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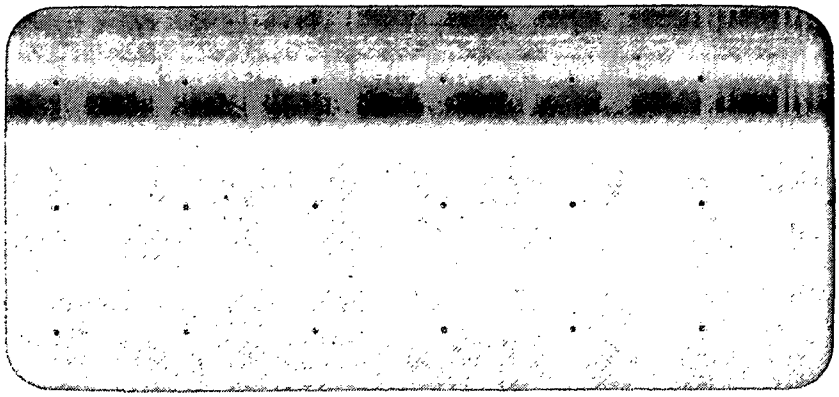

SOS

SPACE ORDNANCE SYSTEMS, INC.

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SPACE ORDNANCE SYSTEMS, INC.

DEVELOPMENT TEST REPORT

for

Evaluation of Epoxy Systems
for use in
SBASI

Prepared for:

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

under

Contract No. NAS9-12085
and
SOS Sales Order No. 3409

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DATE 1 November 1971

1.0 INTRODUCTION

The test program described herein was performed for NASA/Manned Spacecraft Center under Contract NAS 9-12085. Requirements for the test program are defined by the referenced contract and NASA Statement of Work entitled "Prototype of SBASI Modified to Use Readily Available Epoxy Systems". Space Ordnance Systems, Inc. TWX, dated 10 June, 1971, defines the program as finally negotiated.

2.0 PURPOSE

The purpose of the test program was to evaluate the performance of different epoxy systems as replacements for existing epoxy systems in the SBASI. The three areas of investigation were 1) the connector shell potting, 2) epoxy tape under the charge cup, and 3) the epoxy impregnated fiberglass over the output charge. Factors considered, in addition to performance, were availability, shelf life, pot life, and effect on producibility and cost.

3.0 SCOPE

Various subassemblies and complete assemblies were constructed and subjected to a series of tests. The results of these tests and a technical meeting between SOS and NASA personnel were used to determine the most suitable configuration. At this point, 200 complete assemblies were manufactured to that configuration, subjected to an LAT program, and shipped to NASA for further evaluation.

4.0 MATERIALS

The materials to be used in the program were agreed upon by NASA and SOS at the time of program award. The data on these materials indicates that all are suitable for SBASI qualification environments. Manufacturer's data sheets are enclosed in Appendix A.

4.1 Connector Shell Potting

The potting compound presently used in the SBASI is Epocast H867 A, a three component system manufactured by the Furane Plastics Corporation. It is a non-standard material which the manufacturer considers obsolete. If manufacturing of the material is discontinued, a suitable substitute should be

available. The Epocast H867 A material has other disadvantages in that it is very viscous and has only a ten minute pot life. To allow for this characteristic, SOS had to develop a technique for handling the material involving pneumatic powered throw-away syringes.

The replacement material evaluated in this program was Epon 828 with Curing Agent Z. Both of these components are standard products of the Shell Chemical Company and are extensively used in commercial and aerospace applications. The material has a pot life in excess of thirty minutes and can be easily dispensed with a hand-operated syringe.

4.2 Charge Cup Epoxy Tape

The material presently used for Component SDB26100008 is Scotch-Weld #588, a product of the 3M Company. The high cohesion of this material allows it to be stamped, handled, and installed efficiently. Paragraph 1.3 of the referenced SOW indicates that this material may be a source of spark gap deterioration by trapping water under the charge cup. For this reason, two materials were evaluated as repalcement candidates.

The first candidate was Scotch-Weld #584. This

material is from the same family of 3M tapes as #588 but is .002 inch thick (#588 is .006 inch thick).and contains a thermoplastic resin in addition to the thermosetting resin.

The second candidate was Loktac Y 9169 tape, also a 3M product. This product is not yet in full production and is subject to "modification, production limitations, or cancellation" according to the data sheet. The chemical composition is not publicized except that it is a thermosetting resin and appears to be different from the 500 series of materials. Film thickness of Y9169 is .006 inch.

4.3 Sealing Washer Over Output Charge

The present sealing washer, SDB26100011, is epoxy impregnated fiberglass manufactured by the U.S. Polymeric Corp. under P/N E-787. The only problems with this material are that it has a relatively short shelf life, must be stored under refrigeration, frozen prior to stamping, and tends to get sticky at room temperature.

Another similar material, F502, was evaluated as a replacement candidate. This material has the advantage of being stable at room temperature and not requiring refrigeration for

storage or stamping.

RTV-3144, manufactured by Dow Corning, was the other candidate. This material is a viscous silicone material which is packaged in a squeeze tube. It cannot be preformed into a washer but must be spread into place using a pointed instrument.

5.0 CONFIGURATION OF TEST ASSEMBLIES

Most of the published data on adhesives is obtained by using etched aluminum platens and is not directly applicable to bond strengths of alumina and Inconel components. For that reason, the test assemblies were manufactured using actual production components. Table I summarizes the configurations tested. Paragraphs 5.1 through 5.6 describe the manufacturing techniques and characteristics of the materials being evaluated.

5.1 Figure 1

The subassembly shown in Figure 1 was used to evaluate Scotch-Weld 584. The header body had the press fit diameter machined undersize so it could be installed into a cartridge body and be easily removed. The body served as a jig for alignment of the ceramic and the header body while curing the disc. After curing at 200°F for two hours in the standard SBASI fixtures, the subassembly was removed from the body and subjected to the environmental test program.

Manufacture and handling of the 113064 disk presented several problems. The stamping dies used for the 588 disks are designed for .006 material. When attempting to stamp the .002 584 stock, the dies could not make a clean cut. The material

ASSEMBLY PART NO.	QTY	CONNECTOR POTTING	TAPE MAT'L	TAPE PART NO.	WASHER MAT'L	WASHER PART NO.
Figure 1	5	N/A	584	113064	N/A	N/A
Figure 2	5	N/A	Y9169	113065	N/N	N/A
Figure 3	5	N/A	N/A	N/A	F502	113066
Figure 4	5	N/A	N/A	N/A	RTV3144	None
None	5	828/2	N/A	N/A	N/A	N/A
113063-1	5	828/2	584	113064	F502	113066
113063-2	5	828/2	Y9169	113065	F502	113066
113063-3	5	828/2	584	113064	RTV3144	None
113063-4	5	828/2	Y9169	113065	RTV3144	None

TABLE I

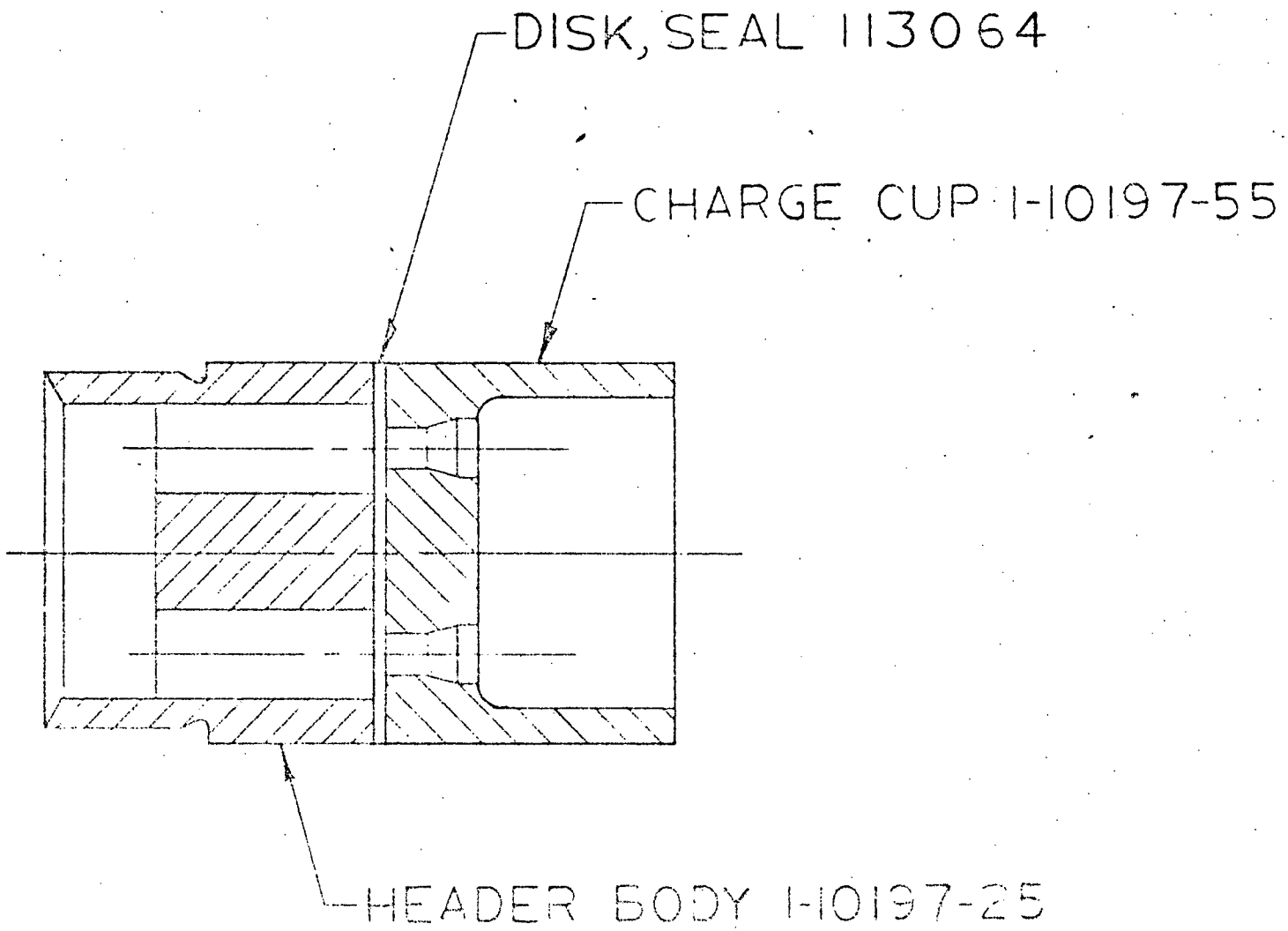


FIGURE I

tended to extrude into the die clearances thus deforming the disk. Freezing the tape in LN_2 prior to stamping did not improve the process nor did using a double layer of backing. The problem has two basic aspects. The first is the tooling itself. With closer clearances there is a greater probability that the material could be cleanly sheared. The second aspect is related to the material itself. Scotch-Weld 584 is a thin, cohesive, non-elastic, material which can be compared to common household saran sheet. As such, it is difficult to shear.

To fabricate the parts, it was necessary to hand cut each disk with a razor knife while holding the tape in position against an aluminum plate with a ceramic charge cup. Once cut, it was difficult to remove the disk from the paper backing without deformation. It was found that dipping the tape in LN_2 expedited this procedure. Scotch-Weld 584 is not sticky at room temperature and therefore, once fabricated, the part can be positioned and aligned using clean metal instruments.

5.2 Figure 2

The subassembly shown in Figure 2 was fabricated in a similar manner to the subassembly in Figure 1 using standard SBASI curing fixtures and a SBASI body for an alignment fixture.

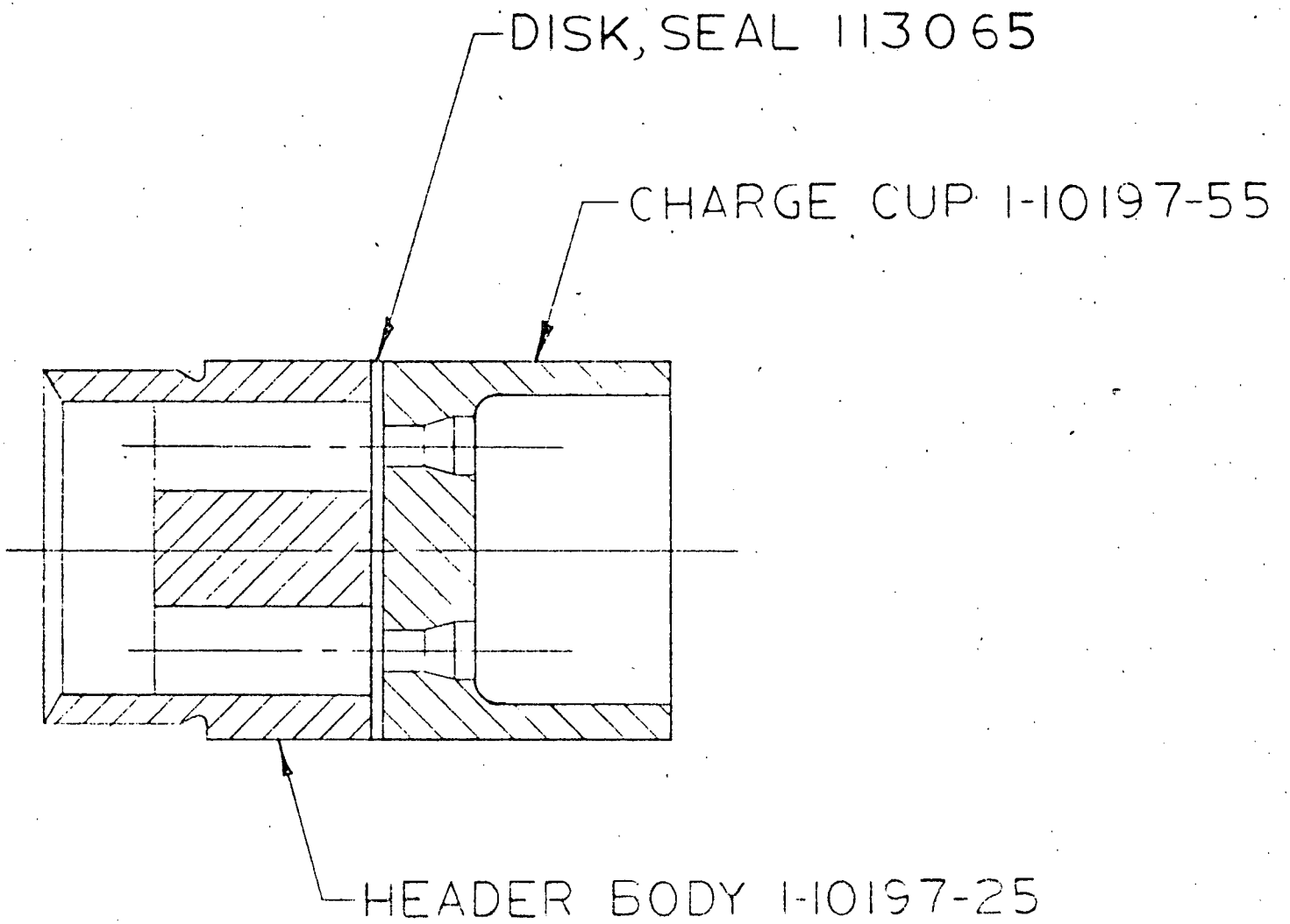
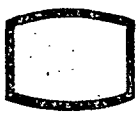


FIGURE 2

The material for the disk, 113065, was Loktac Y 9169. This material presented even greater manufacturing problems than did the 584 material. Although Y 9169 is .006 inch thick it is gum like, sticky, and susceptable to stretching. The material stuck to the stamping dies upon closing and strung out like gum as the dies opened. Stamping with backing on both sides of the tape helped somewhat but it was not possible to obtain useable disks. As with the 584 material, all Y 9169 disks were fabricated by hand with one important difference. The ceramic used to hold down the tape remained stuck to the tape after cutting. The backing could then be pulled from the tape leaving a tape/ceramic subassembly. A disk cut from Y 9169 cannot practically be handled as a separate item. Even when carefully handled with metal instruments the disk tends to deform under its own weight causing permanent folds and wrinkles. The only technique which could be adapted to production would be one which cuts the disk after contact adhesion to the ceramic.

