.050	1/2 1/1	10 5	Unacceptable -
Anderol Low Temperature Oil L-451		1335			.050	1/2 1/4	10 5	Unacceptable -
Anderol Thixotropic Grease L-730		1443			.050	2/8 1/2 1/10	10 5 2	Unacceptable - -
Anderol Synthetic Long Fiber Grease L-752		1447			.050	1/7 0/13	5 2	Unacceptable -
Anderol Synthetic Long Fiber Grease L-754		1444		Violent explosion	.050	2/20	10	Unacceptable
Anderol Grease (MIL-G-15793) L-793		875			.050	0/20	10	Incomplete
Anderol Grease L-795		1339			.050	2/9	5	Unacceptable
Anderol Fluid X-1368	Lehigh Chemical Company	811	Halogenated hydrocarbon	Experimental product	.050	0/20	10	Incomplete
Apiezon L Grease	A. H. Thompson Company	739	Long chain aliphatic		.050	2/12 2/2 2/4	10 8 5	Unacceptable - -
Apiezon M Grease	A.H. Thompson Company	740	Long chain aliphatic		.050	2/12	10	Unacceptable
CBS Dry Film Lubricant 5940	Columbia Broadcasting Company Laboratory	2723	Copper, silver, and molydisulfide	Coating on stainless steel inserts		0/19	10	Batch Test

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
CBS Dry Film Lubricant CLD 5940	Columbia Broadcasting Company Laboratory	3797	Copper, silver, and molydisulfide	Applied to stainless steel inserts		0/20	10	Satisfactory
Cellulube Oil 220	Celanese Corporation	1057		Violent reactions	.050	2/5	10	Unacceptable
Celvacene Light Vacuum Grease	Consolidated Electrodynamics Corporation	1788		Violent reactions	.050	4/20	10	Unacceptable
Compound Rust and Corrosion Inhibiting (MIL-C-12178)		1616			.050	3/20	10	Unacceptable
Conducto Lube Grease	Conducto Lube Company	600		Electrically conductive grease		2/5 1/4 1/6	10 5 1	Unacceptable - -
Cosmoline Grease 1044	E. F. Houghton Company	1337		Violent explosion	.050	1/1	10	Unacceptable
Cosmolube No. 1 Grease		793			.050	2/6	10	Unacceptable
Cosmolube Grease 101		794		Violent explosions	.050	2/11	10	Unacceptable
Cosmolube (MIL-L-4343A) 615	E. F. Houghton Company	798		Violent explosions	.050	2/9 1/11	10 5	Unacceptable -
Dag Dispersion Dip Coating 154	Acheson Colloids Company	3451	Colloidal graphite in alcohol	Applied to stainless steel inserts		0/20	10	Incomplete
Dag Dispersion 155		3448	Colloidal graphite and Triclene D			0/20	10	Batch Test
Dag Dispersion 210		3453	Colloidal molydisulfide in isopropyl alcohol			4/20 2/5 0/20	10 5 3	Unacceptable - -
Dag Dispersion 211		3449	Colloidal molydisulfide in trichloroethylene			0/20	10	Batch Test
Dag Dispersion 217	Acheson Colloids Company	844	Graphite and organic vehicle	Violent explosion		1/10	10	Unacceptable
Dow Corning Grease 3	Dow Corning Corporation	831	Silicone		.050	2/6 4/10 1/14	10 8 5	Unacceptable - -
Dow Corning Grease 4		809	Silicone		.050	3/13 1/17	10 5	Unacceptable -
Dow Corning Grease 5		832	Silicone		.050	2/2 2/6	10 5	Unacceptable -
Dow Corning Grease 6	Dow Corning Corporation	835	Silicone		.050	2/3 1/17	10 5	Unacceptable -

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Test	Energy Level Kg-M	Rating
Dow Corning Grease 7	Dow Corning Corporation	930	Silicone		.050	2/2 2/3 0/15	10 5 2	Unacceptable - -
Dow Corning Grease 11		445	Silicone		.050	2/3 0/15	10 5	Unacceptable -
Dow Corning Grease 33 (Light Consistency)		159	Silicone		.050	2/11 1/6 0/20	10 5 3	Unacceptable - -
Dow Corning Grease 41		829	Silicone		.050	2/20	10	Unacceptable
Dow Corning Grease 44		158	Silicone		.050	2/20	10	Unacceptable
Dow Corning Grease 55		420	Silicone		.050	1/2 1/6 0/8	10 5 2	Unacceptable - -
Dow Corning Fluid 200 (200 cs)		177	Silicone		.050	7/20	10	Unacceptable
Dow Corning Fluid 550		838	Silicone		.050	2/8	10	Unacceptable
Dow Corning Fluid 702		383	Silicone		.050	2/9 1/5	10 5	Unacceptable -
Dow Corning Fluid 703		384	Silicone		.050	2/4	10	Unacceptable
Dow Corning Fluid 710		781	Silicone		.050	2/6 2/4 2/20 0/20	10 5 3 2	Unacceptable - - -
Dow Corning Valve Seal A		444	Silicone		.050	2/20	10	Unacceptable
Dow Corning High Vacuum Grease		213	Silicone		.050	10/20	10	Unacceptable
Dow Corning Electric Motor Grease	Dow Corning Corporation	593	Silicone		.050	1/6 1/20	10 5	Unacceptable -
Drilube 701	Drilube Company	2116 1469	Molydisulfide in ethyl alcohol and ethyl acetate	Spray coating on stainless steel inserts		0/35	10	Batch Test
Drilube 702		1650	Molydisulfide in chromous and phosphoric acid		.050	0/20	10	Satisfactory
Drilube 703		825	Molydisulfide in chromous and phosphoric acid		.050	0/20	10	Satisfactory
Drilube Dip Coating 90	Drilube Company	1368		Dip coating on stainless steel inserts		2/3 1/17	10 5	Unacceptable -

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Du Metal	Garlock Packing Company	814	Teflon and sintered metal	For bearing surfaces	.063	0/20	10	Satisfactory
Dumore "O" Cool Bearing Oil	Dumore Company	1334			.050	1/1 1/3	10 5	Unacceptable -
Duo Vacuum Pump Oil	Welch Scientific Company	876			.050	1/9 0/11	10 7	Unacceptable -
Electrofilm 2006	Electrofilm Incorporated	534	Molydisulfide, synthetic graphite with silicone and formaldehyde resins	Violent explosions		2/2 2/2 1/3	10 5 3	Unacceptable - -
Electrofilm 4396		2724	Molydisulfide and graphite with vinyl binder		.001	7/20 4/20 3/20 0/20	10 5 3 2	Unacceptable - - -
Electrofilm 1000		535	Ceramic bonded molydisulfide	Spray coating		0/20	10	Unacceptable
Electrofilm 66-C		1310	Molydisulfide and organic vehicle	Spray coating		1/80	10	Batch Test
Electrofilm 17-S		981	Solid film lubricant with thermosetting resin			2/20	10	Unacceptable
Electrofilm 2396	Electrofilm Incorporated	4256	Molydisulfide and graphite with sodium silicate	Coating applied to stainless steel inserts	.001	0/40	10	Batch Test
Everlube 811B	Everlube Corporation	4306	Molydisulfide and sodium silicate	Coating applied to stainless steel inserts		0/20	10	Batch Test
Everlube 811	Everlube Corporation	1829	Molydisulfide and sodium silicate	Dip coating, cured at 400° F		0/20	10	Batch Test
Esso Grease M-100 Super MIL ASU	Esso Oil Company	1317			.050	3/10 1/10	10 5	Unacceptable -
Fel Pro C-100	Felt Products Company	3761	Molydisulfide and organic vehicle		.010	2/3 1/4 1/3 1/5 0/7	10 4 3 2 1	Unacceptable - - - -
Fluorochemical FC-75	Minnesota Mining and Manufacturing Company	448	Fluorinated cyclic ether		.050	0/20	10	Satisfactory
Fluorochemical FC-101		939			.050	0/20	10	Satisfactory
Fluorochemical FC-43		447	Heptacosafluorotributylamine		.050	0/20	10	Satisfactory
Fluorinated Grease		2149			.005	0/20	10	Satisfactory
Fluorochemical FX-45	Minnesota Mining and Manufacturing Company	3233			.050	0/20	10	Satisfactory

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Fluorolube G.R. 362	Hooker Chemical Company	437	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Fluorolube T-45		1173	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Fluorolube T-80		1852	Chlorofluorocarbon	Three batches tested	.050	0/60	10	Satisfactory
Florolube T-80		3335	From Allpax treating bath	Four batches tested	.050	0/20	10	Satisfactory
Fluorolube 350		3760	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Fluorolube GR-544		2208	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Fluorolube LG		3876	Chlorofluorocarbon	Two batches tested	.050	0/20	10	Satisfactory
Fluorolube GR-362	Hooker Chemical Company	2528	Chlorofluorocarbon		.050	0/20	10	Satisfactory
FS 1281 Grease (Lot 28)	Dow Corning Corporation	3621	Fluorosilicone	Sensitivity varies from batch to batch	.050	0-5/20	10	Batch Test
FS 1281 Grease (Lot 28)		4308	Fluorosilicone		.005	4/9	10	Unacceptable
						4/9	5	-
						3/24	3	-
						1/11	1	-
FX 46 Grease (Lot 1)	Minnesota Mining and Manufacturing Company	3873			.050	0/20	10	Batch Test
FX-46 Grease (Lot 1)	Minnesota Mining and Manufacturing Company	3874			.002	0/20	10	Batch Test
Fluorolube S-30	Hooker Chemical Company	4355	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Fluoro-Glide	Chemplast Incorporated	1876	Teflon-Freon	Two batches tested		0/20	10	Satisfactory
Grease (GAA-MIL-C-10924)	Sta-Vis Oil Company	908			.050	2/5	10	Unacceptable
						2/10	5	-
						0/5	2	-
Grease (GLT-MIL-G-3278A)	Socony Mobil Oil Company	599	Petroleum base grease		.050	2/10	10	Unacceptable
Grease, Lubricating, O.D. No. OO	Warren Refining and Chemical Company	611		Violent reaction	.050	1/20	10	Unacceptable

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Halocarbon Grease 13-21	Halocarbon Corporation	989	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Halocarbon Oil 11-21		1287	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Halocarbon Grease 25-20MB		1262	Chlorofluorocarbon	Contains rust inhibitor	.050	0/20	10	Satisfactory
Halocarbon Grease 25-20MA		1261	Chlorofluorocarbon	Contains rust inhibitor	.050	0/20	10	Satisfactory
Halocarbon Grease 25-20MZ		1244	Chlorofluorocarbon	Contains rust inhibitor	.050	0/20	10	Satisfactory
Halocarbon Grease 25-10MZ		1243	Chlorofluorocarbon	Contains rust inhibitor	.050	0/20	10	Satisfactory
Halocarbon Grease 25-20M-5A	Halocarbon Corporation	1831	Chlorofluorocarbon with a barium sulfonate inhibitor		.050	0/20	10	Satisfactory
Houghton Hi-Temp Grease 2409	E. H. Houghton Company	4421	Polyglycol		.050	3/20	10	Unacceptable
Kel-F-10-200 WAX	Minnesota Mining and Manufacturing Company	356	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Kel-F Oil No. 1		451	Chlorofluorocarbon		.050	0/20	10	Satisfactory
Kel-F Polymer Oil No. 10		2744	Chlorofluorocarbon	Two batches tested	.050	0/20	10	Satisfactory
Kel-F-90 Grease		3243	Chlorofluorocarbon	Two batches tested	.050	0/20	10	Satisfactory
Kel-F Polymer Oil KF-3		2721	Chlorofluorocarbon	Contains rust inhibitor	.050	1/60	10	Batch Test
Kel-F Polymer Oil KF-1		2722	Chlorofluorocarbon	Contains rust inhibitor	.050	0/20	10	Satisfactory
Kel-F Polymer Oil Lot 1006-1		2897	Chlorofluorocarbon		.050	0/20	10	Satisfactory
KX-262 NB-1247-36		3604	Chlorofluorocarbon		.050	0/40	10	Satisfactory
KX-245 Lot 2	Minnesota Mining and Manufacturing Company	3606	Chlorofluorocarbon		.050	0/40	10	Satisfactory
Lapping Compounds 38-1200	United States Products Company	1960			.050	2/4 2/16	10 5	Unacceptable -
Lube Rex	General Cement Company	597	Hydrocarbon grease		.050	2/6	10	Unacceptable
Lubriko MD-T-419	Masden-Lubricant Company	588	Hydrocarbon grease		.050	3/12	10	Unacceptable
Lubriplate	Fiske Brothers Incorporated	643	Hydrocarbon grease		.050	2/10	10	Unacceptable
Lubriseal	A. H. Thomas Company	637	Hydrocarbon grease		.050	2/6 0/20	10 5	Unacceptable -
McLube 99	McGee Chemical Company	3895			.050	0/40	10	Satisfactory

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
McLube 2010	McGee Chemical Company Incorporated	3896	Molydisulfide with graphite and Fluorolube		.050	0/20	10	Batch Test
McLube 2023	McGee Chemical Company Incorporated	3897	Molydisulfide with graphite and Fluorolube		.050	0/20	10	Batch Test
Metco Valvelube	Metallizing Engineering Company	562	Hydrocarbon grease	Very violent reaction	.050	1/20	5	Unacceptable
Midwest Research Institute Dry Film Lubricant	Midwest Research Institute	3614	Molydisulfides, graphite, and bismuth in sodium silicate 10:1:5/7			0/20	10	Satisfactory
Midwest Research Institute Dry Film Lubricant		3613	Molydisulfide, graphite, and bismuth in sodium silicate 10:1:2.5/7			0/20	10	Satisfactory
Midwest Research Institute Dry Film Lubricant		3612	Molydisulfide, graphite, and bismuth in sodium silicate 10:1:5/7			0/20	10	Satisfactory
Midwest Research Institute Dry Film Lubricant	Midwest Research Institute	3611	Molydisulfide, and graphite in sodium phosphate 10:1/7			0/20	10	Satisfactory
Mogul Taper Valvelube	Metallizing Engineering Company	561			.050	2/20	10	Unacceptable
Mold Release Lubricant S-122	Miller-Stephenson Company	2736				0/20	10	Satisfactory
Molykote G Grease	Alpha Molykote Corporation	716	Molydisulfide and petroleum base oil	Violent reactions	.050	3/4	10	Unacceptable
Molykote Grease M-55		518	Molydisulfide and organic vehicle		.050	2/20	10	Unacceptable
Molykote Spray Lube		772	Molydisulfide with Freon propellant			0/20	10	Batch Test
Molykote M-8800		3363				5/20 2/20 0/20	10 5 3	Unacceptable - -
Molykote X-15		3362	Sodium silicate, molydisulfide, Sodium silicate, and graphite			0/60	10	Batch Test
Molykote Z		1655	Molydisulfide powder	Two batches tested		0/20	10	Satisfactory
Molykote Z	Alpha Molykote Corporation	1654		Without stainless steel inserts		2/20	10	
Molylube	Bell Ray Company	2735	Molydisulfide Freon propellant			0/20	10	Batch Test
Molylube AR	Bell Ray Company	2734	Molydisulfide and binder			8/80	10	Unacceptable