After curing at 200°F for two hours, the subassemblies were removed from the bodies and put into the environmental test program.

NOTE: Additional information on fabrication of Y9169 Disks is contained in Paragraph 8.0.



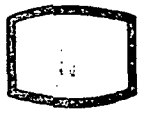
5.3 Figure 3

Figure 3 subassembly was used to evaluate F502 epoxy impregnated sheet for use as a sealing washer (P/N 113066) over the output charge. A header body (again, reduced diameter) and a ceramic were placed in a SBASI body. Diatomaceous earth was used in place of an output charge and pressed in place. Fabrication and handling of the F502 washers was superior to E 787 because it did not become sticky at room temperature. Freezing of F502 for the stamping operation (required for E 787) was not necessary. Installation and curing (300°F for two hours) was accomplished with the standard SBASI spring loaded fixtures. The subassemblies remained in the body for environmental testing. The epoxy in the washer forms a bond between the isomica disks, the ceramic, and the side wall of the body.

5.4 Figure 4

Figure 4 subassembly was used to evaluate RTV 3144 installed over the output charge. Components used for the sub-assembly were prepared in a similar manner to those discussed under Figure 3.

The RTV 3144 cannot be preformed but must be installed bit by bit using a pointed instrument and then smoothed



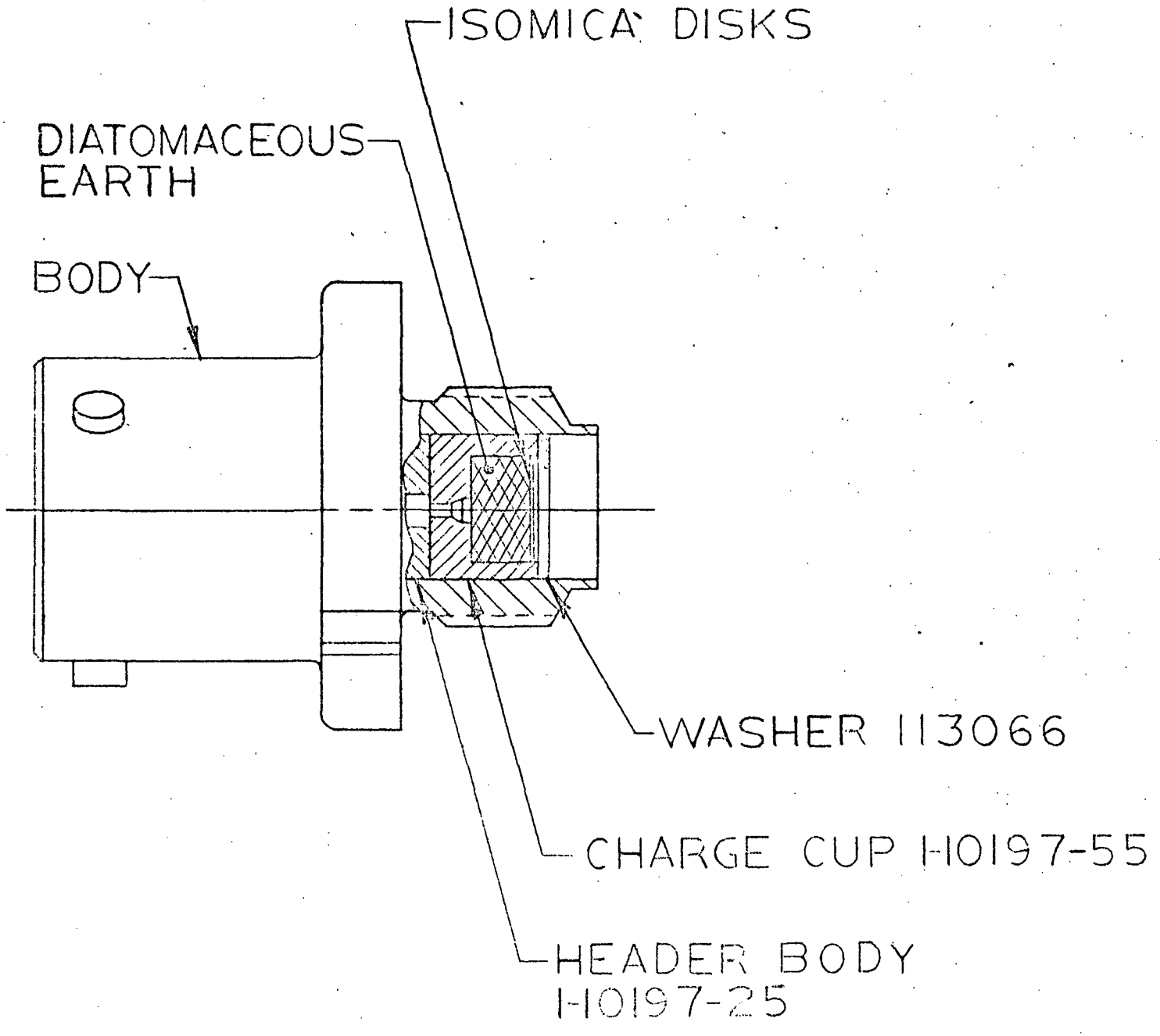

ISOMICA DISKS
DIATOMACEOUS EARTH
BODY
WASHER 113066
CHARGE CUP H0197-55
HEADER BODY H0197-25

FIGURE 3

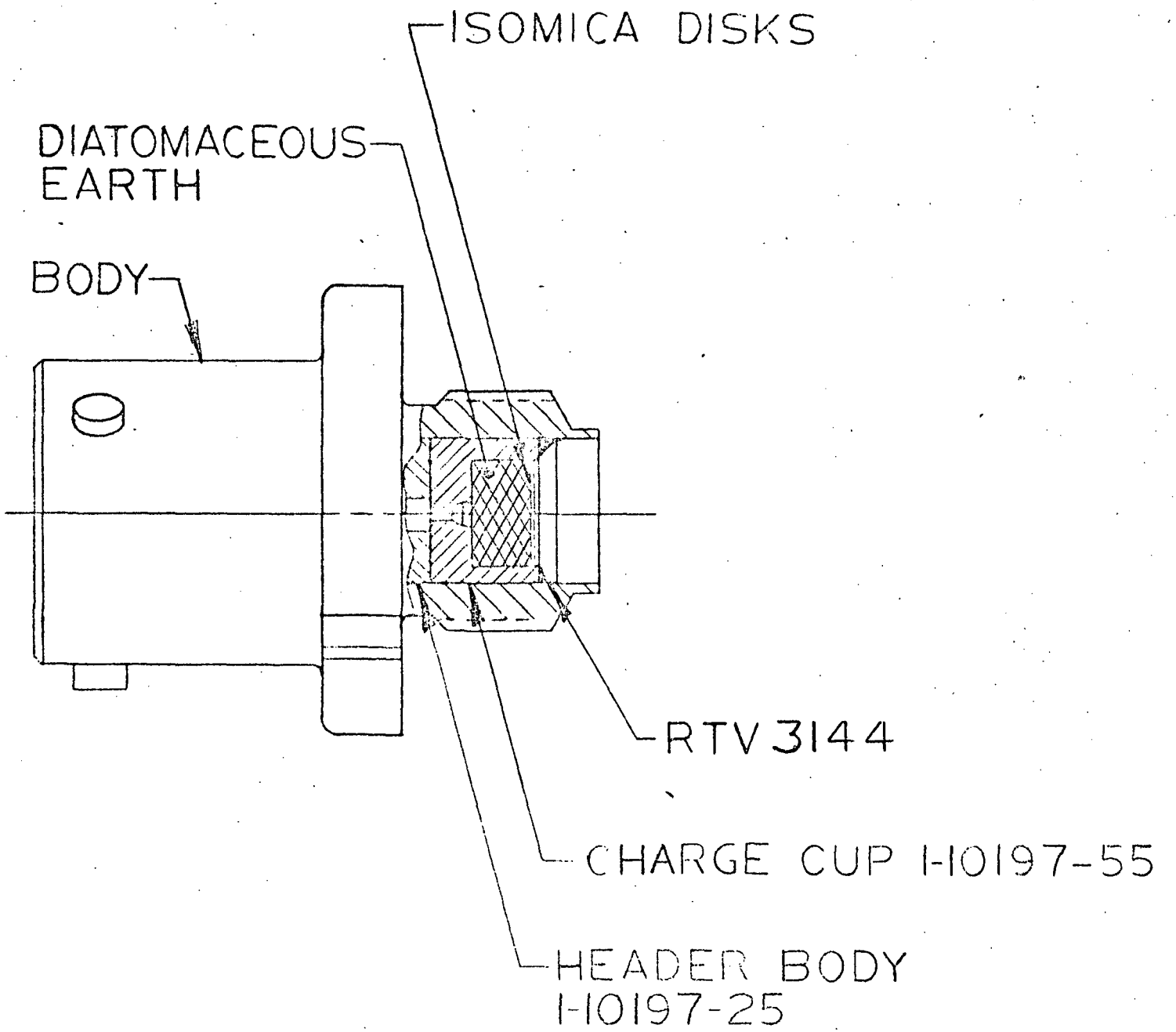

ISOMICA DISKS
DIATOMACEOUS EARTH
BODY
RTV 3144
CHARGE CUP I-10197-55
HEADER BODY I-10197-25

FIGURE 4

into a fillet. The material is somewhat sticky and extremely thixotropic (it will not flow and can be mounded and peaked).

According to the manufacturer's recommendations, curing of an .025 inch thickness requires at least 24 hours of exposure to air with 30% relative humidity. optimum properties are developed after seven days. Because the cure requires air contact, the cartridge cannot be closed until the desired degree of curing has been achieved.

5.5 Loaded Assemblies

The loaded assemblies as outlined in Table I and on Drawing 113063 were assembled using the same basic techniques used on the subassemblies.

Assembly procedures were developed by modifying the standard SBASI AI (Assembly Instructions). A production engineer supervised the assembly operations to assess the feasibility of incorporating candidate materials into normal production.

6.0 Test Sequence

6.1 Subassemblies

Subassemblies Figure 1 thru 4 and the 5 units containing only connector potting were subjected to the following sequence of tests as specified by an EWOL (Engineering Work Order Log):

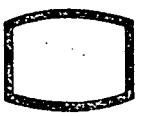
1. Examination of units to verify satisfactory appearance of epoxy joints.
2. Insulation resistance check (connector potting units only).
3. Thermal shock 1 hr. at -260°F followed by 1 hr. at +300°F - total of 3 complete cycles.
4. Insulation resistance check (connector potting units only).
5. Bond Strength Test.
   a. For subassemblies per figures 1 and 2, the strength was tested by securing the header body in a V block and applying a shear load to the joint by pushing on the ceramic. Force required to shear the bond was monitored on a Dillon force gage.

b. For subassemblies per figures 3 and 4, bond strength was determined by monitoring the load required to push the ceramic out of the body.

6.2 Loaded Assemblies

The twenty complete cartridges defined by drawing 113063 (5 each of -1, -2, -3 & -4) were subjected to the following tests:

1. Insulation resistance at 500 VDC
2. Bridgewire resistance
3. Electrostatic discharge pins to case 25 KV from a 500 Pico Farad capacitor thru a 500 Ohm resistor.
4. Thermal shock, -260°F for 1 hour followed by + 300°F for 1 hour - total of 3 cycles.
5. Bridgewire resistance.
6. Insulation resistance at 500 VDC.
7. Fire in 10 CC bomb by the application of 5 Amp. Record current VS time and pressure VS time.



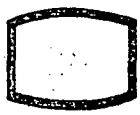
7.0 Test Results

7.1 Subassemblies per Figures 1 and 2.

Bond strengths of Scotchweld 584 and Loktac Y 9169 were as follows:

Material	Shear Load in Pounds
584	8
584	9
584	10
584	5
584	2
Y9169	25
Y9169	30
Y9169	15
Y9169	19
Y9169	28

The test data sheet also indicates that a certain amount of separation of the 584 joint was observed after thermal shock whereas the Y9169 appeared unchanged.



7.2 Subassemblies per Figures 3 and 4.

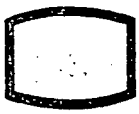
The bond strengths of F502 and RTV 3144 were as follows:

Material	Load in Pounds
F502	28
F502	25
F502	10
F502	15
F502	31
RTV 3144	0
RTV 3144	0
RTV 3144	0
RTV 3144	0
RTV 3144	0

During testing it was observed that the RTV 3144 appeared to separate from the sidewall of the body at +300°F, but there was no noticeable affect at -260°F. The RTV 3144 data sheet recommends roughening of the surface to be bonded and specifies use of a primer for maximum bond strength. It is apparent that satisfactory bonding to a clean, smooth Inconel surface is not practical.