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Molynamel E	Lockrey Company	3239	Molydisulfide, teflon, and toluene			7/60 2/20	10 5	Unacceptable -
Parker "O" Lube	Parker Appliance Company	788			.050	2/5	10	Unacceptable
Parker Water Oil Lube Grease 50	Parker Appliance Company	274			.050	1/2 1/2 1/4	10 5 3	Unacceptable - -
P.D. 822	Frankford Arsenal	3996	Fluorinated polymer		.050	4/20	10	Unacceptable
P.D. 821		3995	Fluorinated polymer		.050	0/20	10	Batch Test
P.D. 819		3993	Fluorinated oil and polymer gelling agent		.050	0/20	10	Batch Test
P.D. 820		3994	Fluorinated polymer		.050	0/20	10	Batch Test
P.D. 816		3991	Fluorinated amine oil and fluorinated polymer gelling agent		.050	0/20	10	Batch Test
P.D. 817		3992	Fluorinated oils and polymer gelling agent		.050	0/20	10	Batch Test
P.D. 811		3570	Special grade graphite			0/20	10	Batch Test
P.D. 812		3569	Perfluorotrialkylamine blend			0/20	10	Batch Test
P.D. 810		3564	Silica gelling agent			0/20	10	Batch Test
P.D. 809		3563	Silica gelling agent			0/20	10	Batch Test
P.D. 808		3560	Silica gelling agent			0/20	10	Batch Test
P.D. 800		3561	Perfluorotrialkylamine base oil and silica gelling agent		.050	0/20	10	Batch Test
P.D. 797		3553	Perfluorotrialkylamine base oil and silica gelling agent		.050	0/20	10	Batch Test
P.D. 801		3552	Perfluorotrialkylamine base oil and silica gelling agent		.050	0/20	10	Batch Test
P.D. 791		2106	Purified sample of perfluorotrialkylamine		.050	0/10	10	Incomplete
P.D. 787	Frankford Arsenal	2105	Polytetrafluoroethylene gelling agent			0/20	10	Batch Test

TABLE I LUBRICANTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
P.D. 788	Frankford Arsenal	2081	Grease consisting of P.D. 787 and P.D. 789		.050	0/20	10	Batch Test
P.D. 785		2079	Mixture of perfluoro-trialkylamines		.050	0/20	10	Batch Test
P.D. 792		2078	Grease consisting of graphite gelling agent and perfluorotrialkyla-mine base oil (P.D. 789)		.050	0/20	10	Batch Test
P.D. 786		2080	Grease consisting of polytetrafluoroethylene gelling agent (P.D. 787) and perfluorotrialkyla-mine oil (P.D. 785)		.050	0/20	10	Batch Test
P.D. 789	Frankford Arsenal	2077	Mixture of perfluorotri-alkylamines		.050	0/20	10	Batch Test
Polyglycol 11-200 Lot 8-6	Dow Chemical Company	1940	Polyglycol		.050	0/20	10	Incomplete
QC-2-0093	Dow Corning Corporation		Fluorosilicone	Sensitivity varies from batch to batch	.050	0-5/20	10	Batch Test
QC-2-0026			Fluorosilicone	Sensitivity varies from batch to batch	.050	0-3/20	10	Batch Test
QF-1-0065 Fluid (2500 cs)		1288	Fluorosilicone		.050	3/12 0/8	10 5	Unacceptable -
QF-1-0065 (7500 cs)	Dow Corning Corporation	4438	Fluorosilicone		.050	0/20	10	Batch Test
Sealube Grease	Parker Appliance Company	550			.050	2/2 1/4 3/10	10 5 3	Unacceptable - -
Semco No. 551		1442			.050	0/20	10	Incomplete
Silgon 6 (1000 cs)	Anderson Chemical Company	4415			.050	7/20	10	Unacceptable
Silgon Fluid 6 (300 cs)		965			.050	2/5 2/3	10 5	Unacceptable -
Silgon 6 (500 cs)		4413			.050	2/20	10	Unacceptable
Silgon Grease 10	Anderson Chemical Company	4410			.050	2/20	10	Unacceptable
Silicone Lubricant 398-38-1114	General Electric Company	955	Silicone		.050	2/3 1/1 1/5	10 5 1	Unacceptable - -
Silicone Lubricant 20057	Electromechanics Corporation	478	Silicone grease		.050	2/10	10	Unacceptable

TABLE I LUBRICANTS (Concluded)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Silicone Lubricant 81717	General Electric Company	569	Silicone		.050	2/3 1/1	10 5	Unacceptable -
Silicone Fluid SF 96 (275 cs)		564	Silicone		.050	2/10 0/10	10 5	Unacceptable -
Silicone Fluid SF 96 (100 cs)		565	Silicone		.050	2/5 4/6	10 5	Unacceptable -
Silicone Fluid SF 96 (40 cs)		566	Silicone		.050	2/6 2/6	10 5	Unacceptable -
Silicone Fluid SF 81 (40 cs)	General Electric Company	493	Silicone		.050	2/4 2/3	10 5	Unacceptable -
Templube Grease 124	National Engineering Products Company	542			.050	2/7	10	Unacceptable
Ucon Lubricant 50 HB-280X	Union Carbide Corporation	3214	Polyalkylene glycol		.050	4/20 0/20	10 5	Unacceptable -
Ucon Lubricant 50-HB-280X		785	Polyalkylene glycol		.050	2/2 1/18	10 5	Unacceptable -
Ucon Lubricant 50 HB-280X		3207	Polyalkylene glycol		.030	2/20	10	Unacceptable
Ucon Fluid LB-300X		4416	Polyalkylene glycol		.050	5/20	10	Unacceptable
Ucon Fluid 50-LB-65		433	Polyalkylene glycol		.050	1/3 1/3 1/3	10 5 3	Unacceptable - -
Ucon Fluid LB-135	Union Carbide Corporation	434	Polyalkylene glycol		.050	1/2	10	Unacceptable
Versilube Fluid F-50	General Electric Company	238	Silicone		.050	2/2 2/2	10 5	Unacceptable -
Versilube Fluid G-300		270	Silicone		.050	2/10	10	Unacceptable
Viscasil Fluid 5000	General Electric Company	552	Silicone	Violent explosion	.050	1/20	10	Unacceptable
WD-40 Stoprust	Rocket Chemical Company	2667		Violent explosions	Spray Film	3/24 2/15	10 5	Unacceptable -
Whytekote 505	Alpha Molykote Corporation	3469			.002	1/1 1/1 1/1 1/2	10 5 3 1	Unacceptable - - -
Wire-lube Pulling Lubricant	Ideal Industries Incorporated	4080			.050	0/20	10	Incomplete
XLE-42 Fluid	Union Carbide Corporation	926	Silicone		.050	0/20	10	Incomplete
X520		876	Silicone		.050	2/20	10	Unacceptable
Sample IIF	Union Carbide Corporation	1449	70% Ucon 65LB		.050	5/20 4/20	10 5	Unacceptable -

TABLE II SEALANTS AND THREADING COMPOUNDS

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Anderol 1333	Lehigh Chemical Company	704	Antimony compound in fluoro-silicone fluid	Corrosive to aluminum alloys	.050	0/34	10	Unacceptable
Anti-scoring Extreme Pressure Lube No. 3	Chicago Manufacturing and Distributing Company	3772			.050	2/20	10	Unacceptable
Anti-scoring Extreme Pressure Lube No. 3	Chicago Manufacturing and Distributing Company	3773			Thin film	10/20	10	Unacceptable
Anti-seize Compound 32-Z	Materials Division, P&VE Lab MSFC	2192			.050	0/20	10	Batch Test
AR-1F (Lot 67)	Materials Division, P&VE Lab MSFC	1462	Arochlor 1254 and graphite		.050	0/20	10	Batch Test
AR-1F	Hayes Aircraft Corporation	3129	Arochlor 1254 and graphite		.050	0/20	10	Batch Test
Dag Dispersion No. 217	Acheson Colloids Company	84			.050	1/10	10	Incomplete
E.C. 1730	Acheson Colloids Company		Arochlor 1254 and graphite	Thirty-three batches tested	.050	0/20	10	Satisfactory
Fluroseal	Industrial Plastic Fabricators Incorporated	485	Water dispersion of Teflon and ammonia		.050	0/20	10	Batch Test
Leak Lock	Highside Chemical Company Incorporated	545		Two batches tested	.050	1/11	10	Unacceptable
Loctite A	American Sealants Company	827			.050	2/7 2/2	10 5	Unacceptable -
LOX-Lube (Spec NA-2-20502)	North American Aviation	249	Graphite and chlorinated hydrocarbon	Sensitivity varies from batch to batch	.050	10/20	10	Batch Test
LOX-Safe	Redel Incorporated		Graphite and chlorinated hydrocarbon	Sensitivity varies from batch to batch	.050	2/20	10	Batch Test
LOX-Sealant (Spec NA-2-20502)	North American Aviation		15% Dixon 200-10 graphite, 85% Arochlor 1254	Sensitivity varies from batch to batch	.050	2/20	10	Batch Test
LOX Sealant	Rolls Royce Limited	935	Graphite, chlorinated hydrocarbon		.050	0/20	10	Batch Test
Oxyseal	Parker Appliance Company	217	Graphite and chlorinated hydrocarbon		.050	6/10 0/12	10 3	Unacceptable -
Permatex 1516	Permatex Company Incorporated	861	Graphite and chlorinated hydrocarbon		.050	4/60	10	Unacceptable
Plastic Lead Seal No. 1	Crane Packing Company	234	Lead compounds in rubber binder		.050	3/10 1/20 1/10	10 8 7	Unacceptable - -

TABLE II SEALANTS AND THREADING COMPOUNDS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions / No. Tests	Energy Level Kg-M	Rating
Plastic Lead Seal No. 2	Crane Packing Company	744	Lead compounds in rubber binder		.050	2/6	10	Unacceptable
Plastic Lead Seal No. 4	Crane Packing Company	236	Lead compounds in rubber binder		.050	2/3 2/10 0/10	10 5 3	Unacceptable - - -
Potting Compound No. 420	Carl Biggs Company	520			.050	3/14 1/20	10 5	Unacceptable -
Rectorseal 25X-1	Rector Well Equipment Company Incorporated	169	Graphite and chlorinated hydrocarbon		.050	2/10	10	Unacceptable
Rectorseal No. 15	Rector Well Equipment Company Incorporated		Graphite and chlorinated hydrocarbon		.050	1-5/20	10	Unacceptable
Reddy-Lube No. 2	Redel Incorporated	245	Graphite and chlorinated hydrocarbon	Sensitivity varies from batch to batch	.050	0-2/20	10	Batch Test
Reddy-Lube No. 2	Redel Incorporated		Graphite and chlorinated hydrocarbon	Thin samples		3-5/20 1/12	10 7	Unacceptable -
Sauereisen No. 1	Sauereisen Cements Company	744			.050	2/2 1/18	10 5	Unacceptable -
Sauereisen No. 51		351			.050	0/20	10	Batch Test
Sauereisen No. 52	Sauereisen Cements Company	289			.050	1/1 1/1 1/1 1/2	10 7 5 3	Unacceptable - - -
Seal-Rite No. 5	Macksons Company	241	Graphite, aluminum silicate binder, and carbohydrate vehicle	Sensitivity varies from batch to batch	.050	0-2/20	10	Batch Test
Sodium Silicate and Graphite	Materials Division, P&VE Lab MSFC	580	Sodium silicate and graphite		.050	0/20	10	Batch Test
Sodium Silicate and Talc	Materials Division, P&VE Lab MSFC	723	Sodium silicate and talc		.050	0/20	10	Batch Test
T-Film Thread Compound	Eco Engineering Company	820	Teflon-water dispersion		.050	0/20	10	Batch Test
Thread Compound No. 265	Valley Products Company	507			.050	2/37	10	Unacceptable
Thread Lube	Parker Appliance Company	273			.050	1/2 1/2 1/2 1/2	10 7 5 3	Unacceptable - - -

TABLE II SEALANTS AND THREADING COMPOUNDS (Concluded)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Universal Thread Seal Teflon Ribbon	W.S. Shamban and Company	2554	Teflon			0/20	10	Batch Test
X-Pando	X-Pando Corporation	641	Silicate cement		.050	0/20	10	Batch Test

TABLE III THERMAL AND ELECTRIC INSULATION (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Aluminum and Mylar Covering from Fibrous Glass Insulation	Fibrous Glass Incorporated	3799	Aluminum and Mylar			2/2 2/4 2/4 2/4 2/7	10 5 3 1 1/2	Unacceptable - - - -
Alsimag Ceramic Insulation 196	American Lava Corporation	1006	Clinonstatite crystals			2/20	10	Unacceptable
Convair Liquid Hydrogen Insulation	Convair Division General Dynamics	3189	Phenolic resin, fiberglass honeycomb, epoxy fiberglass sealer, epoxy adhesive		.313	2/2 11/11 20/20 7/20 0/20	10 5 2 1 1/2	Unacceptable - - - -
Dyna-Therm D-65	Dyna-Therm Chemical Corporation	2321	Polyurethane, sodium phosphate, sodium borate, and carbon		.063	0/40	10	Batch Test
Dyna-Therm D-65		3250	Polyurethane, sodium phosphate, sodium borate, and carbon		.125	0/20	10	Batch Test
Dyna-Therm D-65		3255	Polyurethane, sodium phosphate, sodium borate, and carbon	Aged 8 months	.063	0/20	10	Batch Test
Dyna-Therm D-65 with 904 Coating		3251	Polyurethane, sodium phosphate, sodium borate, and carbon		.063	0/20	10	Incomplete
Dyna-Therm D-904		2323	Polyurethane		.050	6/20 2/15 0/20	10 5 4	Unacceptable - -
Dyna-Therm D-100	Dyna-Therm Chemical Corporation	1801	Polyurethane		.063	2/20 1/40	10 2	Unacceptable
Fiber Frax	Carborundum Company	2355	Mineral fiber	With aluminum foil backing		4/40	10	Unacceptable
Fiber Frax (XSW)		2381	Mineral fiber	Heat treated inserts used		2/20	10	Unacceptable
Fiber Frax	Carborundum Company	2410	Mineral fiber	Heat treated 3 hours at 1000°F		0/20	10	Batch Test
Fibrous Glass Insulation	Fibrous Glass Incorporated	3798	Glass		.125	2/2 2/2 2/2 2/2	10 5 3 1	Unacceptable - - -
Foamglass Insulation	Pittsburgh-Corning Corporation	799	Cellular glass			0/20	10	Satisfactory

TABLE III THERMAL AND ELECTRIC INSULATION (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Foamseal Joint Sealer 30-45	Benjamin Foster Company	923				2/2	10	Unacceptable
						2/3	5	-
						2/2	2	-
Foamsil Insulation	Pittsburgh-Corning Corporation	878	Cellular glass			0/20	10	Satisfactory
Foster Fire Resistive Coating 60-30N	Benjamin Foster Company	1017				2/2	10	Unacceptable
						2/5	5	-
						2/2	2	-
Foster Flexfas Bonding Agent 82-10		970				0/20	10	Batch Test
Foster Fire Resistive Coating 60-65		1016				2/2	10	Unacceptable
						2/2	5	
						2/7	2	-
Foster Sealfas Insulation Coating 31-96	Benjamin Foster Company	968				2/4	10	Unacceptable
						2/4	5	-
						2/5	2	-
Glass Fiber "B" No. 621	Owens-Corning Corporation	2357	Glass		.063	0/40	10	Satisfactory
Glass No. 621	Owens-Corning Corporation	2378	Glass		.063	0/20	10	Satisfactory
Hexcell 91LD	Hexcell Products Company	4234	Honey comb phenolic and epoxy		.063	20/20	10	Unacceptable
						20/20	5	-
						20/20	3	-
						15/20	1	-
Hexcell Polyurethane Insulation 1414-2	Hexcell Products Company	3680	Polyurethane		.250	20/20	10	Unacceptable
						19/20	5	-
						8/20	3	-
						0/20	2	-
Inserts, Fired Durock Type D117-063	Physical Science Corporation	3220	Lead oxide, cobalt oxide, nickel oxide, and bismuth oxide			0/20	10	Batch Test
Isowood	North American Aviation	3209	Quartz spheres and epoxy		.125	15/20	10	Unacceptable
						7/20	7	-
						2/20	5	-
						0/20	3	-
Johns-Manville Rock Cork Insulation	Johns-Manville Company	800	Mineral fiber			2/5	10	Unacceptable
						2/7	5	-
						1/8	2	-
Johns-Manville Thermo-bestos Insulation	Johns-Manville Company	795	Calcium silicate			0/20	10	Batch Test