7.3 Loaded Assemblies

Reference to the data sheet in Appendix B indicates no significant change in either insulation resistance or bridgewire resistance as a result of thermal shock. All units checked out basically the same as standard SBASI's. Peak pressures were not as consistent as with flight quality hardware but this can be considered typical for short-run prototype assemblies. S/N's 19 and 20 (584/RTV 3144 combination) indicated rather low pressures, (580 avg. and 575 avg.). Since it is difficult to control the amount of RTV installed in one unit as compared to another it is likely that the pressure output will vary accordingly. A performance deficiency was observed when firing S/N's 16 and 17 (both 584/3144 combinations). The time between bridgewire burnout and initial pressure was 1.2 ms for 16 and 1.1 ms for 17. The current vs time trace shows that the current due to ionization was also delayed indicating that the problem was at the prime interface rather than farther downstream.



Within the scope of this program it is not possible to research this area sufficiently to obtain a definitive cause and effect relationship. The fact that the 584 and 3144 materials both exhibited relatively low bond strengths suggests that the charge cup may have moved and disturbed the bridgewire/prime interface but this is just one of many possibilities.

8.0 Summary

Although the Y9169 material exhibited superior mechanical and chemical properties, it had a detrimental effect on producibility because of the tackiness. The 3M Company informed us that the material is available only in the tacky condition because this is an asset in most applications. They also reported that the tackiness decreases with age and/or high temperature (+ 150^{o}F) storage but bonding properties remain essentially the same. In a meeting at NASA on September 9, 1971, SOS obtained a three year old roll of Y9169 which was essentially tack-free. This material was fabricated into subassemblies per Figure 2, and the bond strength test was repeated. Shear values of 75 lbs., 40 lbs., 30 lbs., and 80 lbs. were obtained. These values actually exceed those obtained with the fresh material. The evaluation of Y9169 as discussed in Paragraph 5.2 therefore must be qualified; i.e., the tacky material is very difficult to handle but the aged material is quite satisfactory.

The following matrix, Table II, summarizes the characteristics of the candidate materials relative to use in the SBASI. A discussion of the results, along with recommendations, follows the table.

MATERIAL	PERFORMANCE APPRAISAL	EFFECT ON PRODUCIBILITY
EPON 828/Z	Electrical and structural characteristics equivalent to existing material (E787). No detrimental effects observed. The material is, however, more brittle than E 787.	Positive effect on producibility based on longer pot life and easier mixing and handling.
SCOTCHWELD 584 584	Bond strength following thermal shock is inferior to Y9169.	Negative effect on producibility because of difficulty in manufacture and handling of disks.
LOKTAC Y9169	Bond strength good following thermal shock - superior to # 584.	Very negative effect on producibility because of adhesion and lack of structural integrity. Can be used only with revision to manufacturing procedures.*
F502	Bond strength and electrical isolation properties good following thermal shock	Positive effect on producibility because of stability at room temperature.
RTV 3144	Bond strength unacceptable	Very negative effect on producibility because of hand work involved in application.

*NOTE: Aged Y9169 becomes tack free and has good handling characteristics similar to #588 tape.

TABLE II

Recommendations:

At the connector shell interface, EPON 828 with curing agent Z is a good candidate for a replacement material. SOS feels that there is no reason not to use EPON 828 in the 200 deliverable items.

At the charge cup/header interface, Y9169 was found superior to 584 in all respects except producibility and handling. Both materials are much more difficult to manufacture and handle than the existing material, Scotchweld 588. For the 200 deliverable items, SOS would have to recommend either remaining with 588 or aged Y9169.

Over the output charge, RTV 3144 was found unsatisfactory and is not recommended. F502 was found to be a good candidate and can be recommended for use in the 200 deliverable units.

Configuration of 200 deliverable items:

(SOS/NASA joint decision)

CONNECTOR SHELL: 828/Z

BONDING TAPE: half with 588, half with Y9169

INSULATING WASHER: F502

APPENDIX A

Epoxy Data Sheets

SHELL

PLASTICS AND
RESINS
DIVISION

APPLICATION
INFORMATION

EPON® RESIN SYSTEM NO. SP-24-C

EPON RESIN CURING AGENT Z

EPON Resin Curing Agent Z is used in casting applications where excellent chemical resistance, high heat distortion temperature and good electrical properties under conditions of high moisture are desired. A liquid of approximately 20 poise viscosity, this curing agent may be blended readily with the liquid EPON Resins at room temperature.

The curing agent is quite stable, samples having shown no change in curing characteristics after storage of one year at 77°F. At room temperature Curing Agent Z is essentially a supercooled liquid and as such may occasionally crystallize. Material which has crystallized, however, can easily be reconstituted by heating at 120°F. Reconstitution has not been found to affect the curing properties or stability of EPON Resin Curing Agent Z.

This curing agent offers a method for obtaining the excellent properties afforded by the aromatic type amine curing agents in castings applications without the inconvenience of hot melt operations. In making filled castings, e.g., for plastic tooling or electrical use, Curing Agent Z catalyzed resin mixtures exhibit longer pot lives than mixtures employing solid aromatic amine curing agents. This is because the mass of filled resin does not have to be preheated as would be the case if a solid aromatic amine were used. In tooling applications, EPON Resin Curing Agent Z has the added advantage of offering a means for controlled cure of large masses of heavily filled resin. Although such controlled cures are also possible through use of slow-acting tertiary amines and aliphatic polyamines, the products obtained do not have the strength at elevated temperatures characteristic of EPON Resin-Curing Agent Z systems.

APPLICATION

The optimum concentration of EPON Resin Curing Agent Z for most casting applications is 20 phr. Heat is normally required during the curing process. The optimum curing cycles for castings based on this EPON Resin system will vary considerably with the application.

SC: 60-302.6

Small castings based on EPON 828 and 820 can be cured satisfactorily in two hours at 80°C. (175°F.), followed by a post cure of two hours at 150°C. (300°F.). Large castings, however, should be allowed to gel at room temperature, before heating. If the casting is sufficiently large, it may not require oven curing, since the heat evolved during cure may be sufficient to provide complete curing of the casting. Where optimum heat distortion point is less important than high mechanical strengths, e. g., in plastic tooling, a satisfactory cure cycle is 12 hours heating at 65°C. (150°F.).

In some applications, it may be desirable to allow samples of the catalyzed resin to harden at room temperature before further curing, resulting in the formation of a "B-stage" or partially cured resin. If this "B-stage" resin is heated rapidly to a temperature of about 175°F., it will melt and remain fluid for a short period of time prior to transition to the final cured condition. This fluid stage can be eliminated, if desired, by heating the "B-stage" material at 60°C. for 2-3 hours and subsequently increasing the temperature slowly to the final post cure temperature of 150°C. (300°F.). The advantage of step-wise cure, through the "B-stage" as previously described, is that exothermic heating can be more easily controlled in this manner.

RESIN PROPERTIES

The properties of catalyzed EPON Resin mixtures containing EPON Curing Agent Z before curing and as cured castings are summarized below. These tables are based on laboratory data obtained with EPON 828, the resin offering the ultimate in strength and heat resistance with this curing agent. Somewhat poorer over-all properties are obtained with EPON 820 or 815. These resins, for example, show lower values in the ASTM test of heat distortion temperatures. Typical comparative values for castings based on EPON 828, EPON 820, and EPON 815, all cured with EPON Curing Agent Z (at curing agent concentrations of 20 phr) are 145°C., 138°C. and 105°C., respectively.

As is the case for most curing agents used with EPON Resins, efficient curing with EPON Curing Agent Z can be obtained over a wide range of time-temperature relations without significant differences appearing in final properties. Figure 1, which shows the curing curves for several EPON 828 castings, illustrates this property. As can be seen, although curing rate increases as curing temperature is raised, the final properties as measured by heat distortion point are the same throughout the 125°C.-200°C. curing range when all specimens have been fully cured. Expressed in another fashion, it may be said that a cured resin specimen having a heat distortion point of 145°C. can be obtained after post cures of four hours at 125°C., two hours at 150°C. or one hour at 200°C.

Table I

TYPICAL PROPERTIES OF
THE EPON 828-CURING AGENT Z SYSTEM[1]

PROPERTIES OF CATALYZED RESIN MIXTURE (BEFORE CURE)	
Viscosity at 25°C. (77°F.)	8000-9000 cps.
Pot Life, 1 gallon, at 45°C. (115°F.)	about 3 hours
Pot Life, 1 quart, at 25°C. (77°F.)	about 8 hours
PROPERTIES OF CASTINGS CURED FOR 2 HOURS AT 80°C. (175°F.) AND POST CURED FOR 2 HOURS AT 150°C. (300°F.)	
Density	1.20
Hardness, Rockwell	M105-M110
Coeff. of Thermal Expansion, Linear (between -50°C. and + 50°C.)	5.1×10^{-5} per °C.
Impact Strength, Notched Izod	0.5 ft.-lb./in of notch
Heat Distortion Point	145°C. (293°F.)
Weight Change after 24 hours in Boiling H_2O	+ 0.67%
after 24-hour Re-dry at 110°C.	+ 0.06%
Electrical Insulation Resistance	-
Original at 95°F. and 95% Rel. Humidity	3×10^{12} ohms
After 100 hours at 95°F. and 95% Rel. Humidity	5×10^{9} ohms

[1] *20 phr of curing agent used in all cases.*

Table II

TYPICAL STRENGTH PROPERTIES OF EPON 828-CURING AGENT Z CASTINGS[1]

TEST TEMPERATURE	ULTIMATE STRENGTH PSI	YIELD STRENGTH AT 0.2% OFFSET PSI	MODULUS PSI	% ELONGATION AT YIELD	% ELONGATION AT ULTIMATE
COMPRESSIVE TEST VALUES					
25°C. (77°F.)	19,000	10,500	4.6×10^5	2.6	8.7
50°C. (122°F.)	15,000	10,000	4.1×10^5	3.2	7.4
75°C. (167°F.)	12,500	8,500	3.6×10^5	3.1	7.4
TENSILE TEST VALUES				% ELONGATION AT YIELD	% ELONGATION AT ULTIMATE
25°C. (77°F.)	13,000	8,000	3.6×10^5	2.2	4.8
50°C. (122°F.)	10,500	7,500	3.5×10^5	2.2	4.2
75°C. (167°F.)	9,000	6,500	3.2×10^5	2.3	4.5
100°C. (212°F.)	6,500	5,000	3.1×10^5	1.8	5.5

[1] *Unfilled castings, incorporation 20 phr of curing agent and cured for one hour at 90°C. (194°F.) plus 2 hours at 175°C. (347°F.).*

Table III

EFFECT OF CURING AGENT Z CONCENTRATION ON THE HEAT DISTORTION TEMPERATURE OF EPON 828 CASTINGS
(Cure Cycle: 2 Hours at 80°C. plus 1 Hour at 200°C.)

CURING AGENT Z CONCENTRATION (PHR)	HEAT DISTORTION TEMPERATURE (°C.)
18	142
19	147
20	149
21	147
22	141
23	137

Table IV

EFFECT OF POST CURE ON THE HEAT DISTORTION TEMPERATURE OF EPON 828/20 PHR CURING AGENT Z CASTINGS
(Cure Cycle: 2 Hours at 80°C. Prior to Post Cure)

POST CURE		HEAT DISTORTION TEMPERATURE
HOURS	°C.	(°C.)
5	100	120
8	100	122
12	100	124
24	100	127
1	150	142
2	150	147
3	150	148
5	150	152
8	150	152
12	150	156
24	150	156
2	200	146
4	200	147
8	200	148
24	200	144

FIGURE 1

EFFECT OF POST CURE TEMPERATURE AND TIME ON HEAT DISTORTION POINT FOR EPON 828-CURING AGENT Z CASTINGS

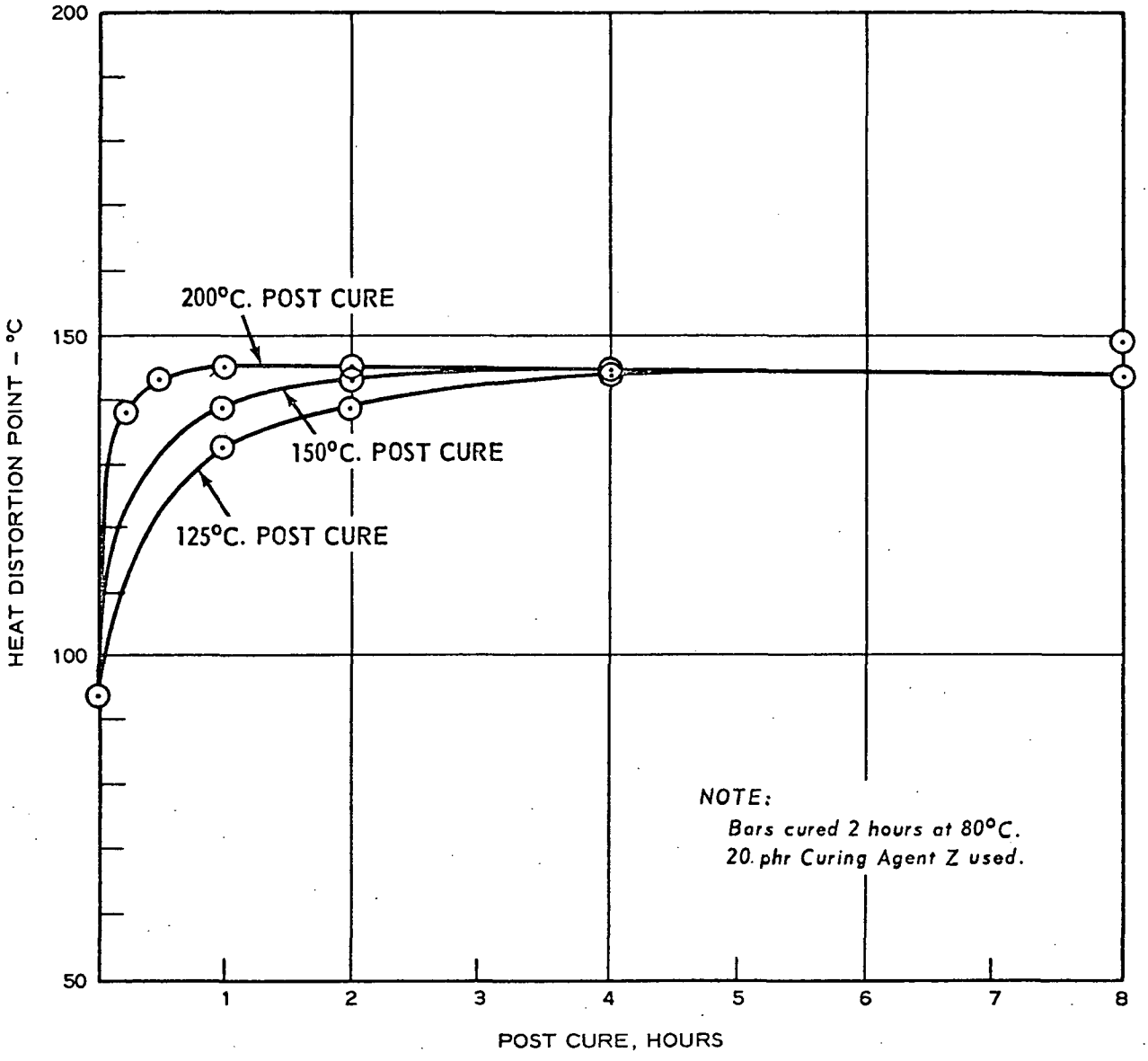


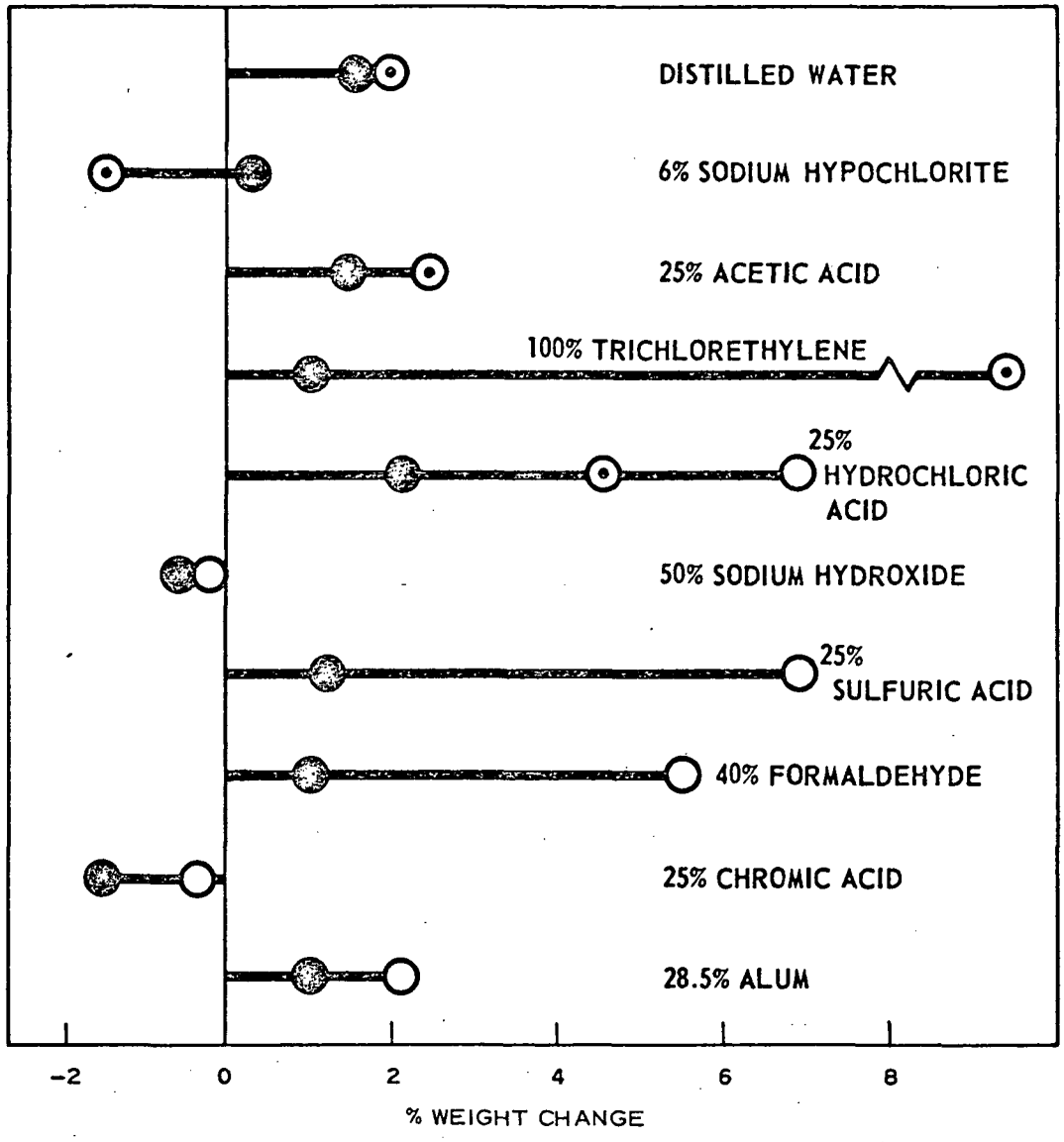
Table V

CHEMICAL RESISTANCE OF UNFILLED EPON 828/20 PHR CURING AGENT Z CASTINGS 180-DAY IMMERSION

CHEMICALS	APPEARANCE CHANGES		CHANGE IN FLEXURAL STRENGTH (PSI)	
	SOLUTION	SPECIMENS	ORIGINAL	AFTER 180 DAYS IMMERSION
	- 75°F. IMMERSION -			
50% Sodium Hydroxide	No Change	No Change		
25% Sulfuric Acid	No Change	Greenish & Some Slight Darkening		
25% Hydrochloric Acid	No Change	Greenish & Some Slight Darkening		
25% Acetic Acid	No Change	No Change		
100% Trichloroethylene	No Change	Slightly Greenish		
40% Formaldehyde	No Change	No Change		
6% Sodium Hypochlorite	No Change	Slight Chalking		
25% Chromic Acid	No Change	Slight Surface Whitening		
Distilled Water	No Change	No Change		
28.5% Sod. Al. Sulfate	No Change	Slight Whitening		
	- 130°F. IMMERSION -			
25% Hydrochloric Acid	No Change	Greenish in Color	20,200	19,700
25% Acetic Acid	No Change	No Change	20,200	18,600
100% Trichloroethylene	No Change	Greenish in Color	20,200	12,900
6% Sodium Hypochlorite	No Change	Considerable Chalking	20,200	18,400
Distilled Water	No Change	No Change	20,200	18,100
	- 180°F. IMMERSION -			
50% Sodium Hydroxide	No Change	Slight Surface Dulling	20,200	20,900
25% Sulfuric Acid	No Change	Greenish & Some Slight Darkening	20,200	11,300
25% Hydrochloric Acid	No Change	Greenish & Some Slight Darkening	20,200	12,000
40% Formaldehyde	No Change	Edges Slightly Swollen	20,200	13,800
25% Chromic Acid	No Change	Dulling & Chalking	20,200	18,800
28.5% Sod. Al. Sulfate	No Change	Slight Surface Dulling	20,200	19,500

FIGURE 2

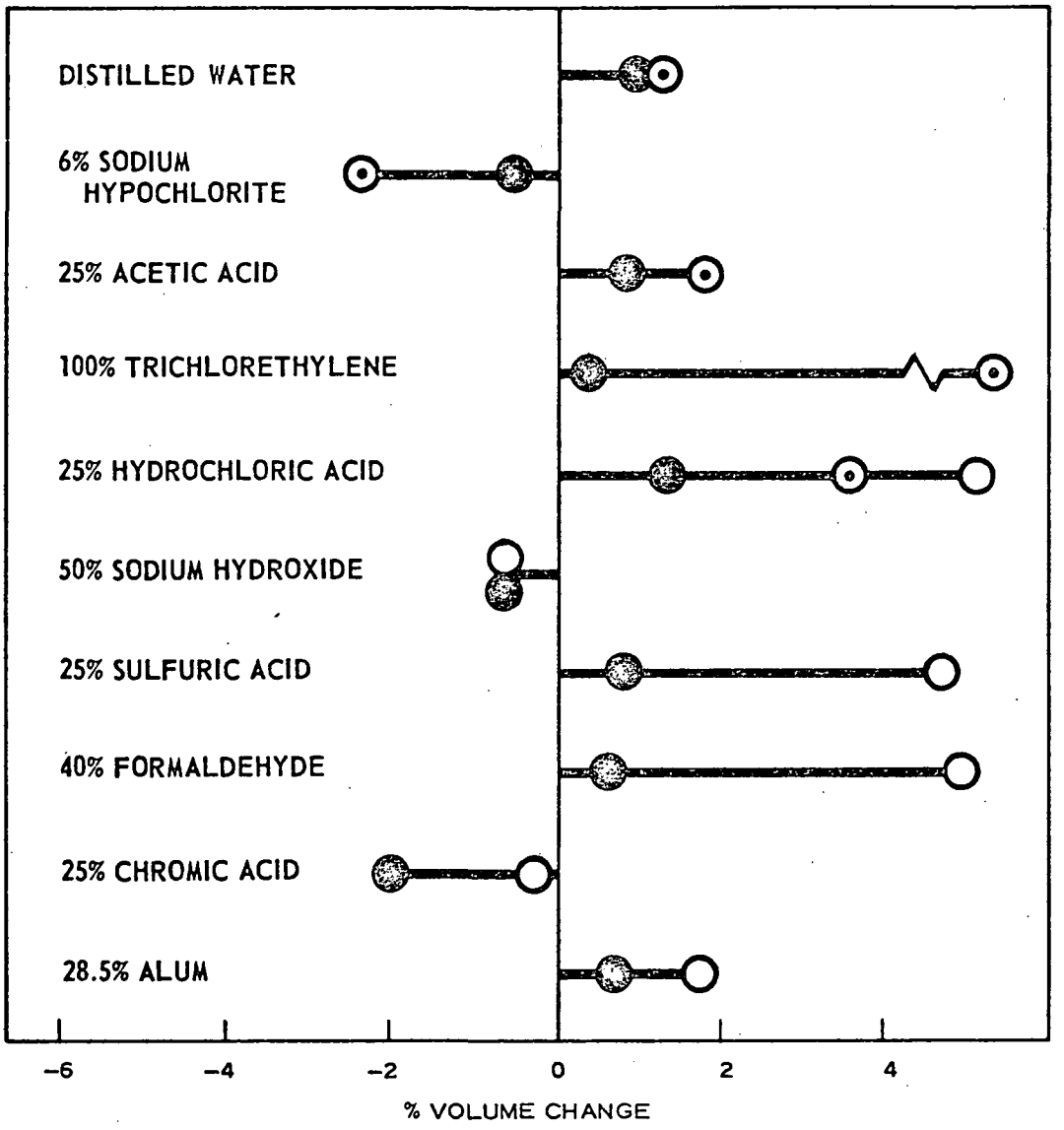
% WEIGHT CHANGE OF UNFILLED EPON 828/CURING AGENT Z CASTINGS AFTER 180 DAY IMMERSION



IMMERSION TEMPERATURE	
75°F.	●
130°F.	⊙
180°F.	○

FIGURE 3

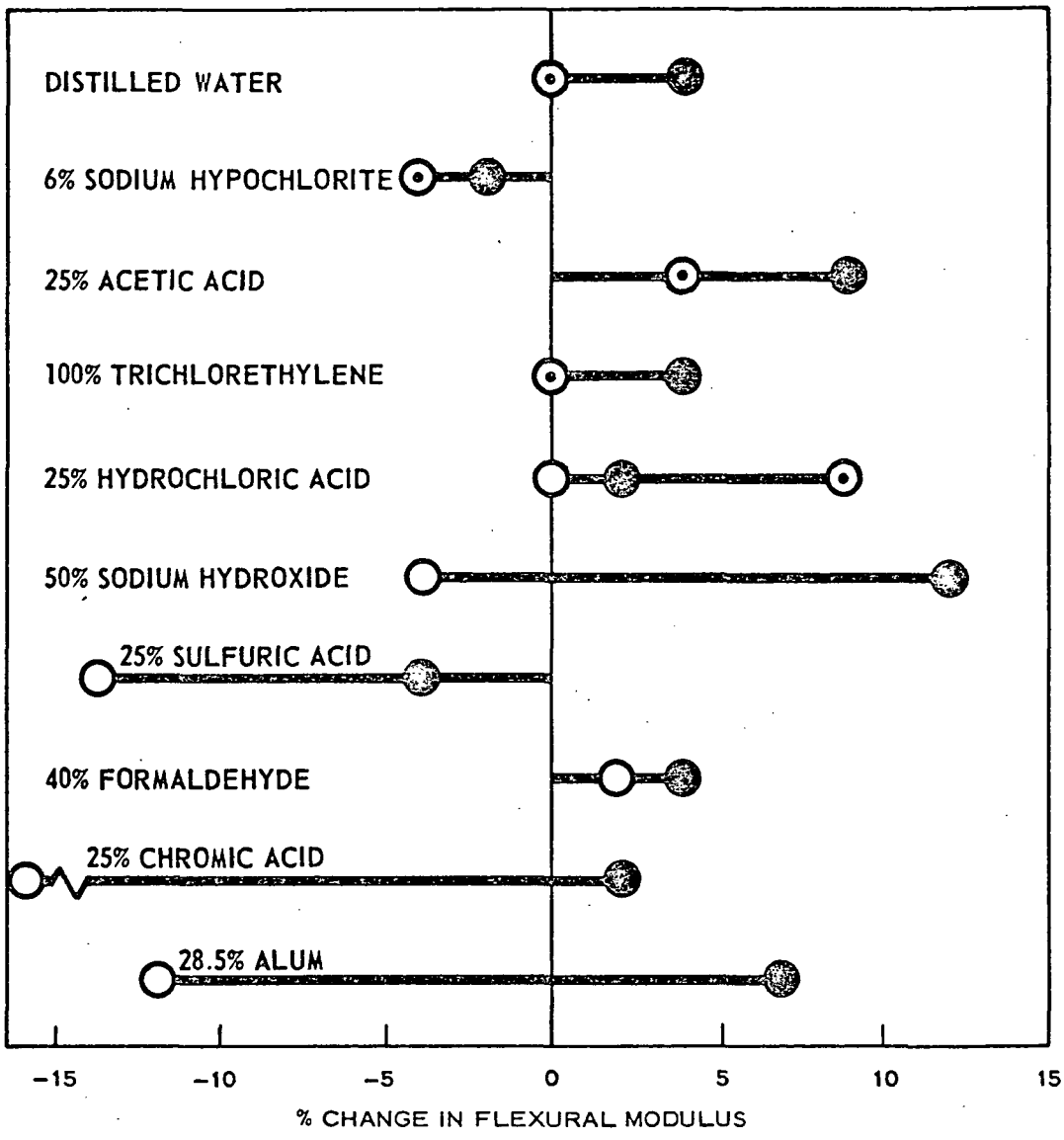
% VOLUME CHANGE OF UNFILLED EPON 828/CURING AGENT Z CASTINGS AFTER 180 DAY IMMERSION