TABLE III THERMAL AND ELECTRIC INSULATION (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Johns-Manville Thermomat Style 281	Johns-Manville Company	3228	Asbestos felt saturated with phenolic resin and inorganic filler		.063	11/20 6/20 5/20 3/20 0/20	10 5 3 2 1	Unacceptable - - - -
Kaowool	Babcock and Wilcox Company	2346	Ceramic fiber	Two batches tested		2/20 0/20	10 5	Unacceptable -
Kaowool	Babcock and Wilcox Company	2488	Ceramic fiber	Heat treated 2 hours at 1000°F	.063	0/40	10	Batch Test
Micro-Fibrous Felt No. 108	Johns-Manville Company	4027	Glass		.125	0/20	10	Batch Test
Microlite Fiber Glass Insulation		3126	Fiber glass		.094	0/20	10	Batch Test
Micro-Quartz		2347	Quartz fibers			5/40	10	Unacceptable
Micro-Quartz	Johns-Manville Company	2382	Quartz fibers	Heat treated inserts used		1/20	10	Incomplete
Potassium Titanate		2221	Potassium titanate		.063	8/40	10	Unacceptable
Potassium Titanate		2728	Potassium titanate	Heated 4 hours at 1000°F	.063	0/20	10	Batch Test
Silicone RTV Foam QR 7131	Dow-Corning Corporation	3769	Silicone		.250	4/20 3/20 0/20	10 5 3	Unacceptable - -
Scotch Foam I Insulation	Minnesota Mining and Manufacturing Company	798	Foamed plastic		.060	2/2 2/12 0/5	10 5 3	Unacceptable - -
Smooth On Cement	Smooth On Manufacturing Company	1646			.050	0/20	10	Satisfactory
Snap-On Insulation	Gustin-Bacon Company	796	Glass fiber			2/20	10	Unacceptable
Stafoam Insulation AA202	Dayton Rubber Company	781				3/20	10	Unacceptable
Stafoam Insulation C-02	Dayton Rubber Company	782				2/8 2/4 0/8	10 5 3	Unacceptable - -
Styrofoam Insulation No. 33	Styrofoam Plastics Corporation	707	Styrofoam			2/3 3/4	10 5	Unacceptable -
Thermo-Resist 69	Thermo Resist Company	3674	Phenylated nylon			11/20 8/10 4/10	10 5 3	Unacceptable - -

TABLE III THERMAL AND ELECTRIC INSULATION (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Unicrest Insulation, Outer Covering	United Cork Company	788				2/2 2/2 2/3	10 5 3	Unacceptable - -
Unicrest Insulation		747				2/2 2/4 0/14	10 5 3	Unacceptable - -
Unicrest Type S E Insulation	United Cork Company	709				2/20 2/20	10 5	Unacceptable -
Vimasco Insulation Coating WC-1	Vimasco Corporation	921				2/3 2/2 2/4	10 5 3	Unacceptable - -
Vimasco Carlon Insulation Coating 500	Vimasco Corporation	919				3/20	10	Unacceptable
White Mercury Resistant Electrical Insulation Coating 168-W-20	W.P. Fuller and Company	4012	Modified silicone	Baked on stainless steel inserts	Brush coat	2/20	10	Unacceptable
AWG No. 22 Copper Wire Coated with Aluminum Phosphate Impregnated Felt Asbestos	General Electric Company	3197	Aluminum phosphate, asbestos, and copper			0/20	10	Batch Test Batch Test
Cable, Type 4TX-22-1934	Hi-Temp Wires Incorporated	1705				0/20	10	Batch Test
Cable, Type 4TX-22-1934 Outside Covering	Hi-Temp Wires Incorporated	1778				3/20	10	Unacceptable
Cable Transonics, Type 1932	Suprenant Manufacturing Company	1706				0/20	10	Batch Test
Chromel-Alumel, Teflon Singles, Nylon Wrap	Revere Corporation of America	1691	Chromel-Alumel, Teflon, and Nylon			3/20	10	Unacceptable
Chromel-Alumel, Teflon Singles, Asbestos Jacket		1686	Chromel-Alumel, Teflon, and asbestos			2/2 2/2 2/10 1/6	10 5 3 2	Unacceptable - - -
Copper-Constantan Sinterex Teflon Tape Cover		1687	Copper, Constantan, and Teflon			1/60	10	Batch Test
Copper-Constantan Conductor with Polyvinyl Insulation	Revere Corporation of America	1682	Copper, Constantan, and polyvinyl plastic			2/2 2/2 1/1 1/7	10 5 3 2	Unacceptable - - -
20-2 Conductor Standard No. 1741 Shielded	Alpha Wire Corporation	1681				3/4 2/15	10 5	Unacceptable -

TABLE III THERMAL AND ELECTRIC INSULATION (Concluded)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Silvered Gage Twenty Four Conductor Wire	Revere Corporation of America	1688	Silvered gage twenty-four conductor wire. Inner wire insulation-revcothene. Outer covering Geon Shield-Tinned Copper		.594	2/2	10	Unacceptable
Teflon Type 2857, No. 18 Strained Copper, Silver Coated		1690	Tefon, copper, and silver			0/20	10	Satisfactory
Tensolite Alpha Type 2812-2	Alpha Wire Corporation	1684				2/11 2/3 1/6	10 5 3	Unacceptable - -
Tensolite Alpha Type 2812-4	Alpha Wire Corporation	1683				0/20	10	Batch Test
Type 2TX-22-1934ZX Wire	Hi-Temp Wires Incorporated	1679	Stranded silver-plated copper conductor with extruded Teflon insulation, shielded in tinned copper. Outside polyvinyl chloride			2/2 1/1 2/12 0/5	10 5 3 2	Unacceptable - - -
		1680				2/11 1/9	5 3	- -
Wire, Ceramic Coated Nickel-Clad Copper	General Cable Corporation	3218	Ceramic coated, nickel-clad copper			23/40	10	Unacceptable
Wire, Ceramic Coated Nickel-Clad Copper	General Cable Corporation	3322	Ceramic coated, nickel-clad copper			20/40 9/20	10 5	Unacceptable -
Wire Coated with ML Enamel		4009				0/20	10	Batch Test
Wire Coated with ML Enamel and Covered with Felt Asbestos		4008				0/20	10	Batch Test

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Aclar Type 22A	Allied Chemical Company	3997	Fluorohalocarbon		005	0/20	10	Batch Test
Aclar Type 22A	↕	3998	Fluorohalocarbon		.002	0/40	10	Batch Test
Aclar Type 191 (MIL-F-22191)	Allied Chemical Company	4185	Fluorohalocarbon		.002	0/20	10	Batch Test
Aero Quip Black		1012	Erradiated polyvinyl chloride	Liner for flex hose		2/4 2/12 0/4	10 5 2	Unacceptable - -
Aero Quip Orange		1011	Teflon	Liner for metal flex hose		0/20	10	Batch Test
Amco Adhesive F-88	American Consolidated Manufacturing Company	3404	Fluorohalocarbon		.050	2/3 2/11 0/20	10 5 1	Unacceptable - -
Armstrong Cement	Armstrong Products Company	657			.050	2/2 1/1	10 5	Unacceptable -
Araldite 6010 and Catalyst 125	CIBA Chemical Company	743	Epoxy		.050	3/3 2/4 2/2	10 5 2	Unacceptable - -
B.F.C. Transparent Blue Liquid Envelope	Better Finishing Company Incorporated	3840		Film on stainless steel inserts		2/10 2/13 0/20	10 5 2	Unacceptable - -
Blastguard Tape Grade AAA	H K. Porter Company Incorporated	2327		Treated pressure sensitive tape	.125	12/20 2/11 0/5	10 5 5	Unacceptable - -
Blastape MX4647	Johns-Manville Company	2328			125	0/20	10	Batch Test
Buna-N Rubber		656				2/3	10	Unacceptable
Butyl Fairprene	E. I. du Pont de Nemours & Co., Inc. Incorporated	618	Fabric impregnated with butyl rubber			4/6 2/20	10 5	Unacceptable -
Coast Pro Seal 793	Coast Pro Seal Manufacturing Company	2759	Polyurethane		.063	2/7	10	Unacceptable
Compound Rubber X-58	Bacon Industries Incorporated	280	Teflon impregnated silicone rubber			2/3	10	Unacceptable
Compound Th 1057	Steelman Rubber Company	2385	Fluoro-silicone		.063	0/20	10	Batch Test
Crystal MG Inorganic Paper	Minnesota Mining and Manufacturing Company	3195			.003	2/20	10	Unacceptable
Crystal MP Inorganic Paper	↕	3196			.003	0/20	10	Batch Test
Crystal M Inorganic Paper	Minnesota Mining and Manufacturing Company	3194			003	0/20	10	Batch Test

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
D.C. 274 Adhesive	Dow Corning Corporation	640	Silicone			2/8 0/12	10 5	Unacceptable -
Dip Pak No. 661	Fidelity Chemical Corporation	3762	Cellulose acetate butyrate		.063	2/10	10	Unacceptable
Dip Pak No. 661	Fidelity Chemical Corporation	3764	Cellulose acetate butyrate	Stainless steel inserts dipped in molten Dip Pak	.001	9/20 3/20 7/20 0/20	10 2 5 1	Unacceptable - - -
Du Pont H Film	E. I. du Pont de Nemours & Co., Inc.	3647			.002	0/20	10	Batch Test
Du Pont HT-1 No. 67011 (361A)		4192			.002	14/20 2/20 2/20 0/20	10 5 3 1	Unacceptable - - -
Du Pont HT-1 No. 67014 (171A)		4198			.010	4/4 4/4 2/8	10 5 1	Unacceptable - -
Du Pont HT-1 Felt No. 1280-74-0		4195			.125	2/2 2/2 2/14 1/20	10 5 2 1	Unacceptable - - -
Du Pont HT-1 No. 380 369-370		4197			.030	2/2 2/2 2/2 3/3	10 5 2 1	Unacceptable - - -
Du Pont No. 97-001A		3596	0.005 FEP laminated to TFE fabric and metallized with aluminum		.010	0/20	10	Satisfactory
Du Pont No. 506A112		3595	Armalon and FEP dispersion coated glass		.006	0/20	10	Satisfactory
Du Pont ML Film		3558			.008	2/20 0/20	10 5	Unacceptable -
Du Pont ML Film		3536			.004	0/40	10	Batch Test
Du Pont ML Film	E. I. du Pont de Nemours & Co., Inc.	3555			.002	0/40	10	Batch Test
E-Bond Rubber Sealant	International Epoxy Corporation	4199	Epoxy and polysulfide	LP/32 activator	.050	10/20 14/20 10/20	10 5 1	Unacceptable - -
Ec 1944 B	Minnesota Mining and Manufacturing Company	2745			.063	3/20 0/20	10 5	Unacceptable -
Ecco Bond No. 45 and Catalyst No. 15	Emerson and Cuming Incorporated	742	Epoxy Cement	Violent reactions	.050	2/2 2/2 2/2	10 5 2	Unacceptable - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Epibond 123 and Hardner 952A	Furane Plastics Incorporated	741	Epoxy Cement	Violent reactions	.050	5/20	10	Unacceptable
Epon Glass Terminal Board		659				2/3 1/1	10 5	Unacceptable
Epoxy Potting Compound	Bendix Corporation	1945	Epoxy		.063	1/1 1/1 1/1	10 5 2	Unacceptable - -
Epoxy Filled Glass Fabric (MIL-P-18177)	General Electric Company	3790	Epoxy-Glass	Type G.E.E. Grade G-10	.063	19/20 4/20 3/20 0/20	10 5 2 1	Unacceptable - - -
Epoxy Filled Glass Fabric (MIL-P-18177)	General Electric Company	4289	Epoxy-Glass	Type G.E.E. Grade G-10	.063	20/20	10	Unacceptable
Fibrous Glass Tubing	Taylor Fibre Company	3812	Epoxy-Glass		.063	2/2 2/2 2/3	10 5 2	Unacceptable - -
Fibrous Glass Tubing	Taylor Fibre Company	3810	Epoxy-Glass		.063	2/2 2/2 2/3	10 5 2	Unacceptable - -
Fluorel KX2141	Minnesota Mining and Manufacturing Company	2262			.094	0/20	10	Satisfactory
Fluorel-Elastomer (orange, brown, black, white)	Minnesota Mining and Manufacturing Company	1318 1067	Chlorofluoro-carbon	Five batches tested	.063	0/20	10	Satisfactory
Fluorolin Tape 101	Joclin Manufacturing Company	773	3 mil Teflon and 3 mil adhesive			2/3 2/17	10 5	Unacceptable -
Fluorolin Tape 303		770	6 mil Teflon impregnated glass fibers and 4 mil adhesive			2/2 2/6 0/12	10 5 2	Unacceptable - -
Fluorolin Tape 404	Joclin Manufacturing Company	771	3 mil aluminum foil, 4 mil Teflon, 2 mil adhesive			2/3 0/2 2/4	10 5 2	Unacceptable - -
FM 1000 Adhesive	Bloomingdale Rubber Company	4057	Nylon Epoxy	Violent reactions	.010	17/20 11/20 9/20	10 5 2	Unacceptable - -
G.E. Formulation II	General Electric Company	3861	Potting compound of Adiprene - L100 parts Caster oil - 10 parts Teflon 7X - 100 parts Quadrol - 5.7 parts	Sample A	.018	2/3 2/2 2/6 2/11	10 5 3 1	Unacceptable - - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
G.E. Formulation II	General Electric Company	3863	Potting compound of Adiprene L - 100 parts Castor oil - 10 parts Teflon 7X - 100 parts Quadrol - 5.7 parts	Sample B	.028	2/2 2/8 2/9 2/10 0/20	10 5 3 2 1	Unacceptable - - - -
G.E. Formulation II		2952		Sample C	.034	2/5 0/20	10 5	Unacceptable -
G.E. Formulation II		3866		Sample D	.043	6/20 2/8 0/20	10 5 1	Unacceptable - -
G.E. Formulation II		2951		Sample E	.063	0/20	10	Unacceptable
G.E. Formulation II		2955		Sample F	.070	0/20	10	Unacceptable
G.E. Formulation		3869		Sample F aged 1 year	.070	2/4 2/4 0/20	10 7 5	Unacceptable - -
G.E. Formulation II		3871	Potting compound of Adeprene L- 100 parts Castor oil - 10 parts Teflon 7X - 100 parts Quadrol - 5.7 parts	Sample G	.105	2/20 0/20	10 8	Unacceptable -
G.E. Formulation II		2743		Sample H	.125	0/20	10	Unacceptable
G.E. Formulation I		2945	Potting compound of Adeprene L - 100 parts Castor oil - 10 parts Quadrol - 5.7 parts		.063 .125	2/11 1/3 0/11 3/0 0/20	10 5 3 10 5	Unacceptable - - - -
G.E. Formulation III		2954	Potting compound of Adeprene L - 100 parts Castor oil - 10 parts Quadrol - 4.5 parts Fluorolube - 30 parts		.152	0/20	10	Unacceptable
G.E. Formulation III A		3040	Same as above except Fluorolube increased to 45 parts		.063	6/20 2/7 0/20	10 5 3	Unacceptable - -
G.E. Formulation III A	General Electric Company	3041	Same as above except Fluorolube increased to 45 parts		.032	10/20 2/4 0/20	10 5 3	Unacceptable - -
Gen-Flex Plastic Tubing No. 603	General Cements Company	1678				2/4 2/2 1/14	10 5 2	Unacceptable - -
Glid Air	Glidden Company	1900			.063	5/8 1/1 1/1 1/1	10 5 2 1	Unacceptable - - -
Hypalon Rubber	E.I. du Pont de Nemours & Co., Inc.	1946			.094	2/2 2/4 2/7 0/7	10 5 3 2	Unacceptable - - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Hypalon Rubber	E. I. du Pont de Nemours & Co., Inc.	1958			.094	2/3 2/5 2/6 1/8	10 5 3 2	Unacceptable - - -
Hypalon-Asbestos		1959			.063	2/10 1/10	10 5	Unacceptable -
HT-424 Adhesive	E. I. du Pont de Nemours & Co., Inc.	4220	Epoxy phenolic	Violent reactions	.013	20/20 20/20 20/20 6/20	10 5 3 1	Unacceptable - - -
Hysol Cement 6020	Houghton Labs Incorporated	1003	Epoxy Cement	Violent reactions	.050	2/3 2/2 2/4	10 5 2	Unacceptable - -
Kel-F (Plasticized)	Minnesota Mining and Manufacturing Company	3320	Polytrifluorochloro-ethylene		.032	0/20	10	Batch Test
Kel-F (Unplasticized)		822	Polytrifluorochloro-ethylene			0/20	10	Batch Test
Kel-F L-1380		3999	Polytrifluorochloro-ethylene		.005	0/20	10	Satisfactory
Kel-F L-1381		4006	Polytrifluorochloro-ethylene		.005	0/20	10	Satisfactory
Kel-F Film Type 8105		4003	Polytrifluorochloro-ethylene		.005	0/20	10	Satisfactory
Kel-F Film Type KX202		4000	Polytrifluorochloro-ethylene		.002	0/20	10	Satisfactory
Kel-F Film Type KX8110		4004	Polytrifluorochloro-ethylene		.010	0/20	10	Satisfactory
Kel-F Film Type 8210		4002	Polytrifluorochloro-ethylene		.010	0/20	10	Satisfactory
Kel-F Film Type 8205		4001	Polytrifluorochloro-ethylene		.005	0/20	10	Satisfactory
Kel-F 81 Plastic	Minnesota Mining and Manufacturing Company	3045	Polymer based on chlorotrifluoro carbon		.063	0/20	10	Satisfactory
Kel-F800 (Pressurized can)	Spraylon Products Company	2601		Sprayed on stainless steel inserts. Dried 72 hours		2/60	10	Unacceptable
Kel-F800 Resin	Minnesota Mining and Manufacturing Company	1421	Polytrifluorochloro-ethylene		.063	0/20	10	Satisfactory
Kel-F800 Plastic	Minnesota Mining and Manufacturing Company	3060	Polytrifluorochloro-ethylene		.063	0/20	10	Satisfactory

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Kel-F800 Plastic	Minnesota Mining and Manufacturing Company	3319	Polytrifluorochloro-ethylene	Soaked in petroleum ether and dried	.125	6/20	10	Unacceptable
Kel-F-PN25 Primer		1676		One coat sprayed on stainless steel inserts		0/20	10	Satisfactory
Kel-F PN25 Primer and NW-25TN Coating		1675		Two coats sprayed on stainless steel inserts		0/20	10	Satisfactory
Kel-F Dispersion 625		3518	Polytrifluorochloro-ethylene	Film	.005	0/20	10	Satisfactory
Kel-F Dispersion KX633		4005	Polytrifluorochloro-ethylene	Film	.003	0/20	10	Satisfactory
Kel-F Elastomer		3852	Polytrifluorochloro-ethylene		.125	0/20	10	Batch Test
Kel-F Elastomer	Minnesota Mining and Manufacturing Company	3853	Polytrifluorochloro-ethylene		.063	0/20	10	Batch Test
Koroseal	B. F. Goodrich Company	4286	Vinyl rubber		.125	2/20	10	Unacceptable
Krylon Crystal Clear Spray Coating	Krylon Incorporated	3226	Acrylic resin and aromatic hydrocarbons		.002	2/3 2/6 0/20	10 5 1	Unacceptable - -
Kynar (RC-2525)	Pennsalt Chemical Company	2874	Vinylidene Fluoride		.063	0/10	10	Incomplete
Lamicoid	Minnesota Mining and Manufacturing Company	3169	Teflon glass cloth		.125	0/20	10	Satisfactory
Lexan Polycarbonate Resin	General Electric Company	2730	Polycarbonate resin		.063	20/20 16/20 0/20 3/17	10 5 2 4	Unacceptable - - -
Liquid Envelope, Aluminum Cold Spray	Better Finishing and Coating Company	3854			.050	2/2 2/2 2/8 0/20	10 5 2 1	Unacceptable - - -
Liquid Envelope, Aluminum Cold Spray 675-291-A		3858			.050	2/2 2/2 2/4 2/10	10 5 2 1	Unacceptable - - -
Liquid Envelope, Coverlac S.C. 224	Better Finishing and Coating Company	3856		Dip coating on stainless steel inserts		3/20 2/14 0/20	10 5 3	Unacceptable - -
Micarta	Westinghouse Electric Corporation	2530	Phenolic laminate, fabric base		.063	16/20 16/20 6/20 0/20	10 5 2 1	Unacceptable - - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Monolamic, Expulsion Bladder Material	G. T. Schjeldahl Company	3989			.006	0/20	10	Incomplete
Monolamic, Expulsion Bladder Material	G. T. Schjeldahl Company	3990			.004	0/20	10	Incomplete
Mylar Film	E. I. du Pont de Nemours & Co., Inc.	3379	Polyester film		.006	2/22 2/28 0/20	10 5 3	Unacceptable - -
Mylar Film		3368	Polyester film		.002	2/22 2/20 0/20	10 5 3	Unacceptable - -
Mylar Film		149	Polyester film			2/7 0/13	10 5	Unacceptable -
Mylar Tape		726	Polyester film			8/10	10	Unacceptable
Mylar (0.001A) Plastic Film		147	Polyester film			1/2 1/3 1/5	5 2 7	- - -
Mylar (0.005A) Plastic Film		148	Polyester film			2/2 1/6	10 2	Unacceptable
Mylar Insulation Tape		724	Polyester film			2/2 2/13	10 5	Unacceptable
Mylar Weatherable Plastic Film		536	Polyester film			2/3 0/20	10 2	Unacceptable
Mylar 25C Plastic Film		725	Polyester film			2/20	10	Unacceptable
Mylar 25UA Plastic Film		730	Polyester film			2/11	10	Unacceptable
Mylar 50A Plastic Film		729	Polyester film			2/20 0/9	10 5	Unacceptable -
Mylar 50C Plastic Film		731	Polyester film			2/20	10	Unacceptable
Mylar 50K Plastic Film		736	Polyester film			2/20	10	Unacceptable
Mylar 50T Plastic Film		734	Polyester film			2/4 2/3 0/12	10 5 2	Unacceptable - -
Mylar 100T Plastic Film	E. I. du Pont de Nemours & Co., Inc.	735	Polyester film			3/20	10	Unacceptable

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Mylar R22 Plastic Film	E. I. du Pont de Nemours & Co., Inc.	722	Polyester film			2/20	10	Unacceptable
Mylar Film		4545	Polyester film		.001	4/20	10	Unacceptable
Mylar Film		3414	Vapor coated with aluminum on both sides 400 Å thick		.002	4/20 3/20 0/20	10 5 3	Unacceptable - -
Mylar Film		3444	Vapor coated on one side with 200Å aluminum, 400Å aluminum on other side		.006	5/20 5/20 0/20	10 5 3	Unacceptable - -
Mylar Film		3409	Vapor coated with 400 Å aluminum on one side		.002	2/25 0/20 2/20	10 5 6	Unacceptable - -
Mylar Film	E. I. du Pont de Nemours & Co., Inc.	3442	Vapor coated with 400 Å aluminum on one side		.006	2/23 0/20	10 5	Unacceptable -
Mylar, Aluminized	B. F. Goodrich Company	3397	Aluminized Mylar reinforced with No. 477 vedine adhesive between filaments			1/1 1/1 1/5	10 5 3	Unacceptable - -
Mylar, Aluminized		3398	Aluminized Mylar reinforced with No. 476 Vedine adhesive between filaments			1/1 1/1 1/1 0/6	10 5 2 1	Unacceptable - - -
Mylar, Aluminized		3399	Aluminized Mylar reinforced with No. 52042			1/1 1/6 1/1	10 3 2	Unacceptable - -
Mylar, Aluminized		3396	Aluminized Mylar reinforced with No. 15345			1/1 1/1 1/2 0/1	10 5 2 1	Unacceptable - - -
Mylar, Aluminized		3395	Aluminized Mylar reinforced with No. 15094			2/2 1/1 1/2 0/3	10 5 2 1	Unacceptable - - -
Mylar, Aluminized	B. F. Goodrich Company	3394	Aluminized Mylar reinforced with No. 482			2/2 2/3 1/4	10 5 3	Unacceptable - -
Mylar		3493	1-1/2 mil Mylar between two pieces of 0.0035 aluminum polyester adhesive	Three batches tested		2/8 2/9 1/3 0/20	10 5 3 2	Unacceptable - - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Mystik Foil No. 7402 Tape	Mystik Adhesive Products Company	835 426	Aluminum, silicone adhesive			2/3 2/3 1/14	10 5 2	Unacceptable - -
Mystik Foil No. 7402 Tape			Aluminum, silicone adhesive	Baked 100° F overnight and stripped		0/20	10	Incomplete
Mystik Foil No. 7402 Tape	Mystik Adhesive Products Company		Aluminum, silicone adhesive	Aged 1 week and stripped		1/20	10	Incomplete
Narmco Experimental Adhesive No. 1	Narmco Research and Development Company	4082	Chlorinated polyester cured with 2% MEK, peroxide and cobalt naphtenate		.050	7/10 4/10 2/20 0/20	10 5 3 2	Unacceptable - - -
Narmco Experimental Adhesive No. 2		4085	Chlorinated polyester with 33.3% antimony trichloride, cured with 2.0% MEK, peroxide and cobalt naphtenate		.050	9/10 2/5 1/10 2/10 0/20	10 5 3 2 1	Unacceptable - - - -
Narmco Expermental Adhesive No. 3		4088	ERL 0625 epoxy cured with 10.6 Phr meta-phenylene diamine		.050	7/10 2/10 0/20	10 5 3	Unacceptable - -
Narmco Experimental Adhesive No. 4		4090	ERL 0625 epoxy, cured with 14.5 phr chlorendic anhydride and 0.5% benzyldimethylamine		.050	6/10 6/20 2/10 1/10 0/20	10 5 3 2 1	Unacceptable - - - -
Narmco Resin 3135		3624	Aluminum alloy 7075-T6 cross laminated with layers of adhesive, two pieces of 1 mil FEP Type 544 between aluminum		.050	2/20 3/20 2/20	10 5 1	Unacceptable - -
Narmco Resin 3135		3512	Adhesive consisting of 50% epoxy and 50% polyamide		.050	3/3 2/2 2/7 0/12	10 5 2 1	Unacceptable - - -
Narmco Metlbond 3170		3508	Adhesive consisting of 50% filled epoxy, 50% filled polyamine		.050	16/24 2/8 2/14 0/20	10 5 3 1	Unacceptable - - -
Narmco 2-Part Adhesive	Narmco Research and Development Company	3514	Adiprene L-100 polyurethane prepolymer, Moca curing agent		.050	5/5 3/5 4/5 2/5	10 5 3 1	Unacceptable - - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Non-metallic Inserts (MSFC Stock No. 127-912-4200)		4285			.063	2/2 2/6 2/12	10 5 3	Unacceptable - -
Nylon Basket Weave No. 1803		2250	Polyamide		.032	2/2 2/2 2/2 2/12	10 5 2 1	Unacceptable - - -
Nylon Type 127-1		3545	Polyamide		.250	8/20 1/1 1/2 0/20	10 5 3 1	Unacceptable - - -
Nylon "C" Lot 8762		4184	Polyamide		.001	13/20	10	Unacceptable
Nylon, Zytel	E. I. du Pont de Nemours & Co., Inc.	4180	Polyamide		.001	10/20	10	Unacceptable
Nylon, Zytel	↑	4183	Polyamide		.002	3/20	10	Unacceptable
Nylon, Zytel	E. I. du Pont de Nemours & Co., Inc.	4182	Polyamide		.004	8/20	10	Unacceptable
Nylon Extruded Rod		855			.063	2/2 2/2 2/3	10 5 2	Unacceptable - -
Parco "O" Rings 947-70	Plastics and Rubber Product Company	1430	Viton A		.063	0/20	10	Batch Test
Permacel P421 Tape	Permacel Tape Corporation	1261				1/6 0/2	10 5	Unacceptable -
Permafil		3529				7/20 7/20 0/20	10 5 3	Unacceptable - -
Plaskon Alkyd 440 Sheet Plastic	Barrett Division Allied Chemical Company	1004	Glass and polyester			2/5 2/13 0/2	10 5 1	Unacceptable - -
Plastic KF52 (MIL-B-131B Class 2)	Plastic Film Corporation	300		Lot No. 46		1/2 1/4	10 5	Unacceptable -
Plastic P35A (MIL-B-131B Class 1)	Plastic Film Corporation	301		Lot No. 150		1/2 2/2	10 5	Unacceptable -
Plastic Rod (MIL-P-79B)		857		Electrical insulation		2/2 2/2 1/16	10 5 2	Unacceptable - -
Plastic Plugs		3501	Dyed polyethylene		.063	4/11 2/10 2/14 0/20	10 5 3 1	Unacceptable - - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Plastic Steel Putty Type A	Devcon Corporation	3390	80% Steel with epoxy binder	Violent reactions	.050	5/5	10	Unacceptable
						5/5	5	-
						9/12	2	-
						4/20	1	-
Plexiglass		558		Three batches tested		2/2	19	Unacceptable
						1/3	5	-
						1/4	3	-
Polyken No. 110 Tape	Kendall Company					2/2	10	Unacceptable
						2/2	5	-
Polyethylene		1698			.032	4/7	10	Unacceptable
						2/19	5	-
						1/3	2	-
						0/17	1	-
Polyethylene Tubing		2627				2/11	10	Unacceptable
						2/10	5	-
						2/20	2	-
Polyurethane Wiping Material		2502			.016	2/3	10	Unacceptable
						2/9	3	-
						0/20	1	-
Polyvinyl Chloride	Teledyne Corporation	3785			.125	2/2	10	Unacceptable
						2/9	5	-
						2/14	2	-
						0/20	1	-
Polyvinyl Chloride		4280		Tested in air 11/20 charge noted	.050			
Polyvinyl Chloride		4279		Tested in air 8/20 charge noted	.025			
Polyvinyl Chloride		3782		Cotton cloth coated with PVC 0.015 inches per side	.050	2/2	10	Unacceptable
						2/2	5	-
						2/5	3	-
						1/20	1	-
Polyvinyl Chloride Electrical Insulation	Revere Corporation of America	1692	Polyvinyl chloride		.063	2/3	10	Unacceptable
						2/3	5	-
						2/11	2	-
						1/3	3	-
Potting Compound	Bendix Corporation	1945	Epoxy		.063	1/1	10	Unacceptable
						1/1	5	-
						1/1	2	-
						1/2	1	-
PR341 Casting Resin	Product Research Corporation	713				3/3	10	Unacceptable
						2/3	5	-
						2/7	3	-