IMMERSION TEMPERATURE	
75°F.	●
130°F.	⊙
180°F.	○

FIGURE 4

% CHANGE IN FLEXURAL MODULUS OF UNFILLED EPON 828/CURING AGENT Z CASTINGS AFTER 180 DAY IMMERSION



IMMERSION TEMPERATURE	
75°F.	●
130°F.	⊙
180°F.	○

Scotch-Weld®
BRAND

BONDING TAPES

technical DATA for industry

NO. 583 BONDING TAPE FOR THE NAMEPLATE INDUSTRY
NO. 584 BONDING TAPE FOR GENERAL HIGH STRENGTH BONDS
NO. 588 BONDING TAPE (6 MIL) FOR GENERAL HIGH STRENGTH BONDS

DESCRIPTION:

"SCOTCH-WELD" Bonding Tapes #583 and #584 are flexible, 100% solids, heat or solvent activated dry film adhesives composed of synthetic elastomers and various thermoplastic and thermosetting resins; #588 is identical except that it is composed of synthetic elastomers and various high strength thermosetting resins. These films soften and flow when either heat or solvents are applied, and provide a strong, permanent bond to the surfaces to which they are applied. #583 is specially formulated for the Nameplate Industry where its special formulation allows it to be easily heat laminated and die-cut sharply by equipment peculiar to that industry. It also has special solvent activation properties for increased bond strength and resistance to peel and picking. #584 and #588 are specially formulated for higher internal strength that enables them to be removed from the liner unsupported. This special property makes #584 especially suitable for various splicing and general purpose applications; similarly, this property --plus the high caliper of its adhesive --makes #588 especially suitable for various splicing and general purpose bonding of irregular and porous surfaces. In the case of solvent activation, bond strength for all three tapes increases as the solvent evaporates. Likewise, for heat activation, bond strength increases as the film cures (or sets) with continued application of heat and pressure. Heat activation, too, is recommended over solvent activation for high strength bonds or when bond strength is required shortly after application. The resultant bonds are strong (extremely so for #583), flexible and shock resistant, and have excellent resistance to solvents, temperature and deteriorating aging effects.

AVG. PHYSICAL PROPERTIES: (FED. STD. 147) *Not recommended for specification purposes.*

	#583	#584	#588
Film Composition:	Synthetic Elastomer Thermosetting Resin Thermoplastic Resin	Synthetic Elastomer Thermosetting Resin Thermoplastic Resin	Synthetic Elastomer Thermosetting Resin
Film Color:			
(Uncured)	Dark Brown	Dark Brown	Yellow
(Cured)	Dark Brown	Dark Brown	Deep Tan
Film Caliper:	.002	.002	.006
Liner:			
Paper	Treated Fiber	Treated Fiber	Treated Fiber
Color	Light Blue	Light Blue	Light Blue
Maximum Width:	48 inches	48 inches	20 inches
Minimum Width:	¼ inch	¼ inch	¼ inch
Heat Activation:			
Temperature	200 - 400°F.	200 - 400°F.	225 - 400°F.
Pressure	25 - 200 psi	25 - 200 psi	25 - 200 psi
Time	5 - 30 min.	5 - 30 min.	15 - 30 min.
Shear Strength	600 - 2200 psi	600 - 2200 psi	800 - 2600 psi
Solvent Activation:	Ketones (MEK)	Ketones (MEK)	Ketones (MEK)
Peel Strength	14 lbs./sq. in.	14 lbs./sq. in.	14 lbs./sq. in.

APPLICATION METHODS (all three tapes):

The following are the most generally used methods of application:

1. Solvent activation and wet lamination.
2. Hand activation with an ordinary household flat-iron.
3. Oven curing in spring loaded jigs.
4. Heated platen press curing.

NOTE: Pre-lamination to most surfaces can be accomplished with all three tapes by applying them with 200° F. heat or a minimum of MEK solvent. Dielectric heating and R.F. Currents can also be used if equipment is available and the application is appropriate to these methods.

PREPARATION OF SURFACES PRIOR TO BONDING:

Metal surfaces should be cleaned so that they will sustain a continuous water film. Grease, oil, etc., must be removed. For degreasing, a combination of 10 parts concentrated sulfuric acid, 1 part sodium dichromate, and 30 parts water at 140-160°F. for 10 minutes has proven most suitable for high strength metal-to-metal bonds and is recommended wherever possible. Where an acid bath is not practical, a solvent degreaser such as TCE (trichloroethylene) should be used. Ketones or other volatile solvents are also suitable for cleaning certain surfaces where bond strength is less critical.

ADHESIVE BONDING PROPERTIES (Conditions must exist at glue line):

Typical values for adhesive bonds cured between heated platens are listed below. All bonds were made with cleaned ST-24.064 inch alunimum panels and tested at room temperature.

#583 & #584				#588			
TEMP. (°F.)	PRESS (PSI)	TIME (MIN.)	SHEAR TENSILE (PSI AVERAGE)	TEMP. (°F.)	PRESS (PSI)	TIME (MIN.)	SHEAR TENSILE (PSI AVERAGE)
200	150	30	600	225	150	30	800
250	150	30	950	250	150	30	1400
300	150	30	2000	300	150	30	2200
325	150	30	2200	330	150	30	2600
325	50	30	1500	375	150	30	2200
325	50	30	1900	325	25	30	1000
325	200	10	1000	325	50	30	1500
325	200	20	1400	325	100	30	2400
325	200	30	1900	325	150	30	2600
				325	215	15	1600
				325	215	30	2600

The above specific conditions result in a maximum strength bond for that temperature. Since approximately 90% of the maximum strength is obtained within the first 75% of the recommended time, the bonding cycle can be shortened 25% without a great loss in bond strength. Also, please keep in mind that in many applications maximum strength may not be necessary and, therefore, shorter time can be used.

The following general statements can be made concerning the bonding requirements.

1. For high strength bonds, the pressure used must exceed the steam pressure of water at the bonding temperature. A 50% pressure safety factor is recommended.
2. An excessively high pressure is not detrimental unless the adhesive is being squeezed out from between the parts to be bonded.
3. The higher the temperature and pressure, the shorter the time required to reach maximum strength.

SOLUBILITY DATA (Applies to all films unless noted):

	UNCURED FILM	CURED FILM
Ketones *:	Yes	Soften on soaking
Aliphatic Hydrocarbons: (Gasoline, Oil, etc.)	No	No
Aromatic Hydrocarbons: (Benzol, Toluol, etc.)	Swells	No
Clorinated Hydrocarbons: (Carbon Tetrachloride, Trichlorethylene, etc.)	#583 & #584 -- Yes	No
	#588 -- Swells	No
Alcohols:	Swells	No
Ether:	#583 - #584 -- Yes	No
	#588 -- Swells	No
Water:	#583 - #584 -- No	--
	#588 -- Swells	--

* **MEK** (Methyl-ethyl-ketone) is most generally used for solvent activation.

CURED FILM RESISTANCE TO:

	#583	#584	#588
Heat:			
(Below curing temp.)	Fair - Good	Fair - Good	Good
(Above curing temp.)	Fair	Fair	Fair
Shear Stress:	Good	Good	Excellent
Shock:	Excellent	Excellent	Excellent
Flexing:	Excellent	Excellent	Good

RECOMMENDED APPLICATIONS:

Tape #583 is specially formulated for use in production and application of nameplates. Its formulation allows it to be heat laminated and die-cut into individual nameplates. #583's superior solvent activation properties allow easy application with optimum bond strength.

Tape #584 is a very versatile bonding film used in a variety of applications. It is widely used for plate mounting in printing, splicing paper, cloth, nylon and for general industrial laminations of wood, metal, vinyls, and plastics. It is frequently desirable for iron-on applications where the low temperature, quick-flow thermoplastic properties of the film are utilized.

Tape #588's largest use is in the bonding of friction surfaces to metal back-up plates such as brake linings and clutch facings. It is especially suitable for such applications where the comparatively thick, easily activated film provides good flow and contact with the rough porous friction material surface. Other large #588 uses are cloth and paper splicing, metal to metal bonding and general lamination of various materials to each other.

BONDING TAPE RESTRICTIONS:

Due to the characteristics of the following surfaces, bonding tapes will not adhere strongly to:

1. "Teflon"
2. Silicones
3. Crude rubber, neoprene, and synthetic Buna-S rubbers. (Good results, however, have been obtained with certain Buna-N rubbers.)

NOTE: Copper and copper-bearing metals react unfavorably with #588 because of a chemical reaction which hinders bond formation. Only #584 should be used when bonding to copper surfaces.

USES:

#583	#584	#588
Nameplates.	Paper splicing - all types. Carpet identification labels. Mounting printing plates. Bonding movie screens to metal rollers. Laminating asbestos to aluminum. Honeycomb construction. Bonding electrotypes to aluminum base. Bonding honing stones to metal holders. Holding wood tape to plywood edge.	Bonding Formica to metal components. Splicing of textile fabrics. Laminating clutch facing plates and brake surfaces. Miscellaneous high strength bonding of irregular and porous surfaces.

SPECIFICATIONS:

#583 meets MIL-P-19834A, Type II, for metal label uses.

#583 also meets MIL-P-6906, Amendment 1.

#588 meets MIL-P-19834A, Type II, for metal label uses.

Industrial Tape Division 3M COMPANY

P-PDF-9R(40.5)R

LITHO IN U.S.A.

SANTA ANA, CALIF., P.O. BOX 2187, PHONE 549-1101 • STAMFORD, CONN., P.O. BOX 546, DAVIS 47545 • UTRECHT, HOLLAND

DESCRIPTION

F-502 is a MIL-R-9299 phenolic resin suitable for preimpregnation on any MIL-C-9084 glass fabric having Volan or A1100 finish.

PREPREG SPECIFICATIONS	TYPICAL PROPERTIES	TEST METHODS
Resin Solids (Burnoff)	40 ± 3%	QC PTM-11
Volatiles (9 min. @ 320°F)	7% Maximum	QC PTM-17
Roll Lengths	100 yds.	

LAMINATED PROPERTIES

Properties obtained when using 181 glass fabric, curing as below and testing per FTMS 406:

100 psi @ 300-320°F for 60 minutes for 1/8" laminate

	TYPICAL PROPERTIES (ROOM TEMPERATURE)	TYPICAL PROPERTIES (500°F)*
Tensile Strength, psi	60,000	50,000
Tensile Modulus, psi	3.5×10^6	3.0×10^6
Compressive Strength, psi	65,000	38,000
Compressive Modulus, psi	3.3×10^6	2.9×10^6
Flexural Strength, psi	80,000	58,000
Flexural Modulus, psi	3.7×10^6	3.5×10^6
Specific Gravity, gms/cc	1.82	
Hardness (Barcol)	75	

*After 30 minutes @ 500°F.

PACKAGING AND STORAGE

F-502 is packaged in sealed polyethylene bags in fiber cartons. Storage should be in a cool dry atmosphere, preferably @ 70°F.

NOTE: All data given, statements and recommendations reported in regard to this product are based upon our research under controlled conditions and are believed to be accurate. However, seller makes no warranty of any kind concerning the use of this product.

Information about Electrical/Electronic Materials

DOW CORNING

DOW CORNING® 3144 AND 3145 RTV ADHESIVE/SEALANTS

Type ..... One-part vulcanizing silicone rubbers
Physical Form ..... Non-slumping pastes
Cure ..... React with water vapor in the air to cure at room temperature
Special Properties ..... No corrosive by-products; high strength
Primary Uses ..... Sealing and bonding in corrosive-sensitive electronic and electrical applications
Color ..... Dow Corning 3144 RTV adhesive/sealant is translucent
Dow Corning 3145 RTV adhesive/sealant is grey

DESCRIPTION

Dow Corning 3144 and 3145 RTV adhesive/sealants utilize a cross-linking mechanism which produces no exothermic heat and no acetic acid or other corrosive by-products during cure. As a result, these adhesive/sealants can be used in corrosion sensitive electrical and/or electronic equipment with no adverse effect.

Supplied ready-to-use, these adhesive/sealants require no mixing, heating, or solvents. Because these adhesive/sealants will not sag or run off, they may be applied overhead or on sidewall joints and surfaces. They will adhere to glass, ceramics, metals, silicone rubber, and most plastics. These adhesive/sealants are easy to restore by just cutting away old material and reapplying fresh material.

These one-component, room-temperature vulcanizing silicone rubber materials have high tear strength and toughness; resistance to moisture, corona, ozone, and weathering; good dielectric properties over a wide temperature range; and heat stability. Both will withstand long term exposure at 250 C (482 F). Dow Corning 3144 RTV adhesive/sealant remains rubbery from −65 C (−85 F) to 250 C (482 F); Dow Corning 3145 RTV adhesive/sealant, from −65 C to 300 C (572 F).

USES

Typical uses include sealing and enclosing; bonding wires and terminals; mounting resistors, connectors, and other components; repairing or splicing cables and lead wires; repairing RTV silicone rubber encapsulation.

HOW TO USE

Applying the Material:

Tack-Free Time

Dow Corning 3144 and 3145 RTV adhesive/sealants have a paste-like consistency and can be applied directly from collapsible tubes or cartridges. They cure at room temperature with at least 30 percent relative humidity, by reacting with moisture in the air. In about two hours, a tack-free skin will form.