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
PR 1910	Product Research Corporation	990	Silicone		.050	2/2	10	Unacceptable
						2/2	5	-
						0/16	2	-
PR 1902 Primer		2332				2/11	10	Unacceptable
						0/9	5	-
PRC 1525		2939	Polyurethane		.063	3/20	10	Unacceptable
						0/20	5	-
PRC 1525		2932	Polyurethane		.125	2/20	10	Unacceptable
PRC 1527		2937	Polyurethane		.063	7/20	10	Unacceptable
						3/20	5	-
PRC 1527		2936	Polyurethane		.032	11/20	10	Unacceptable
PRC 1538		2935	Polyurethane		.063	10/20	10	Unacceptable
PRC 1538-T		2934	Polyurethane		.063	5/20	10	Unacceptable
						1/20	5	-
PRC 1955	Product Research Corporation	3931			.063	2/4	10	Unacceptable
						2/16	5	-
						2/12	3	-
						0/20	1	-
Pro-Seal 994	Gulf Pro Seal Corporation	3221			.063	7/20	10	Unacceptable
						6/20	5	-
						2/20	2	-
						0/20	1	-
PRC 1955 with Top Coat P-81-2018	Product Research Corporation	4601			.050	2/3	10	Unacceptable
						2/5	8	-
						2/15	5	-
PRC 1955 with Top Coat P-81-2018		4594			.030	2/2	10	Unacceptable
						2/2	8	-
						2/3	6	-
						2/2	4	-
						2/2	2	-
						2/9	1	-
PRC 1955 with Top Coat P-81-2018	Product Research Corporation	492			.025	2/2	10	Unacceptable
						2/2	8	-
						2/2	6	-
						2/2	4	-
						2/2	2	-
						2/2	1	-
PRC 1955 with Top Coat P-81-2018		4591			.015	2/2	10	Unacceptable
						2/4	8	-
						2/4	6	-
						2/6	4	-
						2/8	2	-

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
PRC 1955 with Top Coat P-81-208	Product Research Corporation	4582			.050	2/2	10	Unacceptable
						2/8	8	-
						2/5	6	-
						2/10	4	-
						2/8	3	-
						2/20	2	-
PRC 1955 with Top Coat P-81-2020		4584			.025	2/2	10	Unacceptable
						2/2	8	-
						2/2	6	-
						2/5	4	-
						2/4	2	
						2/6	1	-
PRC 1955 with Top Coat P-81-2035	Product Research Corporation	4587			.015	2/2	10	Unacceptable
						2/2	8	-
						2/2	6	-
						2/4	4	-
						2/2	2	-
						0/20	1	-
PT-201 and Solvent PT-1001	Product Techniques Incorporated	1893	Phenolic epoxy			1/1	10	Unacceptable
						1/1	5	-
						1/2	2	-
PT-201 Coated Coil Spring		3615				3/10	10	Unacceptable
						2/9	5	-
						0/4	3	-
Pyro Prey AC-81 Type 1 Plastic	Cordo Molding Products Incorporated	916	Phenolic impregnated fiberglass		.060	2/2	10	Unacceptable
						2/2	5	-
						2/3	3	-
Q9-0002A and B Adhesive	Dow Corning Corporation	3532	Fluorosilicone rubber	RTV cured	.050	0-2/20	10	Batch Test
Q-2-0046 Adhesive		3339	Fluorosilicone rubber	RTV cured	.050	1/140	10	Batch Test
Q-2-0046 Adhesive	Dow Corning Corporation	3788	Fluorosilicone rubber	RTV cured	.025	38/40	10	Unacceptable
Raycom 2148 RPR	Raytheon Company	3853			.125	2/20	10	Unacceptable
Red Wing Silicone Rubber		1907			.063	20/20	10	Unacceptable
						20/20	5	-
						14/20	3	-
						1/20	1	-
Red Wing Silicone Rubber		1921		Two 0.063 inches stacked to make 0.125	.125	17/20	10	Unacceptable
						4/20	3	-
						0/20	1	-
Relco A (50%) + Relco B (50%)	Reliance Steel Products Company	2962	Epoxy		.063	2/20	10	Unacceptable
Relco A + Relco B + Grit	Reliance Steel Products Company	2963	Epoxy		.063	3/5	10	Unacceptable
						2/5	5	-
						2/3	3	-
						1/8	2	-
Ricote (MIP) 100-C-1	Modern Industrial Plastics Division of the Durison Company Incorporated	4010		Brush coating on stainless steel inserts		7/20	10	Unacceptable

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions / No. Tests	Energy Level Kg-M	Rating
Sauereisen Low Expansion Cement No. 29	Sauereisen Cements Company	2495	Zirconium base		.050	0/20	10	Satisfactory
Scotch Tape No. Y-9089	Minnesota Mining and Manufacturing Company	2853	Pluton fabric, neoprene base adhesive		.063	20/20 2/2 0/20	10 5 1	Unacceptable - -
Scotch Pressure Sensitive Tape No. Y-9050		2852				17/20 9/10 0/20	10 5 1	Unacceptable - -
Scotch Electrical Tape No. 27		631	White glass cloth with thermosetting adhesive		.007	4/5 5/6 3/3	10 5 1	Unacceptable - -
Scotch Electrical Tape No. 33		516	Black vinyl plastic with pressure sensitive adhesive		.010	2/4 2/3 0/2	10 5 2	Unacceptable - -
Scotch Electrical Tape No. 60		496	Teflon and silicone adhesive		.006	2/3 2/7	10 5	Unacceptable -
Scotch Electrical Tape No. 61		1271	Teflon and silicone adhesive		.006	2/2 2/4	10 5	Unacceptable -
Scotch Resin No. CRP-235		712	Epoxy	One part "A" and two parts "B" cured at 30°C for 1/2 hour		3/6 1/14	10 5	Unacceptable
Scotch Electrical Tape No. 27		517				3/4 2/2	10 3	Unacceptable -
Scotch Tape No. 506		630				3/4 2/5	10 5	Unacceptable -
Scotch Teflon Tape No. 536		149				3/10 1/10 1/7	10 5 8	Unacceptable - -
Scotch Teflon Tape No. 547		37				0/10	10	Incomplete
Scotch Teflon Tape No. 549	Minnesota Mining and Manufacturing Company	786				2/2 2/5 1/13	10 5 2	Unacceptable - -
Silastic No. 50 Rubber	Dow Corning Corporation	736	Silicone rubber			2/2 2/6 2/4	10 5 2	Unacceptable - -
Silastic No. 675	Dow Corning Corporation	163				2/3 2/2 1/1	10 5 2	Unacceptable - -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions / No. Tests	Energy Level Kg-M	Rating
Silastic No. 50-24-480	Dow Corning Corporation	514				8/10	10	Unacceptable
Silastic No. 80-24-480		164				7/10	10	Unacceptable
Silastic No. 290-24-480		321				2/10	10	Unacceptable
						1/10	5	-
Silastic No. 916-4-480		980				2/2	10	Unacceptable
						3/15	5	-
Silastic LS-53		549				2/7	10	Unacceptable
						2/8	5	-
						0/5	2	-
Silastic LS-53-24-300		1007				2/3	10	Unacceptable
						2/5	5	-
Silastic LS-13-8-400		547				2/8	10	Unacceptable
						3/10	5	-
						0/2	2	-
Silastic S-2098-24-480		546				2/3	10	Unacceptable
						0/17	5	-
Silastic S-9711-2-480		545				2/2	10	Unacceptable
						2/2	5	-
						0/2	3	-
Silastic LS-63	Dow Corning Corporation	1232				3/20	10	Unacceptable
Silicone Impregnated Fiberglass Panel 83-5			Silicone and glass			2/2	10	Unacceptable
						3/3	5	-
						2/2	2	-
Silicone Rubber Flexible Tubing		2740	Silicone			5/5	10	Unacceptable
						5/5	5	-
						5/5	3	-
						3/5	1	-
Silverprene Coated Asbestos	Jamac Incorporated	2877			.015	2/2	10	Unacceptable
						2/2	5	-
						2/5	3	-
						2/6	2	-
						1/20	1	-
Stycast 2651		2757	Epoxy		.063	2/2	10	Unacceptable
						2/2	5	-
						2/3	3	-
						0/20	1	-
Teflon	E. I. du Pont de Nemours & Co., Inc.	3402	Polytetrafluoroethylene		.002	0/20	10	Satisfactory
Teflon		3403	Polytetrafluoroethylene		.006	0/20	10	Satisfactory

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Teflon, Dupont Green Primer No. 850-204 and Clear Lacquer No. 850-202	U.S. Aircraft Products Company	1777	Polytetrafluoroethylene	On 321 stainless steel inserts		0/20	10	Satisfactory
Teflon Covering from Cable		3802	Polytetrafluoroethylene		.020	0/20	10	Satisfactory
Teflon Coated Flat Conductor Shielded Type A NASA-POH-41286	Methode Cable Company	4287	Teflon and copper	Organic adhesive	.028	5/40	10	Unacceptable
Teflon Coating No. 852-201 over Primer No. 850-201	E. I. du Pont de Nemours & Co., Inc.	1308	Polytetrafluoroethylene	Applied to stainless steel discs		0/20	10	Satisfactory
Teflon Coating No. 251-214	E. I. du Pont de Nemours & Co., Inc.	1282	Polytetrafluoroethylene	Applied to stainless steel discs		0/20	10	Satisfactory
Teflon O-Ring		1927	Polytetrafluoroethylene			0/20	10	Satisfactory
Telcon	Alvin Products Incorporated	3850	Fluorocarbon	Spray film		0/20	10	Satisfactory
Thermoplaz Formula 1500	Sargent Engineering Corporation	3775			.050	5/5 5/5 5/5 5/5 5/5	10 5 3 2 1	Unacceptable - - - -
Thermoplaz Formula 1501	Sargent Engineering Corporation	3778			.050	0/40	10	Batch Test
Thermo-Resist 69		3875			.063	11/20	10	Unacceptable
Temporell No. 741	Orell Incorporated	1656				2/2 2/2 2/2 4/14	10 5 2 1	Unacceptable - - -
Temporell No. 740	Orell Incorporated	1657				1/1 1/1 7/7	10 2 1	Unacceptable - -
Temp-R-Tape I	Connecticut Hard Rubber Company	3643	Polytetrafluoroethylene with silicone polymer adhesive			3/20 2/20 3/20 0/20	10 5 4 1	Unacceptable - - -
Vinylloyd No. 5909	Vinylloyd Company	143	Chlorofluorocarbon		.032	0/20	10	Batch Test
Viton A on Teflon 86007	E. I. du Pont de Nemours & Co., Inc.	914			.020	2/7 0/15	10 5	Unacceptable -

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions / No. Tests	Energy Level Kg-M	Rating
Teflon Sleeve from Adel Clamp		3389	Polytetrafluoroethylene		.032	0/20	10	Satisfactory
Teflon XA102A522	Goodyear Corporation	3492	Polytetrafluoroethylene	Spray film	.006	2/20 1/2 0/20	10 9 8	Unacceptable - -
Teflon XA102A522	Goodyear Corporation	3491	Polytetrafluoroethylene	Spray film	.015	0/20	10	Batch Test
Teflon 100-X	E. I. du Pont de Nemours & Co., Inc.	1247	Fluorinated ethylene-propylene polymer			0/20	10	Satisfactory
Teflon, Virgin		3489	Polytetrafluoroethylene		.032	0/20	10	Satisfactory
Teflon, White Sheet Stock		5128	Polytetrafluoroethylene		.063	0/40	10	Satisfactory
Teflon, White Hose Lining		95	Polytetrafluoroethylene			0/20	10	Satisfactory
Teflon, Red Hose Lining	E. I. du Pont de Nemours & Co., Inc.	96	Polytetrafluoroethylene	Pigmentation affects test results		0-2/20	10	Unacceptable
Teflon Tube (Thermo-fit TFE)	Rayclad Tubes Incorporated	1830	Polytetrafluoroethylene		.016	0/20	10	Satisfactory
Teflon FEP Film with Teflon TFE Felt	E. I. du Pont de Nemours & Co., Inc.	4190	Polytetrafluoroethylene	0.005 in. film between two pieces 0.125 in. felt	.255	0/40	10	Satisfactory
Teflon FEP Type 544		3527	Polytetrafluoroethylene		.001	0/20	10	Satisfactory
Teflon FEP		3366	Polytetrafluoroethylene		.01	0/20	10	Satisfactory
Teflon FEP		3367	Polytetrafluoroethylene		.021	0/20	10	Satisfactory
Teflon FEP		3365	Polytetrafluoroethylene		.005	0/20	10	Satisfactory
Teflon FEP and Aluminum		4188	Aluminum and Polytetrafluoroethylene	FEP-2 mils, aluminum 2 mils, FEP-2 mils	.006	0/40	10	Satisfactory
Teflon 30 TFE		3516	Polytetrafluoroethylene	Two batches tested		0/20	10	Satisfactory
Teflon 856-200		3641	Polytetrafluoroethylene		.006	0/20	10	Satisfactory
Teflon TFE, Dupont Enamel 852-202		3504	Polytetrafluoroethylene		.001	0/20	10	Satisfactory
Teflon, Dupont Clear Lacquer No. 852-202 over Dupont Primer No. 850-204		1597	Polytetrafluoroethylene	321 stainless inserts used		0/20	10	Satisfactory
Teflon, Dupont Primer No. 850-204	E. I. du Pont de Nemours & Co., Inc.	1596	Polytetrafluoroethylene	321 stainless inserts used		0/20	10	Satisfactory

TABLE IV PLASTICS, ELASTOMERS, AND ADHESIVES (Concluded)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Viton A on Glass Fibers 85001	E. I. du Pont de Nemours & Co., Inc.	912			.011	2/2 2/5 2/3	10 5 2	Unacceptable - -
Viton A on Dacron Fabric		915				2/2 2/4 2/11	10 5 1	Unacceptable - -
Viton A Elastomer	E. I. du Pont de Nemours & Co., Inc.		Copolymer of vinylidene fluoride and hexafluoropropylene	Sensitivity varies from batch to batch		0-4/20	10	Batch Test
Vinyl Covered Nylon		616				2/8 1/10	10 5	Unacceptable -
Vinyl Tubing		674				2/8 3/5	10 5	Unacceptable -
Vynakote	Spectra-Strip Wire and Cable Corporation	976				2/6 4/14	10 5	Unacceptable -
XR 5038	Minnesota Mining and Manufacturing Company	2748	Epoxy		.063	2/25 0/35	10 5	Unacceptable -

TABLE V GASKETS AND PACKINGS

Material	Manufacturer	Test No.	Compositon	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Accopac No. 812	Armstrong Cork Company	1419	Teflon and asbestos		.063	0/20	10	Batch Test
Accopac No. 816	Armstrong Cork Company	1421	Teflon and asbestos	Two batches tested	.063	0/20	10	Batch Test
Allpax 500 Superheat Sheet (as received)	Allpax Company		Styrene-butadiene copolymer with asbestos fiber	Highly variable. Average range of test results shown for each thickness	.250 .125 .094 .063 .016	0-2/20 0-3/20 0-5/20 3-10/20 5-15/20	10 10 10 10 10	Unacceptable - - - -
Allpax 500 Superheat Sheet (impregnated with Fluorolube T-80)			Styrene-butadiene copolymer with asbestos fiber		.250 .125 .063 .031	0/20 0/20 0/20 0-2/20	10 10 10 10	Batch Test - - -
Allpax 500		1567	Styrene-butadiene copolymer with asbestos fiber	Not Fluorolubed	.250	30/120	10	Unacceptable
Allpax 500			Styrene-butadiene copolymer with asbestos fiber	Fluorolubed per MS 750. Highly variable. Test results show range of results for each thickness.	.250 .125 .094 .063 .031 .016	0-18/20 0-2/20 0-1/20 0-8/20 0-11/20 0-4/20	10 10 10 10 10 10	Batch Test - - - - -
Allpax 500	Allpax Company	1572	Styrene-butadiene copolymer with asbestos fiber	AR-1F treated	.250	3/40	10	Unacceptable
Ankorite 425	Anchor Packing Company	1345	Asbestos-rubber composite		.063	0/20	10	Batch Test
Allpax 500		1899		Aging test. Fluorolubed 3/9/'60. Tested 3/23/'61	.063	0/20	10	Batch Test
Allpax 500		2004		Aging test. Fluorolubed 3/9/'60. Tested 4/19/'61	.063	0/20	10	Batch Test
Allpax 500		3560		Aging test. Fluorolubed 3/5/'60. Tested 6/13/'62	.063	0/20	10	Batch Test
Armalon 97-001	E. I. du Pont de Nemours & Co., Inc.	3642	.005 in. TFE fiber, .005 in. FEP film		.010	0/20	10	Batch Test
Armalon PDX 7550		3517	Teflon TFE felt and FEP film		.125	0/20	10	Batch Test

TABLE V GASKETS AND PACKINGS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Armalon No. 410-128	E. I. du Pont de Nemours & Co., Inc.	1689	Teflon and glass		.016	0/20	10	Batch Test
Armalon Teflon Glass		1674	Teflon and glass		.016	2/2 2/5 1/13	10 5 3	Unacceptable - -
Armalon		762	Fluorocarbon felt	Bleached sheet	.063	0/20	10	Batch Test
Armalon	E. I. du Pont de Nemours & Co., Inc.	1070	Fluorocarbon felt	Unbleached sheet	.063	2/4	10	Unacceptable
Asbestos Textile Style 3603 Sheet	Asbestos Textile Company	1343			.063	0/20	10	Batch Test
Asbestos Textile Style 3604 Sheet		1344			.063	2/20	10	Unacceptable
Asbestos Textile Style 3605 Sheet	Asbestos Textile Company	1342			.063	2/6 0/14	10 5	Unacceptable -
Asbestos from Flexitallic Gasket		2220	Asbestos	Stainless steel inserts used		0/20	10	Batch Test
Asbestos Sheeting with GRS Binder	Allpax Company	2151	Asbestos and synthetic rubber	Samples from Test Division	.063	2/120	10	Incomplete
Asbestos Sheeting with GRS Binder	Allpax Company	2157	Asbestos and synthetic rubber	Samples from Test Division	.063	0/60	10	Incomplete
Avronite 5B7 Sheet	Kalendex Corporation	1008	Fiber coated with Buna-N		.032	2/4 2/3 0/13	10 5 3	Unacceptable - -
Avronite Sheet 5B10		993	Fiber core coated with Buna-N		.093	2/3 2/2 2/4	10 5 3	Unacceptable - -
Avronite Sheet 5B20		922	Fiber core coated with Buna-N		.063	2/2 2/3 0/15	10 5 3	Unacceptable - -
Avronite Sheet 10B20	Kalendex Corporation	991	Fiber core coated with Buna-N		.063	2/2 2/2 2/3	10 5 3	Unacceptable - -
Chesterton Packing No. 324	A. W. Chesterton Company	2911		Very violent reaction	.250	1/1 1/1	10 5	Unacceptable -
Convair Gasket, Green	Convair Division General Dynamics Incorporated	1285	Metal gasket with green coating		.063	2/2 0/18	10 5	Unacceptable -
Convair Gasket, Brown	Convair Division General Dynamics Incorporated	1280	Metal gasket with brown coating		.062	0/20	10	Batch Test

TABLE V GASKETS AND PACKINGS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Durabla Gasket Material	Durabla Manufacturing Company	2491	Compressed asbestos and fluorosilicone rubber	Sensitivity varies from batch to batch	.063	3/40 0/20	10 8	Batch Test -
Durabla Gasket Material	Durabla Manufacturing Company	3506	Compressed asbestos and fluorosilicone rubber		.032	2/8 2/19 0/20	10 5 3	Unacceptable - -
Duroid Sheet 900	Rogers Corporation	1346	Cellulose fibers and Buna-N		.032	2/2 2/2 2/16	10 5 3	Unacceptable - -
Duroid Sheet 910			Similar to Duroid 900		.032	2/2 2/2 2/16	10 5 3	Unacceptable - -
Duroid Sheet 3102		1347	Neoprene latex and asbestos fibers	Conforms to (MIL-G-7021 Class 2)	.032	2/3 2/2 0/14	10 5 3	Unacceptable - -
Duroid Sheet 3110		1349	Similar to Duroid 3102		.032	2/2 2/2 1/16	10 5 3	Unacceptable - -
Duroid Sheet 3200		1351	Buna-N latex and asbestos fibers		.032	2/2 2/2 2/3	10 5 3	Unacceptable - -
Duroid Sheet 3210		1352	Similar to Duroid 3200		.032	2/2 2/2 2/16	10 5 3	Unacceptable - -
Duroid Sheet 3300		1353	Buna-S and asbestos fibers		.032	2/2 2/2 0/16	10 5 3	Unacceptable - -
Duroid Sheet 3310		1354	Similar to Duroid 3300		.032	2/3 2/3 0/14	10 5 3	Unacceptable - -
Duroid Sheet 3350		1355	Similar to Duroid 3300		.063	2/2 2/6 0/11	10 5 3	Unacceptable - -
Duroid Sheet 3400		1473	Viton A and asbestos fibers		.063	0/20	10	Batch Test
Duroid Sheet 5600		480	Teflon and ceramic fibers		.063	0/20	10	
Duroid Sheet 5613	Rogers Corporation	492	Similar to Duroid 5600; contains molybdenum disulfide		.063	2/6 0/14	10 2	Unacceptable -

TABLE V GASKETS AND PACKINGS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Duroid Sheet 5650	Rogers Corporation	481	Similar to Duroid 5600; has higher Teflon content		.063	0/20	10	Batch Test
EOR 76574-3 Teflon coated Naflex gasket	Orbit Machine Corporation	2383			.063	2/20	10	Unacceptable
EOR 76574-5 Teflon coated Naflex gasket	Orbit Machine Corporation	2384			.063	5/20	10	Unacceptable
"E" Felt	Unit Cork Company	709			.063	2/20	10	Unacceptable
Flexitallic Gasket	Flexitallic Gasket Company	348	Stainless steel and Teflon		.063	0/20	10	Batch Test
Flexitallic Gasket	Flexitallic Gasket Company	349	Stainless steel and blue asbestos		.063	0/20	10	Batch Test
Flexrock Packing 420	Flexrock Company	2887	Braided Teflon		.250	0/20	10	Batch Test
Flexrock Packing 420		2886	Braided Teflon		.500	0/40	10	Batch Test
Flexrock 420 Packing		2376	Braided Teflon	Stainless steel inserts used	.188	0/20	10	Batch Test
Flexrock 420 Packing		2377	Braided Teflon	Stainless steel inserts used	.313	0/20	10	Batch Test
Flexrock 420 Packing		2880	Braided Teflon		.125	0/40	10	Batch Test
Flexrock 420 Packing	Flexrock Company	2884	Braided Teflon		.375	0/40	10	Batch Test
Fluorobestos LS-7598	Raybestos-Manhattan Incorporated	2068	Teflon and asbestos		.030	0/20	10	Batch Test
Fluorobestos, Unsintered	Raybestos-Manhattan Incorporated	1918	Teflon and asbestos		.063	0/20	10	Batch Test
Fluoroblue Sheet	John L. Dore Company	1391	Compounded Teflon		.063	0/20	10	Batch Test
Fluoroblack Sheet	John L. Dore Company	1312	Compounded Teflon		.063	0/20	10	Batch Test
Flourogold Gasket Material	Fluorocarbon Products Company	3336	Chlorofluorocarbon		.125	0/20	10	Batch Test
Fluorogreen E-600	John L. Dore Company	3372	Teflon and inorganic filler	Seven different batches tested	.063	0/40	10	Satisfactory
Fluorogreen E-600	John L. Dore Company	2066	Teflon and inorganic filler	Seven different batches tested	.063	0/20	10	Satisfactory
Garlock 605 Sheet	Garlock Packing Company	1230	Wire reinforced asbestos		.063	2/2 2/5 0/13	10 5 2	Unacceptable - -
Garlock 900 Sheet	Garlock Packing Company	315	Asbestos-rubber composite		.063	2/2 2/3 2/4	10 5 2	Unacceptable - -

TABLE V GASKETS AND PACKINGS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
John Crane Style C-30 Packing	Crane Packing Company	2910	Braided Teflon		.250	0/20	10	Batch Test
John Crane Style C-94 Packing	Crane Packing Company	2909	Braided asbestos lubricated with Teflon suspensoid		.025	0/20	10	Batch Test
Johns-Manville No. 60 Sheet	Johns-Manville Company		Compressed asbestos with binder	Variable	.063	0-2/20	10	Batch Test
Johns-Manville No. 76 Sheet		1360	Compressed asbestos with binder	Variable	.063	0-5/20	10	Batch Test
Johns-Manville Style 91 Sheet		1059	Chrysolite asbestos cloth with Teflon suspensoid		.063	2/3 0/17	10 5	Unacceptable -
Johns-Manville Style 92 Sheet		1203	Crocidolite asbestos cloth with Teflon suspensoid		.063	2/2 2/2 0/16	10 5 2	Unacceptable - -
Johns-Manville Lo Flo Sheet		1673	Teflon reinforced with glass fiber		.032	0/20	10	Batch Test
Johns-Manville Lo Flo Sheet		1673	Teflon-ground glass		.063	0/20	10	Batch Test
Johns-Manville Style 2024 Packing		1585		Formerly known as Johns-Manville MX 3681 Packing	.250	2/4 1/16	10 5	Unacceptable -
Johns-Manville No. 61 Sheet		1652			.063	3/9 3/11	10 5	Unacceptable -
Johns-Manville No. 76 Sheet		1474 1922	Compressed asbestos with binder		.063	0/20 0/20	10 10	Batch Test Batch Test
Johns-Manville No. 76 Sheet		1926 1925	Compressed asbestos with binder		.032	2/5 2/5	10 10	Unacceptable Unacceptable
Johns-Manville No. 84 Sheet		1653			.063	2/2 2/2 2/2	10 5 3	Unacceptable - -
Johns-Manville No. 219 Sheet		1649			.063	2/3 0/11	10 5	Unacceptable -
Johns-Manville MX-3681		1589	Compressed asbestos with binder	Variable	.500	0/20	10	Batch Test
Johns-Manville MX-3681			Compressed asbestos with binder	Variable	.375	0-13/20	10	Batch Test
Johns-Manville MX-3681	Johns-Manville Company		Compressed asbestos with binder	Variable	.313	5-13/20	10	Batch Test

TABLE V GASKETS AND PACKINGS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Garlock 7021 Sheet	Garlock Packing Company	1231	Asbestos-rubber composite	Violent reactions	.063	2/2 2/3 2/2 0/2	10 5 2 1	Unacceptable - - -
Garlock 7228 Sheet		1395	Asbestos-Neoprene rubber		.063	2/2 0/14	10 5	Unacceptable -
Garlock 7705 Sheet		1229	Blue asbestos-rubber composite	Violent reactions	.063	2/2 2/2 2/2 1/2	10 5 2 1	Unacceptable - - -
Garlock 8573 Sheet	Garlock Packing Company	3321	Glass-filled Teflon		.063	0/20	10	Batch Test
Gatke Buna-PAK I-26 Sheet	Gatke Corporation	1340	Compressed asbestos with binder		.063	2/20 0/10	10 5	Unacceptable -
John Crane Style C-30 Packing	Crane Packing Company	442	Braided Teflon		.250	0/20	10	Batch Test
John Crane Style C-94 Packing		2909	Braided asbestos lubricated with Teflon suspensoid		.250	0/20	10	Batch Test
John Crane Style 177J7 Packing		839	Braided asbestos over graphited asbestos core	Sensitivity varies from batch to batch	.250	0/20	10	Batch Test
John Crane Style 333 Sheet		1199	Compressed asbestos with binder		.063	4/20	10	Unacceptable
John Crane Style 444 Sheet		1211	Chemically treated compressed vegetable plant fiber		.063	2/4 0/16	10 5	Unacceptable -
John Crane Style 888 Sheet		1213	Compressed asbestos with oil resistant binder		.063	2/20	10	Unacceptable
John Crane Style 2150 Sheet		1214	Asbestos with heat resisting binder		.063	2/3 2/17	10 5	Unacceptable -
John Crane Style 2151 Sheet	Crane Packing Company	1212	Similar to Style 2150		.063	2/2 2/4 0/4	10 5 3	Unacceptable - -
Johns-Manville MX-3681	Johns-Manville Company		Compressed asbestos with binder	Variable	.250	0-5/20	10	Batch Test
Johns-Manville MX-3681			Compressed asbestos with binder		.188	26/40 5/60	10 5	Unacceptable -
Johns-Manville MX-3681	Johns-Manville Company	1944	Compressed asbestos with binder	Variable	.125	3-7/20	10	Unacceptable