Cure Time

Curing proceeds inward from the surface at a rate depending upon the relative humidity, the degree of confinement, and the thickness of the adhesive/sealant. Too little moisture or too thick an application

TYPICAL PROPERTIES

These values are not intended for use in preparing specifications

Physical Properties

(After 5 days at room temperature)

	Dow Corning 3144 RTV Adhesive/Sealant	*Dow Corning 3145 RTV Adhesive/Sealant*
Color	Translucent	Grey
Specific Gravity	1.12	1.12
ASTM D 676 Durometer Hardness, Shore A	30	33
ASTM D 412 Tensile Strength, psi	600	700
ASTM D 412 Elongation, percent	675	675
ASTM D 624 Tear Strength, Die B, ppi	125	125
Peel Strength, from primed aluminum panel, ppi (¼ inch by 0.012 primed strip of steel screen)	65	65
Thermal Conductivity 24 to 100 C (75.2 to 212 F), cal per [(cm) (degrees C) (sec)]	--	4.03×10^{-4}
Volume Expansion, 25 to 100 C (77 to 212 F), cc/cc per degree C	--	7.8×10^{-4}
Corrosion Resistance	Excellent	Excellent

TYPICAL PROPERTIES *(continued)*

Electrical Properties

(After 5 days at room temperature)

ASTM D 495 Arc Resistance, seconds ..	50	50
ASTM D 149 Electric Strength, volts/mil	500	600
ASTM D 257 Volume Resistivity, ohm-cm	5.0×10^{14}	5.0×10^{14}
ASTM D 150 Dielectric Constant at 25 C (77 F), 100 Hz	2.85	2.81
100 KHz	2.83	2.78
ASTM D 150 Dissipation Factor at 25 C (77 F), 100 Hz	0.0015	0.0015
100 KHz	0.0013	0.0028

Application Properties

Extrusion Rate (⅛-inch nozzle at 90 psi), grams per minute	120	120
Consistency	Non-slumping	Non-slumping
Skin-Over Time, minutes	25	25
Tack-Free Time, hours	1½	1½
Cure Time, 25 mils, hours	24	24
Cure Time, ⅛-inch thickness, hours	72	72
Full Cure, ⅛-inch thickness, days	7	7
Thin Section Cure	Excellent	Excellent
Non-Volatile Content, percent	98	98

THERMAL AGING OF DOW CORNING 3145 RTV ADHESIVE/SEALANT

		at 260 C (500 F)		*at 320 C (608 F)*	
	Initial	*1 week*	*4 weeks*	*1 day*	*1 week*
Durometer Hardness, Shore A	33	29	38	32	38
Tensile Strength, psi.	675	330	310	230	220
Elongation, percent...	675	400	270	300	140

of the adhesive/sealant will extend the cure time. Likewise, cure time is generally proportional to the degree of confinement. If both members are impermeable, as in the case of two metal plates, complete cure time will depend upon the thickness of the adhesive/sealant and the area confined. The larger the unexposed bond area, the longer the cure time. For best results, in a metal to metal bond, the members should not overlap more than one inch.

For bonding with at least one permeable member, sections up to ⅛ inch thick will cure to rubbery solid masses in 72 hours at room temperature and a relative humidity of at least 30 percent. Optimum physical and electrical properties are reached after curing 7 days at room temperature.

Bonding

1. Thoroughly clean and degrease metal and plastic surfaces, then rinse all, except plastic, surfaces with acetone. Rubber surfaces should be roughened with sandpaper, then wiped with acetone.
2. For maximum adhesion, apply Dow Corning 1203 primer (red) or 1204 primer (clear) to all surfaces except rubber or silicone rubber. Allow the primer to dry for at least two hours at room temperature.
3. Apply Dow Corning 3144 or 3145 RTV adhesive/sealant in a uniform thickness. Best adhesion is obtained with approximately a 15 mil glue line. When bonding two surfaces, join the surfaces with enough uniform pressure to displace any excess adhesive.
4. Let the unit stand undisturbed at *room temperature* with at least 30 percent relative humidity to cure.

Sealing

For sealant applications, apply Dow Corning 3144 or 3145 RTV adhesive/sealant directly from the collapsible tube or cartridge using the supplied plastic nozzle. This nozzle may be cut to the desired orifice size and shape.

STORAGE

To maintain good stability these products must be stored below 90 F (32.1 C). Refrigerated storage is not essential but will extend the useful shelf life of these materials. Containers should always be kept sealed when not in use. After a container of sealant has been opened, a plug of cured material may form in the nozzle or tube tip during storage. This is easily removed and does not affect the remaining contents.

PACKAGING

Dow Corning 3144 and 3145 RTV adhesive/sealants are available in 2 ounce collapsible tubes, 12 ounce foil cartridges and 40 pound pails. Both materials are available from authorized electrical/electronic distributors or directly from Dow Corning Corporation.

DOW CORNING CORPORATION, MIDLAND, MICHIGAN 48640

Atlanta Boston Brussels Chicago Cleveland Dallas Greensboro Honolulu
Los Angeles New York San Francisco Sydney Tokyo Toronto

DOW CORNING

PRINTED IN U.S.A.

Scotch® BRAND industrial tape products

April 1, 1971

"SCOTCH" BRAND DOUBLE-COATED TAPE

Y-9169 THERMOSETTING "LOKTAC"

This new and unique double-coated tape can be used to prepare high strength permanent bonds between various materials. The novel adhesive used in this tape is permanently tacky until cured under light pressure. Bond strengths in the range of 4000 psi. shear tensile are obtained.

PHYSICAL PROPERTIES

Adhesive Layer:	Cream colored with a lightweight rando web embedded in the adhesive layer
Liner:	Brown, silicone treated paper
Over-all Caliper:	.009"
Adhesive Layer Caliper:	Approximately .006"

SUGGESTED USES:

1. Metal to metal bonding to replace rivets or spot welds.
2. Metal lamination.
3. Dissimilar metal bonding.
4. Bond together metals that cannot be soldered or welded conveniently.
5. Metal to wood bonding.
6. Bonding metal to some plastics (unplasticized vinyls, epoxies, phenolics).
7. Permanent bonds to reinforced plastics.
8. Solvent resistant applications (aliphatic type hydrocarbons).

ADHESIVE TACK AND HANDLING PROPERTIES:

If the tape is applied to most clean, smooth, and dry surfaces, the liner can be pulled away easily, leaving the other side of the tacky adhesive ready for bonding to another surface. If desired, the liner can be removed; and the adhesive layer can be handled without support of the liner. One limitation to the use of this product is that materials to be bonded together must be free of grease and oils. Most oils and grease are completely insoluble in the adhesive and act as a barrier between the adhesive and the item to be bonded. For this same reason, the tape may not feel very tacky because of body oils or perspiration on the fingers. The adhesive has very strong adhesion to clean, smooth, dry surfaces.

ADHESIVE BONDING PROPERTIES:

Typical values for adhesive bonds cured between heated platens are listed below. All bonds are ½" overlap shear tensile measurements on chromic acid etched aluminum plates: (Crosshead speed .05"/min.)

Cure Temp. °F.	Cure Time Min.	Platen Pressure PSI	Shear Tensile PSI
450	2	50	4000+
400	5	50	4000+
350	15	50	4000+
350	5	50	3000
300	10	50	1300
300	5	50	400
275	30	50	960
275	15	50	420
250	60	50	820
250	30	50	350

The above shear tensile test results are for bonds tested at room temperature. Sample strips cured at 350°F., 15 min. under a platen pressure of 50 psi. gave the following test values when the test was performed at the indicated temperature:

Test Temp. °F.	Shear Tensile PSI
-67	3800
75	4000+
180	1150
250	320
300	200
500	180

Peel bond strengths of approximately 25-30 lbs./in. are obtained in T-Peel tests of fully cured adhesive bonds. (.020" etched Alclad aluminum strips, crosshead speed 2"/min.)

No volatiles are produced as the adhesive is cured, and so only enough pressure is required to maintain intimate contact between the parts being bonded.

Ovens, heat lamps, radiant heaters, etc. can be used to supply the heat for curing the adhesive, but the cycle must be long enough to bring the adhesive layer up to the cure temperature for the time period indicated.

Fully cured test strips did not lose any of their bond strength after immersion in the following solvents for two months at room temperature: Tap water, JP-4 jet fuel, heptane, mineral spirits, hydraulic oil MIL-O-5606, Freon 12.

Bond strengths were lowered after immersion of test samples in the following solvents: Methyl ethyl ketone, methyl alcohol, carbon tetrachloride, toluene, benzene.

Strength of a cured bond in an aluminum product was not affected by anodizing treatment in a 15% sulfuric acid anodizing bath.

NET PRICE PER ROLL TO CONSUMERS										
	INDIVIDUALLY BOXED					FULL BULK CARTONS				
60 Yard Rolls	Rolls Per Unit	Broken Units	1 to 2 Units	3 to 11 Units	12 Units or More	Rolls Per Unit	1 to 4 Units	5 to 14 Units	15 Units or More	90-Day 100 Carton Orders
1/4"	12	3.12	2.40	2.22	2.08	144	2.00	1.87	1.68	1.58
3/8"	12	3.91	3.01	2.77	2.61	96	2.51	2.34	2.10	1.97
1/2"	12	4.68	3.60	3.32	3.12	72	3.00	2.80	2.52	2.36
5/8"	12	5.46	4.20	3.88	3.64	60	3.50	3.27	2.94	2.76
3/4"	12	6.25	4.81	4.43	4.17	48	4.01	3.74	3.36	3.15
7/8"	12	7.02	5.40	4.98	4.68	44	4.50	4.20	3.78	3.54
1"	12	7.80	6.00	5.54	5.20	36	5.00	4.67	4.20	3.94

INTERMEDIATE WIDTHS - Supplied at next higher price.

OTHER WIDTHS - For widths wider than 1", add 25% of 1" net price for each additional 1/4" of width or fraction thereof. If computation results in fraction, raise or lower to the nearest full cent.

ASSORTING PRIVILEGE

(1) 12 boxed rolls of a single type and size equals one unit.
(2) Each bulk carton equals one unit.
(3) Full units of ALL tapes except resale display items, electrical tapes and sandblast stencil may be combined to determine quantity price in each type of packaging.
(4) Broken units of boxed tape, regardless of order size, will be priced at the broken unit price.

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

"SCOTCH" and the plaid design are registered trademarks for the pressure-sensitive adhesive tapes of 3M Company, St. Paul 6, Minnesota.

Export: 99 Park Ave., New York 16, New York Canada: London, Ontario

APPENDIX B

TEST DATA SHEETS

PACE ORDNANCE SYSTEMS, INC. TEST REQUEST & WORK SHEET

TYPE					
DEVELOP.	PART DESCRIPTION: EPOXY STUDY EPON 828 CONNECTOR END.			FIRING No.	
PRE-QUAL.	PART No. 1-10197-16 Mod.	CART. P/N		FIRING DATE	
QUAL.	JOB No. 2409	CART. S/N		CONDITIONED TEMP.	°F
PROD.	U/N or S/N 021-025	CART. L/N		AMBIENT TEMP.	°F
	UNIT L/N N/A			BAROMETRIC PRESSURE	IN. of HG
				RELATIVE HUMIDITY	%

EXPECTED RESULTS

- ____ THRUST ____ K
- ____ THRUST ____ K
- ____ THRUST ____ K
- ____ THRUST ____ K
- ____ PRESSURE ____ K
- ____ PRESSURE ____ K
- ☐ ACCELERATION ____ G
- ☐ FIRING TIME
- ☐ SEPARATION TIME
- ☐ POSITION-TIME

☐ AMBIENT FIRING

☐ COND. @ ____ °F, ____ HR.

TEST INSTRUCTIONS

DESIRED TEST DATE 8-24-71

WHO MUST WITNESS T. COULTAS

PERFORM INSULATION RESISTANCE AND RECORD RESULTS ON ATTACHED DATA SHEET 500 VDC SHORTED PINS TO CASE. THERMAL CYCLE UNIT 1 HR @ -260°F 1 HR. @ 300°F REPEAT CYCLE 2X. POST THERMAL CYCLE PERFORM INSULATION RESISTANCE SAME AS ABOVE. RECORD ON DATA SHEET.

PHOTO REQUIRED YES ☐ NO ☐

REQUESTED BY: [signature] APPROVED BY: ____

TEST RESULTS

TECH. ____ DATE ____

0351

ENGINEERING WORK ORDER LOG

JOB # 3409-0001 E.R. # _____ DATE 8-11-71 LOG SHEET # _____

OP Prod. Area DATE REQUIRED 8-12-71 JOB ACCEPTED BY W. A. Connell 8/12

Finished

DESCRIPTION OF WORK	BY	INSPECT
OPER. NO 1 – PLEASE IDENTIFY 40 EA. S.B.A.S.I. PER THE FOLLOWING: SERIAL NO. 001 THRU 040 LOCATION OF S/N OPTIONAL (SERIALIZE UNITS WITH PINS 001 THRU 026)	124 8-17-71	
OPER. NO 2 – DEGREASE PARTS FOR 20 MIN IN LONCO, DRY IN OVEN @ 120°F FOR 1 HR.	124 8-17-71	
OPER. NO. 3 – POT CONNECTOR END OF 26 EA UNITS (S/N 001–026) WITH EPON 828 CURING AGENT Z CURE @ 300°F FOR 2 HR.	8-17-71	
Epon 828 5 pts Agent Z 1 pt / By W.T. in oven @ 2 00 out @ 4 00 8-16-71		
complete		

FORM E-820

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

ITEM: Modified S.B.A.S.I.
SOS P/N: 1-10197-16
SOS TEST PROC.: N/a
CUSTOMER P/N: 1-10197-16
CUSTOMER SPEC: N/A
CONT/P.O. NO: NAS9-12085 NASA Epoxy Study
SOS JOB NO. 3409-0001
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	INSULATION RESISTANCE 500 VDC SHORTED PINS TO CASE	THERMAL CYCLE 3X @ -260F/300F FOR 1hr.	INSULATION RESISTANCE 500VDC SHORTED PINS TO CASE	
1	0021	300K	3X@ EA.	320K	
2	0022	300K		360K	
3	0023	400K		320K	
4	0024	350K		360K	
5	0025	300K	3X@ EA.	360K	
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
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21					
22					
23					
24					
25					

TEST TECH (INITIAL)
DATE
APPROVAL SIGNATURES

STAMPS
WITNESS (SOS)
WITNESS (CUSTOMER)
WITNESS (GOVT.)