TABLE V GASKETS AND PACKINGS (Concluded)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
K & M 238 Sheet	Keasby and Mattison Company	1332			.063	2/4 0/11	10 5	Unacceptable -
K & M 239 Sheet	Keasby and Mattison Company	1333	Asbestos with GR-S elastomer	Meets MIL-A-17472	.063	4/20	10	Unacceptable
Leather Chrome-Tanned	Obtained from Bell Aircraft Company	1201	Leather	Violent explosions	.125	2/5 2/7	10 5	Unacceptable -
Leather, Chrome-Tanned, Fluoro-lube Impregnated	Bell Aircraft Company ("Turkhide")	1202			.125	0/20	10	Batch Test
Naflex Seal with Teflon Tape and Adhesive	Rocketdyne	3696	Teflon, silicone adhesive	Seven batches tested (typical data)	.060	2/4 2/2 2/12 0/20	10 5 3 1	Unacceptable - - -
Novabestos 7511T	Raybestos-Manhattan Incorporated	2729	Dispersed asbestos fiber paper		.020	0/20	10	Batch Test
Parco O-ring Sheet No. 945-70	Plastic and Rubber Products Company		Fluorinated elastomer		.063	0/20	10	Batch Test
Raybestos-Manhattan Fluorobestos Sheet	Raybestos-Manhattan Incorporated	1918	Teflon impregnated asbestos	Available as special LOX grade	.063	0/20	10	Batch Test
Raybestos-Manhattan K-68 Sheet		1924	Asbestos with sulfur-free neoprene binder		.063	0/20	10	Batch Test
Raybestos-Manhattan K-68 Sheet		1923	Asbestos with sulfur-free neoprene binder		.094	4/20	10	Unacceptable
Raybestos-Manhattan 655 Sheet		1209			.063	2/8 1/12	10 8	Unacceptable -
Raybestos-Manhattan 670 Sheet		1140		Violent reactions. Should not be confused with Raybestos-Manhattan 607	.063	2/4 2/3 2/5	10 8 2	Unacceptable - -
Rabestos-Manhattan 673 Sheet		1207			.063	2/4 1/16	10 8	Unacceptable -
Raybestos-Manhattan 10,000 Sheet		1069	Crude asbestos fibers with binder		.063	2/2 2/2	10 8	Unacceptable -
Raybestos-Manhattan RL-395		2067	Teflon asbestos cloth		.063	0/20	10	Batch Test
Raybestos-Manhattan RL-80		2474	Teflon impregnated asbestos cloth		.125	0/40	10	Batch Test
Raybestos-Manhattan RL-80		2476	Teflon impregnated asbestos cloth		.063	0/40	10	Batch Test
Raybestos-Manhattan RL-1356	Raybestos-Manhattan Incorporated	2069	Asbestos sheet with 0.009 in. Teflon film		.063	0/20	10	Batch Test
Sacoma 715 Packing	American Asbestos Company	556		Variable	.250	0-2/20	10	Batch Test

TABLE VI METALS, ALLOYS, SOLDERS, AND SURFACE TREATMENTS

Materials	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Aluminum Cups, Vapor Degreased, Alkaline Cleaned and Acid Etched		1511 and after	Aluminum alloy 5052		.063	0/20	10	Batch Test
Aluminum Cups			Aluminum alloy 5052		.063	0-1/20	10	Batch Test
Aluminum Alloy, 2014-T6		2969			.063	1/100	10	Satisfactory
Aluminum Alloy, 2014-T6		3084			.025	0/120 0/100	10 5	Satisfactory -
Aluminum Alloy, 2014-T6		3110			.010	0/100 0/100	10 5	Satisfactory -
Aluminum Alloy, 2014-T6		2854		Hand deburred	.063	0/100 0/100	10 5	Satisfactory -
Aluminum Alloy, 2219-T87		3616			.094	0/20	10	Satisfactory
Aluminum Alloy, 5086-H34		2869		Hand deburred	.063	1/147 0/80	10 5	Satisfactory -
Aluminum Alloy, 5456		2771		Hand deburred	.063	1/120 0/80	10 5	Satisfactory -
Aluminum Alloy, 6061		1840		Anodized Type II soaked in nickel acetate for 10 minutes. Stainless steel inserts used		0/19	10	Incomplete
Aluminum Cups		2826		Iridited 14-2		0/60	10	Batch Test
Aluminum Disks, Anodized and Conversion Coated		2845			.125	1/20	10	Incomplete
Alpha 238 Solder						2/3 9/17	10 5	Unacceptable -
Aluminum Alloy			5086 aluminum			0/10	10	Satisfactory
Aluminum Alloy, Alodined	American Chemical Paint Company		2024 aluminum, alodine 1200	Stainless steel inserts used	.063	0/20	10	Satisfactory
Aluminum Alloy, Alodined			5086-H34 aluminum, alodine 1200	Stainless steel inserts used	.063	0/20	10	Satisfactory
Aluminum Alloy, Alodined	American Chemical Paint Company		6061 aluminum, alodine 1200	Stainless steel inserts used	.063	0/20	10	Satisfactory
Aluminum Alloy, Anodized	Sandoz Chemical Company		6061-T6 aluminum, Sandoz black BK nickel acetate sealer	Stainless steel inserts used	.063	0/20	10	Satisfactory

TABLE VI METALS, ALLOYS, SOLDERS, AND SURFACE TREATMENTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Aluminum Alloy, Anodized	Sandoz Chemical Company		6061-T6 aluminum, Sandoz blue B (MIL-A-8625A, Type II) nickel acetate sealer		.063	0/20	10	Satisfactory
Aluminum Alloy, Anodized			2024-T3 aluminum, Sandoz green AX	Steel inserts	.063	0/20	10	Satisfactory
Aluminum Alloy, Anodized	Sandoz Chemical Company		6061 aluminum, Sandoz green AX (MIL-A-8625A, Type II) nickel acetate sealer	Steel inserts	.063	0/20	10	Satisfactory
Aluminum Alloy, Anodized	Eaton Chemical Company		6061-T6 aluminum, scarlet anodized nickel acetate sealer	Steel inserts	.063	0/20	10	Satisfactory
Aluminum Alloy, Iridited	Allied Research Products		Iridite No. 14-2, nickel acetate sealer	Steel inserts	.063	0/20	10	Satisfactory
Aluminum Alloy, Iridited			5052 aluminum		.063	0/20	10	Satisfactory
Aluminum Alloy, Treated			Soaked 24 hours in 0.1% H_2SO_4 followed by 24 hours in 0.02% Sodium dichromate		.063	0/20	10	Satisfactory
Ampco-24 Alloy		3481	5% iron, 15% aluminum, 80% copper		.063	0/20	10	Satisfactory
Brass Inserts		3016	65% copper, 34% zinc, 2% lead		.063	0/20	10	Satisfactory
Beryllium		3125			.063	0/20	10	Batch Test
Black Anodizing on Aluminum Disks		3165			.063	2/20 1/20	10 5	Unacceptable -
Bronze Filter (Sintered)		2517	Bronze			0/20	10	Satisfactory
Cadmium				Electroplated	.001	0/20	10	Satisfactory
Cerrobend Low Melting Alloy			Contains bismuth, lead, tin	Low Melting Alloy		2/3 1/17	10 5	Unacceptable -
70-30 Cupro-Nickel Alloy No. CN-346	International Nickel Company	3849	Copper - 70% Nickel - 30%		.050	0/20	10	Satisfactory
Cyanamid Black W. A.		1842		On 6061 Aluminum inserts		0/20	10	Batch Test
Eutectic Rod 115 B Solder and Eutectic 151 B Flux	Eutectic Welding Alloy Corporation	2903				13/60	10	Unacceptable

TABLE VI METALS, ALLOYS, SOLDERS, AND SURFACE TREATMENTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions / No. Tests	Energy Level Kg-M	Rating
Eutectic No. 157 Solder	Eutectic Welding Alloys Corporation		Silver alloy (low melting)			3/4	10	Unacceptable
						2/3	5	-
						2/7	3	-
						0/6	2	-
Eutectic No. 1801 Solder	Eutectic Welding Alloys Corporation		Silver alloy			0/20	10	Satisfactory
Iridite 14-2 plus Cab-o-Sil Coating		3851		Coating on 6061 Aluminum		0/20	10	Batch Test
Krieger NR/5285 on 6061 Alumimum Alloy	Krieger Color and Chemical Company Incorporated	1732				3/20	10	Unacceptable
Krieger Blue-B (4 gram/liter) on 6061		1734				1/20	10	Incomplete
Krieger Blue-B on 6061 Aluminum Alloy		1844				0/20	10	Batch Test
Krieger Black BK-NR 15285 on 6061 Aluminum Alloy	Krieger Color and Chemical Company Incorporated	1845				0/20	10	Batch Test
K6 Alloy	Karl Harrison Company	2141	Nickel, lead, and silver alloy on 304 stainless steel			0/40	10	Batch Test
Kovar "A"		962	Nickel, cobalt, iron		.063	0/20	10	Satisfactory
Magnesium-Lithium Alloy CA-91		1222			.063	2/3	10	Unacceptable
						1/2	8	-
						1/3	7	-
						1/12	6	-
						0/20	3	-
Magnesium-Lithium Alloy LA-141		1221			.063	1/2	10	Unacceptable
						0/20	3	-
Magnesium Cups, Untreated		540				2/7	10	Unacceptable
Magnesium Alloy HK 31	Dow Metal Products Company	1703	Magnesium, thorium, zirconium alloy		.063	0/20	10	Incomplete
Magnesium Alloy M-1		1702	Magnesium, aluminum, manganese alloy		.063	2/20	10	Unacceptable
Magnesium Alloy AZ-31	Dow Metal Products Company	1701	Magnesium, zinc, manganese alloy		.063	2/3	10	Unacceptable
						1/4	5	-
						0/11	3	-
Magnesium Alloy M-1		1702	1/5% manganese			2/20	10	Unacceptable
P/N 455224 Shim Spacer Lox Inducer		3848				0/20	10	Satisfactory
Sandoz Yellow 2D on 6061 Aluminum Alloy	Sandoz Incorporated	1735				0/20	10	Batch Test
Sandoz Black V-Orange 3A on 6061 Aluminum Alloy	Sandoz Incorporated	1733				4/20	10	Unacceptable

TABLE VI METALS, ALLOYS, SOLDERS, AND SURFACE TREATMENTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Sandoz OD No. 319	Sandoz Incorporated	1726				5/40	10	Unacceptable
Sandoz Bordeaux R.		1847		On 6061 aluminum alloy		0/20	10	Batch Test
Sandoz Blue B		1737				3/20	10	Unacceptable
Sandoz Orange 2B		1846		On 6061 aluminum alloy		0/20	10	Batch Test
Sandoz Gold Orange 3A Gold Black V	Sandoz Incorporated	1841		On 6061 aluminum alloy		0/20	10	Batch Test
Silbond No. 45 Solder	United Wire and Supply Company	758				0/20	10	Batch Test
Silicon Carbide Abrasive in Bottom of Aluminum Cup		3173		150 mesh	.032	0/20 0/20	10 5	
No. 151B Solder	Eutectic Welding Alloy Corporation	3534	90% tin, zinc, nickel		.032	10/20 3/20 0/20	10 4 2	Unacceptable - -
No. 153 Solder		3538	90% lead, 10% silver		.032	3/20 2/22 0/20	10 7 5	Unacceptable - -
No. 155 Solder	Eutectic Welding Alloy Corporation	3541			.032	2/35 2/20	10 8	Unacceptable -
Solder		34	50% tin, 50% lead	No flux		3/5 0/5	10 5	Unacceptable
Solder		76	60% tin, 40% lead			2/6 1/6	10 3	Unacceptable
Solder			60% tin, 40% lead	With flux		3/5 0/5	10 5	Unacceptable
Solder, High Silver				Paste heated to 1000° F 5 minutes. Droplets degreased with trichloroethylene		0/20	10	Satisfactory
Stainless Steel Wool No. 4-33		379			.50	1/2 0/12	10 7	Unacceptable -
Steel Wool		380				3/4 0/16	10 7	Unacceptable -
Stainless Steel 301 Alloy		2829			.012	0/100 0/100	10 5	Satisfactory -
Stainless Steel 301 Alloy		2818		Hand deburred	.063	0/200 0/100	10 5	Satisfactory -
Stainless Steel 302 Alloy		3603			.094	0/20	10	Satisfactory

TABLE VI METALS, ALLOYS, SOLDERS, AND SURFACE TREATMENTS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Stainless Steel 347 Alloy		3631			.062	0/20	10	Satisfactory
Silver Plated Stainless Steel		2449			.063	0/20	10	Satisfactory
Steel Inserts MXB 1113		3018			.063	0/20	10	Satisfactory
Tin Plate (.004 in.) on 421 Stainless Steel Inserts		1612			.063	2/20	10	Unacceptable
Tin Plate (.001 in.) on Stainless Steel Inserts		2244			.125	2/20	10	Unacceptable
						0/20	4	-
Tin Plate (.002 in.) on Stainless Steel Inserts		2246			.125	3/20	10	Unacceptable
						1/20	8	-
						0/20	5	-
Tin Plate (.0005 in.) on Stainless Steel Inserts		2235			.125	2/5	10	Unacceptable
						1/20	5	-
						0/20	4	-
Tin Plate (.00025 in.) on Stainless Steel Inserts		2230			.125	2/5	10	Unacceptable
						3/18	7	-
						0/20	5	-
Titanium Alloy, 6Al-4V				Deburred	.063	7/40	10	Unacceptable
						1/2	8	-
						2/3	7	-
						2/60	5	-
						0/20	2	-
Titanium Alloy, 6Al-4V				Deburred	.250	18/20	10	
						8/20	2	
						1/20	1	
Titanium Alloy, 4Al-3 Mo-1V				Deburred	.063	2/2	10	Unacceptable
						1/1	5	-
						2/5	3	-
						1/3	2	-
						0/4	1	-
Titanium Alloy, RC55				Deburred	.063	15/20	10	Unacceptable
						1/20	3	-
						2/20	2	-
						0/20	1	-

TABLE VI METALS, ALLOYS, SOLDERS, AND SURFACE TREATMENTS (Concluded)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Titanium Alloy, 13V-11Cr-3AL				Deburred	.063	15/20	10	Unacceptable
						5/20	7	-
						2/20	5	-
						0/20	3	-
						0/20	2	-
Titanium Alloy, 5Al-2.5 Sn				Deburred	.125	15/20	10	Unacceptable
						17/20	5	-
						8/20	3	-
						1/1	2	-
						2/20	1	-
Titanium Alloy, 5Al-2.5 Sn				Deburred	.063	11/20	10	Unacceptable
						3/20	5	-
						1/20	3	-
						1/20	2	-
						0/20	1	-
Titanium Alloy, 5 Al-2.5 Sn				Deburred	.063	4/20	10	Unacceptable
						1/20	5	-
Titanium Alloy, 5Al-2.5 Sn				Deburred	.025	7/20	10	Unacceptable
						2/20	5	-
						0/20	1	-
Titanium Alloy, 5Al-2.5 Sn				Deburred	.010	2/40	10	Unacceptable
						2/20	5	-
						0/20	3	-
Titanium Alloy, 75A	Allegheny Ludlum Steel Corporation			Steel inserts		2/2	10	Unacceptable
						2/2	5	-
						2/4	3	-
Titanium Alloy, 140A	Allegheny Ludlum Steel Corporation			Steel inserts		4/4	10	Unacceptable
						2/3	5	-
						2/3	3	-
Titanium Alloy	Ram Cru		Ram Cru-245	Steel inserts		2/2	10	Unacceptable
						2/3	5	-
						1/15	3	-
Washer AN960PD416		2143	Anodized Type II Aluminum			1/60	10	Batch Test
Young's Alloy Metal Washers	Ardel Corporation	3825			.063	0/20	10	Batch Test
Zirconium		3648			.083	14/20	10	Unacceptable
						8/20	5	-
						2/20	3	-
						2/20	2	-
						0/20	1	-

TABLE VII DYE PENTRANTS

A

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions / No. Tests	Energy Level Kg-M	Rating
Emulsifier E-153	Shannon Luminous Material Company	N/A		Tested in wet form	.050	2/14	10	
Emulsifier 137-95	Magnaflux Corporation			Tested in wet form	.050 .025	0/20 3/20	10 10	
Fluorocheck Penetrant W W	Turco Paint and Varnish Company Incorporated				.050	2/4	10	
Fluorocheck Penetrant Regular					.050	2/6	10	
Fluorocheck Penetrant High Sensitivity					.050	5/20	10	
Fluorocheck Emulsifier	Turco Paint and Varnish Company Incorporated			Tested in wet form	.050	2/13	10	
Penetrant P-138	Shannon Luminous Material Company			Tested in wet form	.050	2/4	10	
Penetrant P-148	Shannon Luminous Material Company			Tested in wet form	.050	3/8	10	
Penetrant 137-115	Magnaflux Corporation			Tested in wet form	.050 .025	0/20 2/10	10 10	
Penetrant 137-89				Tested in wet form	.050 .025	6/20 2/10	10 10	
Penetrant (concentrate) SKL4				Tested in wet form	.050 .025	0/20 2/20	10 10	
Penetrant ZL-2				Tested in wet form	.050 .025	2/6 1/5	10 10	
Penetrant ZL-1A				Tested in wet form	.050	2/3	10	
Penetrant ZL-4A				Tested in wet form	.050	2/6	10	
Penetrant ZL-22	Magnaflux Corporation	N/A		Tested in wet form	.050 .025	2/3 2/4	10 10	