ACE ORDNANCE SYSTEMS, INC. — TEST REQUEST & WORK SHEET

TEST TYPE: DEVELOP. / PRE-QUAL. / QUAL. / PROD.

PART DESCRIPTION: Epoxy Study Charge Cup & Header
PART No.: Test Ass'y
JOB No.: 3409-0001
U/N or S/N: N/A
UNIT L/N: N/A
CART. P/N:
CART. S/N:
CART. L/N:

FIRING No.:
FIRING DATE:
CONDITIONED TEMP.: °F
AMBIENT TEMP.: °F
BAROMETRIC PRESSURE: IN. of Hg
RELATIVE HUMIDITY: %

EXPECTED RESULTS

THRUST K
THRUST K
THRUST K
THRUST K
PRESSURE K
PRESSURE K
☐ ACCELERATION G
☐ FIRING TIME
☐ SEPARATION TIME
☐ POSITION-TIME

☐ AMBIENT FIRING
☐ COND. @ °F, HR.

TEST INSTRUCTIONS

DESIRED TEST DATE: 8-24-71
WHO MUST WITNESS: T. Coultas

PLACE UNITS IN A HERMETICALLY SEALED CONTAINER AND THERMAL CYCLE AS FOLLOWS: 1 hr @ -260°F 1 hr @ +300°F REPEAT CYCLE 2 TIMES. POST CYCLE TEST VISUAL EXAM. AND SHEAR TEST SHEAR UNITS AS FOLLOWS PLACE ASS'Y IN A V-BLOCK WITH CLAMP HOLDING HEADER. ATTACH DILLON FORCE GAUGE TO ARBOR PRESS. ATTACH A .250 DIA. RAM TO UNDER SIDE OF DILLON. SHEAR CERAMIC CUP FROM HEADER & RECORD FORCE TO SHEAR ON ATTACHED DATA SHEET. NOTE UNITS MARKED WITH RED DYE. ASS'Y WITH 3M584 TAPE. BALANCE ASSEMBLED W/ TL9169 TAPE.

PHOTO REQUIRED: YES ☐ NO ☐

REQUESTED BY: L. Stoelting
APPROVED BY:

TEST RESULTS

TECH. DATE

ENGINEERING WORK ORDER LOG

JOB # 3409 E.R. # _____ DATE 8-17-71 LOG SHEET # _____

SHOP MFG DATE REQUIRED 8-20-71 JOB ACCEPTED BY _____

DESCRIPTION OF WORK	BY	INSPECT
ALLOCATE THE FOLLOWING: 10 EA. CHARGE CUPS 10 EA. HEADERS 3M Y9169 TAPE 3M 684 TAPE		
OPER. 1 CUT 6 EA. DISK FROM 3M Y9169 TAPE AND INSTALL ON 6 EA. CHARGE CUPS. PLACE HEADER ON TOP OF CHARGE CUP. PLACE ASSY IN OVEN WITH APPROX. 30 GRAM DEAD LOAD ON TOP OF CHARGE. TO HOLD IN PLACE DURING CURE CYCLE. CURE @ 300°F FOR 2 hr.	124 8-19-71	
OPER. 2 REPEAT ABOVE OPER. USING 3M 584 TAPE	124 8-19-71	
OPER. 3 REMOVE UNITS FROM OVEN IDENTIFY 6 EA UNITS WHICH 3M 584 TAPE WAS USED WITH BLUE DY-KEM.	124 8-19-71	

FORM E-820

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

ITEM: Modified S.B.A.S.I. CUSTOMER P/N: 1-10197-16 SOS JOB NO. 3409-0001

SOS P/N: 1-10197-16 CUSTOMER SPEC: N/A TOTAL ACCEPT REJECT

SOS TEST PROC.: N/a CONT/P.O. NO: NAS9-12085 NASA Epoxy Study

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	THERMAL CYCLE 3X @ -260F/300F FOR 1 hr.	VISUAL EXAMINATION AFTER CYCLE	SHEAR TEST RECORD GAGE READING. (DILLON FORCE	REMARKS
1	Red Dye - 584	3X @ EA. ITEM		08 Lbs	Subsequent To Cold Temp. A Gap
2	Red Dye - 584			09	Is Visible @ Interface.
3	Red Dye - 584			10	
4	Red Dye - 584			05	
5	Red Dye - 584			02	
6	9169 Tape			26	No Visible Change To Seal Disc
7	9169 Tape			30 Lbs	Or Interface Of Seal Area
8	9169 Tape			15 Lbs	
9	9169 Tape			19	
10	9169 Tape	3X @ EA. ITEM		28	
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

TEST TECH (INITIAL) APPROVAL SIGNATURES

DATE

STAMPS

WITNESS (SOS)

WITNESS (CUSTOMER)

WITNESS (GOVT.)

PAGE OF

SPACE ORDNANCE SYSTEMS, INC. TEST REQUEST & WORK SHEET

TEST TYPE: DEVLOP. / PRE-QUAL. / QUAL. / PROD.

PART DESCRIPTION: Modified S.R.A.S.I F-502 & 3144
PART No. 1-10197-16 Mod. CART. P/N
JOB No. 3409-0001 CART. S/N
U/N or S/N 26-35 CART. L/N
UNIT L/N N/A

FIRING No.
FIRING DATE

CONDITIONED TEMP.	°F
AMBIENT TEMP.	°F
BAROMETRIC PRESSURE	IN. of HG
RELATIVE HUMIDITY	%

EXPECTED RESULTS

_____ THRUST _____ K
_____ THRUST _____ K
_____ THRUST _____ K
_____ THRUST _____ K
_____ PRESSURE _____ K
_____ PRESSURE _____ K
☐ ACCELERATION _____ G
☐ FIRING TIME
☐ SEPARATION TIME
☐ POSITION-TIME

☐ AMBIENT FIRING
☐ COND. @ _____ °F, _____ HR.

TEST INSTRUCTIONS

DESIRED TEST DATE 8-24-71
WHO MUST WITNESS T. COLLINS

PLACE UNITS IN A HERMETICALLY SEALED CONTAINER AND PLACE IN -260°F CHAMBER AND PERFORM THERMAL CYCLE FOR 1 HR @ -260°F AND 1 HR @ +360°F
REPEAT CYCLE 2X.
PERFORM SLEEVE TEST AS FOLLOWS:
USING A .125 DIA. RAM ATTACHED TO THE UNDER SIDE OF A DILLON FORCE GAUGE. PRESS OUT INTERNAL COMPONENTS (CHARGE CUP, HEADED ALL DISK) OF INITIATOR BODY RECORD RESULTS ON ATTACHED DATA SHEET.

PHOTO REQUIRED YES ☐ NO ☐

REQUESTED BY: [signature] APPROVED BY: _____

TEST RESULTS

TECH. _____ DATE _____

1067

ENGINEERING WORK ORDER LOG

JOB # 3409-0001 E.R. # 7416 DATE 8-12-71 LOG SHEET # _____

SHOP Prod. Area DATE REQUIRED 8-16-71 JOB ACCEPTED BY W. A. Connell 8/17/71

Scheduled Scott 8/17/71

DESCRIPTION OF WORK	BY	INSPECT
EPOXY STUDY (NASA) ALLOCATE THE FOLLOWING MATL FROM ENG. 5 EA. S.B.A.S.I Bodies S/N ~~27 THRU 30~~ 26 THRU 30 5 EA. CERAMIC CHARGE CUPS 10 EA. 1-10197-52 ISOMICA DISKS 5 EA. 1-10197-25 HEADER BODIES 5 EA. 1-10197-53 Mod. WASHERS MATL F-502 OPER. NO. I INSTALL HEADER INTO INITIATOR BODY. SHOULD NOT BE A TIGHT FIT. INSTALL CERAMIC CHARGE CUP ON TOP OF HEADER HOLE ALLIGMENT NOT REQd.	124 8-18 71	
OPER. NO 2 POUR SUPER FLOSS (APPROX. 50MG.) INTO CHARGE CUP AND HAND TAMP IN PLACE TO TOP OF CHARGE CUP.	124 8-18-71	
OPER NO 3 INSTALL 2 EA. 1-10197-52 disk ON TOP OF SUPER FLOSS AND TAMP IN PLACE.	124 8-18-71	
OPER NO 4 INSTALL 1 EA GLASS WASHER ON TOP OF 2 EA. disk. PLACE UNITS IN T-70743 CURING FIXTURE. CURE IN OVEN @ 300°F FOR 2 HR.	8-18-7	
OPER. NO 5. Cure 10:00 to 12:00 2 hr. REMOVE UNITS FROM OVEN. AND HOLD IN BOND WITH THIS E.W.O.L. UNTIL FURTHER NOTICE FROM ENG.	124 8-18-71	
Complete		

FORM E-820

1069

ENGINEERING WORK ORDER LOG

JOB # 3409-0001 E.R. # 7414 DATE 8-12-71 LOG SHEET #

SHOP Prod Area DATE REQUIRED 8-16-71 JOB ACCEPTED BY W.A. Cornell 8/17/71

DESCRIPTION OF WORK	BY	INSPECT
EPOXY STUDY (NASA) ALLOCATE THE FOLLOWING MATL FROM ENG. 6 EA. S.B.A.S.I. BODIES S/N ~~32 THRU 36~~ 31 THRU 35 6 EA. CERAMIC CHARGE CUPS 10 EA. 1-10197-52 ISOMICA DISK 6 EA. 1-10197-25 HEADER BODIES A/R RTV 3144		
OPER NO. I INSTALL HEADER INTO INITIATOR BOD SHOULD NOT BE A TIGHT FIT. INSTALL CERAMIC CHARGE CUP ON TOP OF HEADER, HOLE ALLIGNMENT NOT REQ'd.	124 8-18-71	
OPER NO. 2 POUR SUPER FLOSS (APPROX 50 MG.) INTO CHARGE CUP AND HAND TO TOP OF CHARGE CUP.	124 8-18-71	
OPER NO 3 INSTALL 2 EA 1-10197-52 disk ON TOP OF SUPER FLOSS AND TAMP IN PLACE.	124 8-18-71	
OPER. NO. 4 APPLY A FILLET OF RTV 3144 @ JUNCTION OF disk AND I.D. OF INITIATOR BODY CURE AT ROOM TEMP. Cure 12 hours	8-18-71	
OPER NO. 5 HOLD UNITS IN BOND WITH THIS EWO UNTIL FURTHER NOTICE FROM ENG.	8-18-71	
complete		

FORM E-820

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

ITEM: Modified S.B.A.S.I.
SOS P/N: 1-10197-16
SOS TEST PROC.: N/a
CUSTOMER P/N: 1-10197-16
CUSTOMER SPEC: N/A
CONT/P.O. NO: NAS9-12085 NASA Epoxy Study
SOS JOB NO. 3409-0001
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	THERMAL CYCLE 3X @ -260F/300F FOR 1 hr.	SHEAR TEST DILLON FORCE READ.	
1	026	3hr @ ER. Temp	28 Lbs	VISUAL EXAM. AFTER EA CYCLE - INDICATED, O
2	027		25 Lbs	DEFECTS OF WASHER MATL DUE TO CYCLE
3	028		10 Lbs	" "
4	029		16 Lbs	" "
5	030		31 Lbs	" "
6	031		0 Lbs	RTV 3144 DOES NOT ADHERE TO BODY
7	032		0 Lbs	POTTING COMPOUND TENDS TO PULL AWAY
8	033		0 Lbs	FROM BODY @ +300°F, NO VISIBLE CHANGE
9	034		0 Lbs	@ -260°F CONDITIONING.
10	035	3hr @ ER. Temp	0 Lbs	
11				
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21				
22				
23				
24				
25				

STAMPS

TEST TECH (INITIAL)
DATE
WITNESS (SOS)
WITNESS (CUSTOMER)
WITNESS (GOVT.)

APPROVAL SIGNATURES

PAGE OF

SHAGE ORDNANCE SYSTEMS, INC.

TEST REQUEST & WORK SHEET

TEST TYPE		PART DESCRIPTION: Modified S.B.A.S.I		FIRING No.	
X	DEVELOP.	PART No. 1-1019-5-16	CART. P/N	FIRING DATE	
	PRE QUAL.	JOB No. 3409-0001	CART. S/N	CONDITIONED TEMP.	°F
	QUAL.	U/N or S/N 001-020	CART. L/N	AMBIENT TEMP.	°F
	PROD.	UNIT L/N N/A		BAROMETRIC PRESSURE	IN. of HG
				RELATIVE HUMIDITY	%

EXPECTED RESULTS

- ____ THRUST ____ K
- ____ THRUST ____ K
- ____ THRUST ____ K
- ____ THRUST ____ K
- ____ PRESSURE ____ K
- ____ PRESSURE ____ K
- ☐ ACCELERATION ____ G
- ☐ FIRING TIME
- ☐ SEPARATION TIME
- ☐ POSITION-TIME

☐ AMBIENT FIRING

☐ COND. @ ____ °F, ____ HR.

TEST INSTRUCTIONS

DESIRED TEST DATE 8-24-71

WHO MUST WITNESS T. COULTAS

THERMAL CYCLE UNITS AS FOLLOWS: 1 HR @ -260°F 1 HR @ +300°F REPEAT CYCLE 2 X POST CYCLE TEST: VISUAL EXAM. INSULATION RESISTANCE, B/W RESISTANCE. ~~HELIUM LEAK TEST~~. RECORD ALL DATA ON ATTACHED DATA SHEET.