TABLE VII DYE PENTRANTS (Continued)

B

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Magnaflux ZL-4B	Magnaflux Corporation	N/A		Oven dried at 100° C for 7 hours	.050	2/20	10	
				Vacuum dried (room temperature) for 1-1/2 hours	.050	3/20	10	
Magnaflux ZL-44				Oven dried at 100°C for 11 hours	.050	2/20	10	
				Vacuum dried (room temperature) for 1-1/2 hours				
Magnaflux ZL-44B				Oven dried at 100°C for 7 hours	.050	0/20	10	
				Vacuum dried (room temperature) for 1-1/2 hours	.050	3/20	10	
Magnaflux SKL-4 (3:1 dilution)				Oven dried at 100°C for 2 hours	.050	0/40	10	
				Vacuum dried (room temperature) for 1-1/2 hours	.050	0/20	10	
Magnaflux SKD-W Developer (for use with SKL-4)				Oven dried at 100°C for 2 hours	.050	0/20	10	
				Vacuum dried (room temperature) for 2 hours	.050	0/20	10	
Magnaflux ZL-42				Oven dried at 100°C for 11 hours	.050	0/20	10	
				Vacuum dried (room temperature) for 1-1/2 hours	.050	0/20	10	
Magnaflux ZE-43 Emulsifier (for use with ZL-42 Penetrant)	Magnaflux Corporation	N/A		Oven dried at 100°C for 3 hours	.050	6/20	10	
				Vacuum dried (room temperature) for 1-1/2 hours	.050	2/20	10	

TABLE VII DYE PENTRANTS (Continued)

B

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Magnaflux ZP-45 Developer (for use with ZL-42 Penetrant)	Magnaflux Corporation	N/A		Oven dried at 100°C for 3 hours	.050	0/20	10	
				Vacuum dried (room temperature) for 2 hours	.050	0/20	10	
Shannon P-505 (25-7-5)	Shannon Luminous Material Company			Oven dried at 100°C for 1 hour	.050	1/20	10	
				Vacuum dried (room temperature) for 1/4 hour	.050	1/20	10	
Shannon 159 (25-7-5) (for use with P-505 Penetrant)				Oven dried at 100°C for 1 hour	.050	5/20	10	
				Vacuum dried (room temperature) for 2 hours	.050	2/10	10	
Shannon 492-A Developer (24-44-4) (for use with E-159 Penetrant)	Shannon Luminous Material Company	N/A		Oven dried at 100°C for 1/2 hour	.050	0/20	10	
				Vacuum dried (room temperature) for 3/4 hour	.050	0/20	10	

TABLE VII DYE PENTRANTS (Continued)

C

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Shannon Glo P-505 (25-7-5)	Shannon Luminous Material Company	N/A		Novabestos soaked in Penetrant for 1 hour. Dried at 60°C for 30 minutes		0/20	10	
Shannon E-159 Emulsifier (25-7-3)	Shannon Luminous Material Company			Novabestos soaked in Penetrant for 1 hour. Dried at 60°C for 30 minutes		20/20	10	
Zyglo ZL-4B	Magnaflux Corporation			Novabestos soaked in Penetrant for 1 hour. Drained for 3 hours		0/20	10	
				Novabestos soaked in Penetrant for 1 hour. Dried at 60°C for 30 minutes. Left in oven with heat off, overnight		14/20	10	
Zyglo ZL-42				Novabestos soaked in Penetrant for 1 hour. Drained for 3 hours		0/20	10	
				Soaked in Penetrant for 1 hour. Dried at 60°C for 30 minutes. Left in oven with heat off overnight		0/20	10	
Zyglo ZE-43 Emulsifier				Novabestos soaked in Penetrant for 1 hour. Drained 3 hours		3/20	10	
				Soaked in penetrant for 1 hour. Dried at 60°C 30 minutes. Left in oven with heat off overnight		20/20		
Zyglo ZL-44B	Magnaflux Corporation	N/A		Novabestos soaked in Penetrant for 1 hour. Drained for 3 hours		0/20	10	
				Soaked in Penetrant for 1 hour. Dried at 60°C for 30 minutes. Left in oven with heat off overnight		18/20	10	

TABLE VII DYE PENTRANTS (Continued)

C

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Zyglo SKL-4 (3:1 dilutions)	Magnaflux Corporation	N/A		Novabestos soaked in Penetrant for 1 hour. Drained for 3 hours		0/20	10	
				Novabestos soaked in Penetrant for 1 hour. Dried at 60°C for 30 minutes.		0/20	10	

TABLE VII DYE PENTRANTS (Concluded)

D

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Florescing Agent GPC	G. W. Gates Company	N/A		1cc saturated solution evaporated to dryness		4/20	10	
Oil Red "O" Dye				Residue from 0.5 cc of saturated solution in methyl isobutyl ketone		5/12	10	
Oil Red "O" Dye				Residue from 0.5 cc dissolved in trichloro-ethylene. Dried 48 hours		2/9	10	
ZL-10 Colorless Dye	Magnaflux Corporation			Full strength		2/11	10	
ZL-10 Colorless Dye				2-1/2 cc of 5% water solution evaporated to dryness		1/7	10	
				2-1/2 cc evaporated to dryness		2/6	10	
ZL-4A Penetrant				2-1/2 cc evaporated to dryness		2/6	10	
ZP-5 Developer	Magnaflux Corporation	N/A		0.5 cc - wet		0/40	10	

TABLE VIII CHEMICALS, SOLVENTS, AND MISCELLANEOUS

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Aluminum Octoate	Witco Chemical Company Incorporated					6/20	10	Unacceptable
						0/20	5	-
Amyl Acetate, Normal						2/10	10	Unacceptable
Aroclor 1254	Monsanto Chemical Company		Chlorinated hydrocarbon		.050	0/20	10	Satisfactory
Aroclor 1254	Monsanto Chemical Company			Sample paper thin	.050	9/20	10	-
Blast 3 Untrasonic Cleaner	Narda Ultrasonic Corporation			Steel samples heated to 100°C in cleaner, rinsed, and dried		0/20	10	Batch Test
Blast 3 Ultrasonic Cleaner	Narda Ultrasonic Corporation			50% solution evaporated dry		2/2	10	Unacceptable
						1/18	5	-
Carbon Tetrachloride, Technical Grade	Fisher Scientific Company					0/10	10	Conditional
Carbon Tetrachloride, C.P.				Residue from 5 ml.		0/20	10	Satisfactory
Carbon Tetrachloride	Fisher Scientific Company			Evaporated to 5% original weight		0/20	10	Satisfactory
Chlorothene Solvent, 1, 1, 1 Trichloroethane	Dow Chemical Company					0/20	10	Satisfactory
Chlorinated Polyether						2/2	10	Unacceptable
						2/2	5	-
Chloroform						0/20	10	Satisfactory
Chlorotrifluoro Hydrocarbon	Halocarbon Corporation					0/20	10	Satisfactory
Chromic Acid Anodizing Solution						0/10	10	Unacceptable
Chlorinated Paraffin	Hercules Powder Company					1/7	10	Unacceptable
Corning Glass Type 9010						0/20	10	Satisfactory
Diak No. 1						2/20	10	Unacceptable
Dioctyl Phthalate						2/10	10	Unacceptable
Ethylene Gylcol						1/20	10	Unacceptable
Ethylene Glycol, 25% Water Solution						0/20	10	Incomplete
Ferrite Cone Material 3c						0/6	10	Incomplete
Ferrox Safety Floor Covering	American Abrasive Metal Company					1/1	10	Unacceptable
						2/2	5	-
						2/2	2	-
						2/6	1	-

TABLE VIII CHEMICALS, SOLVENTS, AND MISCELLANEOUS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Fluorescein			Disodium salt	2 1/2 ml of 5% solution evaporated to dryness		2/2 2/5	10 5	Unacceptable
Fluoroalkyl Camphorate	E. I. du Pont de Nemours & Co., Inc.					2/14 0/6	10 5	Unacceptable -
Fluorosilicone Polymer, Distilled						2/2 2/9 0/9	10 5 2	Unacceptable - -
F-33 Detergent	Dow Chemical Company					0/20	11	Batch Test
Hexafluoropentamethylene Adipate Polyester	Hooker Electrochemical Company					2/11 0/9	10 5	Unacceptable -
Ink, Tech Pen, Black	Mark-Tex Corporation					3/17	10	Unacceptable
Joy Detergent, 5% Solution Evaporated to Dryness						2/2 2/5	10 5	Unacceptable -
Methyl and Fluoro Silicone Copolymer						2/2 2/4 2/7	10 5 2	Unacceptable - -
Morhand Caulking Compound	Moore-Handley Hardware Company					19/20 10/20 9/20 0/20	10 5 2 1	Unacceptable - - -
Magnesium Oxide						0/20	10	Satisfactory
Oxylene Evaporated to 5% Original Volume	John B. Moore Corporation		Freon 11 and Methylene chloride			0/20	10	Satisfactory
Perchloroethylene, Liquid	Hooker Electrochemical Company					0/20	10	Satisfactory
Perchloropentacyclo Decane	Hooker Electrochemical Company					0/20	10	Satisfactory
No. 67 Purified	Pittman-Dunn Laboratory					0/20	10	Satisfactory
Perfluorotributylamine, (Purified)	Pittman-Dunn Laboratory					0/20	10	Satisfactory
Perfluorotributylamine and Chlorotrifluorohydrocarbon (1:1)	Frankford Arsenal					0/20	10	Satisfactory
Primer, Zinc Chromate				Air dried		0/20	10	Conditional
Primer, Zinc Chromate (MIL-P-6889 Type A)				Dried at 80°C		1/20	10	Incomplete

TABLE VIII CHEMICALS, SOLVENTS, AND MISCELLANEOUS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Polyglycol 11-200, Lot 261	Dow Chemical Company					1/20	10	Incomplete
Polyglycol 15-200			Polyoxyalkylene ethers with methyl side chains and terminal hydroxyl groups			2/12	10	Unacceptable
Polyglycol 166-900						0/20	10	Incomplete
Polyglycol 174-500			Polypropylene glycol			1/20	10	Incomplete
Polyglycol P-400			Polypropylene glycol			2/20	10	Unacceptable
Polyglycol P-2000	Dow Chemical Company		Polypropylene glycol			2/2	10	Unacceptable
Quartz (Clear Fused) Sample I-1551-A-20X						0/20	10	Satisfactory
Rely-On Caulking Compound	DAP Incorporated					12/20 13/20 13/20 3/20	10 5 2 1	Unacceptable - - -
Skydrol 500	Monsanto Chemical Company					1/4 0/20	10 7	Unacceptable -
Sodium Dichromate						0/20	10	Satisfactory
Stoddard Solvent				Extremely violent explosion		1/9	10	Unacceptable
Safety Walk Type B	Minnesota Mining and Manufacturing Company					1/1 2/2 4/20	10 5 .75	Unacceptable - -
Semco Bubble Check DPS 4.905	Semco Sales and Service					0/40	10	Batch Test
Sodium Silicate	Fisher Scientific Company					0/20 0/40	10 10	Satisfactory -
Sherlock C G-1 Bubble Tester						0/40	10	Batch Test
Silica Gel, Indicating 6 - 16 Mesh	E. H. Sargent and Company					2/20	10	Satisfactory
Spotcheck Cleaner Type SKC-2-1	Magnaflux Corporation		Chlorinated hydrocarbon			0/60	10	Satisfactory
Snoop Leak Detector	Nuclear Products Company					0/20	10	Batch Test
Thermocolor Number 34 Temperature Sensitive Point	Bodishe Awilin-Soda Fabrik					3/20	10	Unacceptable

TABLE VIII CHEMICALS, SOLVENTS, AND MISCELLANEOUS (Continued)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Thermocolor Number 15 Temperature Sensitive Point	Bodishe Awilin-Soda Fabrik					0/20	10	Incomplete
Tide Detergent	Proctor and Gamble Company			2 ml 1% solution evaporated to dryness		4/20	10	Unacceptable
Trichloroethylene Evaporation Residue	Du Pont Trichloroethylene			Four batches tested		3/17 2/2	10 10	Unacceptable -
Trichloroethylene, Extraction Grade, Evaporation Residue						0/2	10	Conditional
Trichloroethylene, Missile Grade, Liquid						0/20	10	Satisfactory
Trichloroethylene, Liquid	Dow Chemical Company			Liquid		0/20	10	Satisfactory
Trichloroethylene (Perma-A-Chlor-NA) Residue	E. I. du Pont de Nemours & Co., Inc.			10 mg		2/5 2/15	10 5	Unacceptable -
Trichloroethylene (Perma-A-Chlor-NA) Residue				5 mg		2/4 1/16	10 5	Unacceptable -
Trichloroethylene (Perma-A-Chlor-NA) Residue				25 mg		1/20	10	Conditional
Trichloroethylene (Triclene D)	E. I. du Pont de Nemours & Co., Inc.			Sensitivity varies from batch to batch		0-2/20	10	Conditional
Trichloroethylene Evaporation Residue	Detrex Trichloroethylene			Liquid		0/20	10	Satisfactory
Trichloroethylene Evaporation Residue Lot No. 218				Liquid		0/20	10	Satisfactory
Trichloroethylene Evaporation Residue Lot No. WB83	Detrex Trichloroethylene			Liquid		0/20	10	Satisfactory
Tricresyl Phosphate						5/20	10	Unacceptable
Trilaurvl Silicon Fluoride	Frankford Arsenal					2/5 1/4	10 5	Unacceptable -
Tetrone AC	E.I. Dupont Nemours Incorporated					3/20	10	Unacceptable
Tenamene - 3	Dow Chemical Company					1/1 1/3 1/4	10 2 1	Unacceptable - -
Vycor Glass, Corning Type 7913	Corning Glass Works					0/20	10	Satisfactory
Vermiculite (hydrated) Magnesium, Aluminum, Iron Silicate						0/20	10	Satisfactory

TABLE VIII CHEMICALS, SOLVENTS, AND MISCELLANEOUS (Concluded)

Material	Manufacturer	Test No.	Composition	Remarks	Thickness (Inch)	No. Reactions/ No. Tests	Energy Level Kg-M	Rating
Warren Spray Enamel Primer (Brown)	Warren Paint and Color Company					4/20	10	Unacceptable
						2/20	5	
Warren Spray Enamel Yellow Zinc Chromate	Warren Paint and Color Company					2/20	10	Unacceptable
Zinc Chromate Paste						3/20	10	Unacceptable
						1/20	5	-
						2/20	2	-
Zinc Chromate (SPEC-MIL-P-8585)	Chromatone Corporation					2/20	10	Unacceptable
						2/20	5	-
						0/20	1	Conditional
1, 3, 5-Trimethyl, 2, 4, 6-Trifluoro Benzene	Illinois State Geological Survey					1/20	10	Conditional

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