AT THE COMPLETION OF THE ABOVE TEST FIRE UNITS IN 10CC CLOSED bomb RECORD IGNITION FACTORS & PRESSURE ON ATTACHED DATA SHEET

PHOTO REQUIRED YES ☐ NO ☒

REQUESTED BY: J. Coulter APPROVED BY: _____

TEST RESULTS

Completed Per above instructions

TECH C H DATE 8-30-71

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

ITEM: Modified S.B.A.S.I. CUSTOMER P/N: 1-10197-16 SOS JOB NO. 3409-0001

SOS P/N: 1-10197-16 CUSTOMER SPEC: N/A TOTAL ACCEPT REJECT

SOS TEST PROC.: N/a CONT/P.O. NO: NAS9-12085 NASA Epoxy Study

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	X-RAY ACCEPT/REJ.	BRIDGEWIRE RESISTANCE	INSULATION RESISTANCE 500 VDC	THERMAL CYCLE 3 X @ -260F/300F	BRIDGEWIRE RESISTANCE	INSULATION RESISTANCE 500 VDC	CIRCUIT CONTINUITY	TIME FROM APPLICATION OF CURENT TO PEAK.	PEAK PRESSURE	P-1 TRANSDUCER 16908 P-2 TRANSDUCER 301335 POST FIRE LEAKAGE CURRENT (ma)
											P-1 P-2
1	001 9169/502		1.07	400K	3X@EA.	1.07	320K	OK	2.4	625/590	.11 .36
2	002 9169/502		1.13	400K		1.13	380K		2.2	620/600	.18 <.30
3	003 9169/502		1.06	380K		1.06	360K		2.8	600/580	.25 .38
4	004 9169/502		1.12	200K		1.12	210K		2.3	620/600	.21 .21
5	005 9169/502		1.05	380K		1.04	380K		2.4	610/590	.18 .45
6	006 584/502		1.12	500K		1.12	370K		2.1	590/565	.27 .28
7	007 584/502		1.02	300K		1.01	320K		2.2	600/590	.11 .16
8	008 584/502		1.06	390K		1.06	380K		2.2	610/590	.18 .28
9	009 584/502		1.08	300K		1.09	350K		2.2	620/600	.41
10	010 584/502		1.11	320K		1.11	320K		2.3	590/575	.21 .32
11	011 9169/3144		1.11	380K		1.12	380K		2.2	600/575	.16 <.31
12	012 9169/3144		1.05	380K		1.06	380K		2.2	630/600	.23 <.31
13	013 9169/3144		1.10	450K		1.11	400K		2.2	600/580	.41
14	014 9169/3144		1.07	350K		1.07	340K		2.2	625/610	.37 .41
15	015 9169/3144		1.10	400K		1.11	380K		2.0	610/590	.25 <.31
16	016 584/3144		1.08	360K		1.09	360K		3.7	610/600	.21 .26
17	017 584/3144		1.06	390K		1.06	360K		5.4	610/580	.23 .31
18	018 584/3144		1.07	350K		1.07	380K		2.1	620/610	.18 .21
19	019 584/3144		1.12	340K		1.12	340K		2.4	580/580	.30 .31
20	020 584/3144		1.01	380K	3X@EA.	1.01	380K	OK	2.5	580/570	.21 .31
21										P-1/P-2	
22											
23											
24											CH CH
25											8-30-71 8-30-71
	TEST TECH (INITIAL)				CH	CH	CH	CH	RM	RM	APPROVAL SIGNATURES
	DATE				8-30-71	8-30-71	8-30-71	8-30-71	8/31/71	8/31/71	
STAMPS	WITNESS (SOS)										
	WITNESS (CUSTOMER)										
	WITNESS (GOVT.)										

PAGE OF

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

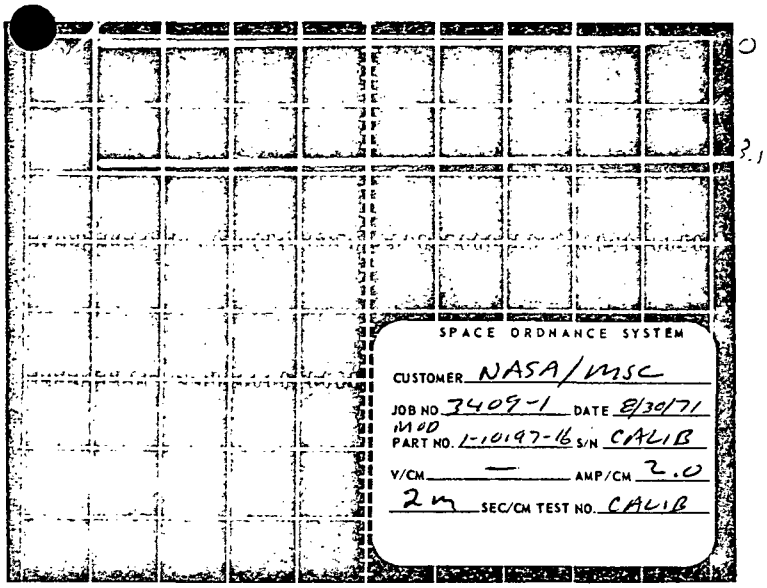
ITEM: Modified S.B.A.S.I.
SOS P/N: 1-10197-16
SOS TEST PROC.: N/a
CUSTOMER P/N: 1-10197-16
CUSTOMER SPEC: N/A
CONT/P.O. NO: NAS9-12085 NASA Epoxy Study
SOS JOB NO. 3409-0001
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	ELECTROSTATIC 25000 V 5000 OHMS 500 PICO FARAD PULSE, PIN$ TO CASE	HELIUM LEAK TEST CLOSED BOMB	POST FIRE LEAKAGE 28TO 29 VDC 50 ma.MAX.	
1	001				
2	002				
3	003				
4	004				
5	005				
6	006				
7	007				
8	008				
9	009				
10	010				
11	011				
12	012				
13	013				
14	014				
15	015				
16	016				
17	017				
18	018				
19	019				
20	020				
21					
22					
23					
24					
25					

TEST TECH (INITIAL)
DATE
APPROVAL SIGNATURES

STAMPS
WITNESS (SOS)
WITNESS (CUSTOMER)
WITNESS (GOVT.)

PAGE OF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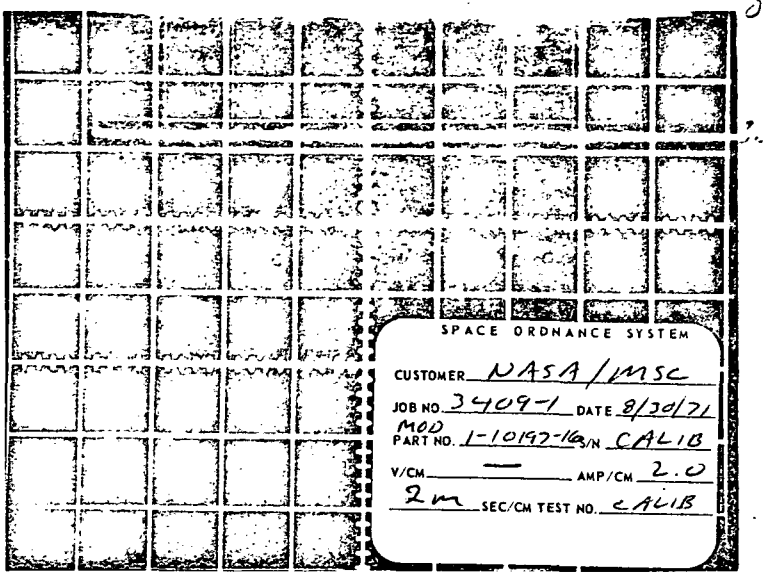
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/71
MOD PART NO. 1-10197-16 S/N CALIB
V/CM — AMP/CM 2.0
2m SEC/CM TEST NO. CALIB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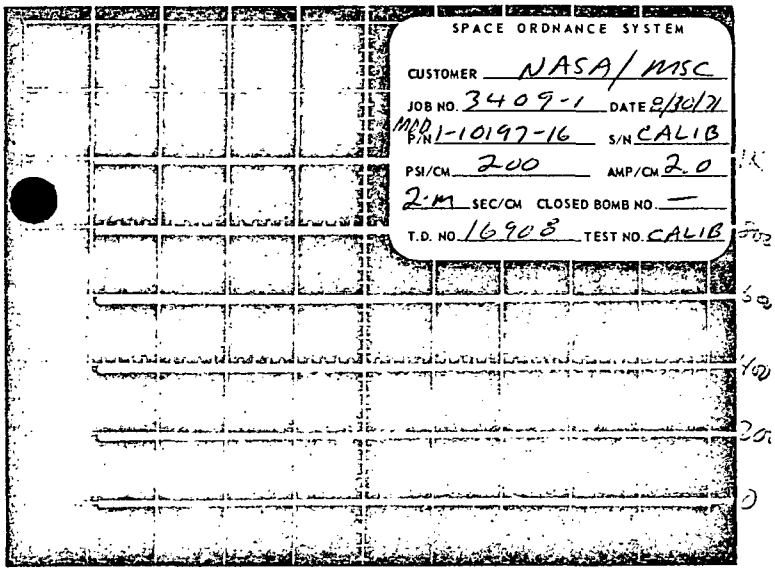
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/71
MOD PART NO. 1-10197-16 S/N CALIB
V/CM — AMP/CM 2.0
2m SEC/CM TEST NO. CALIB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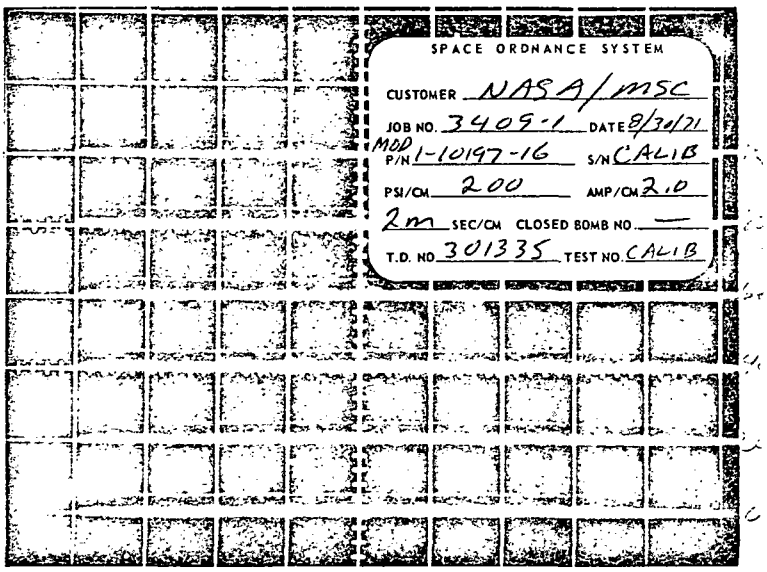
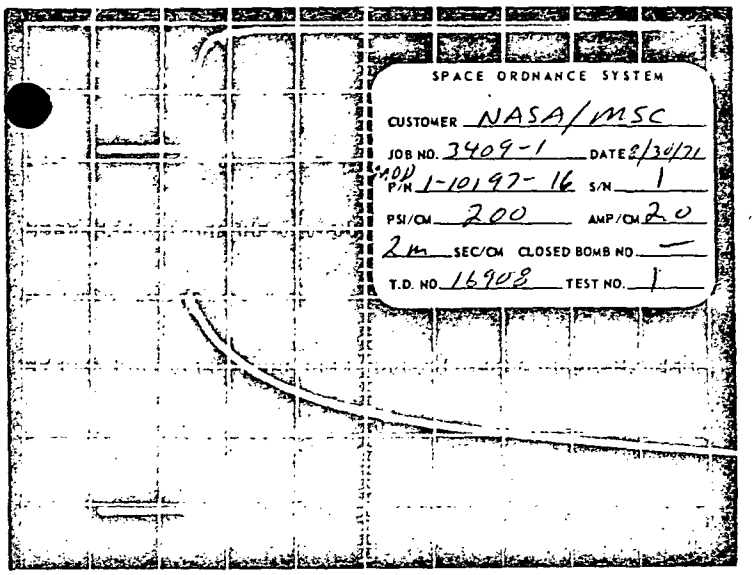
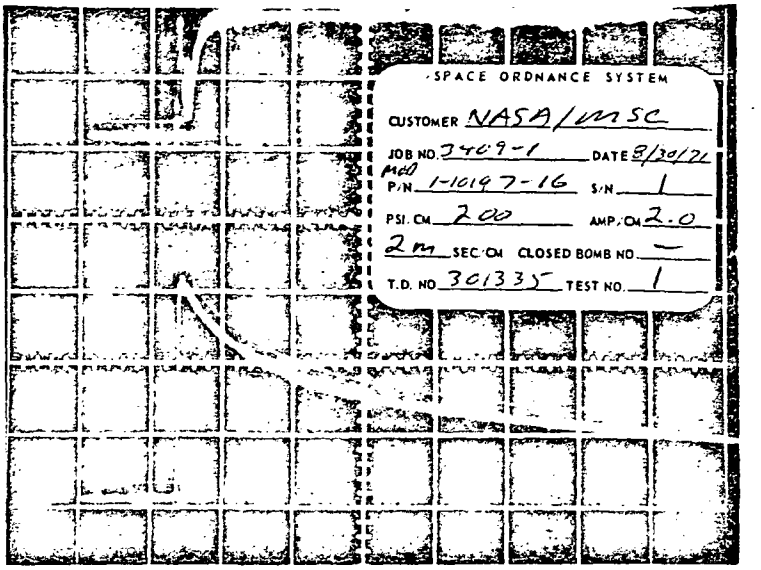
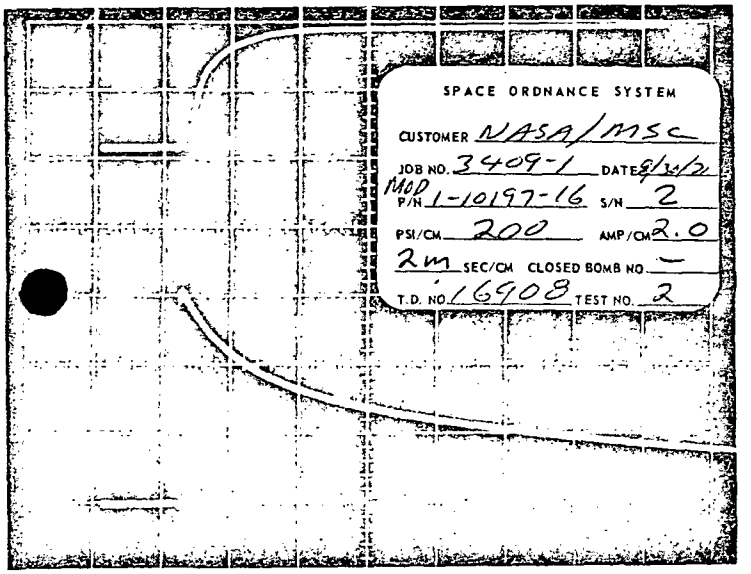
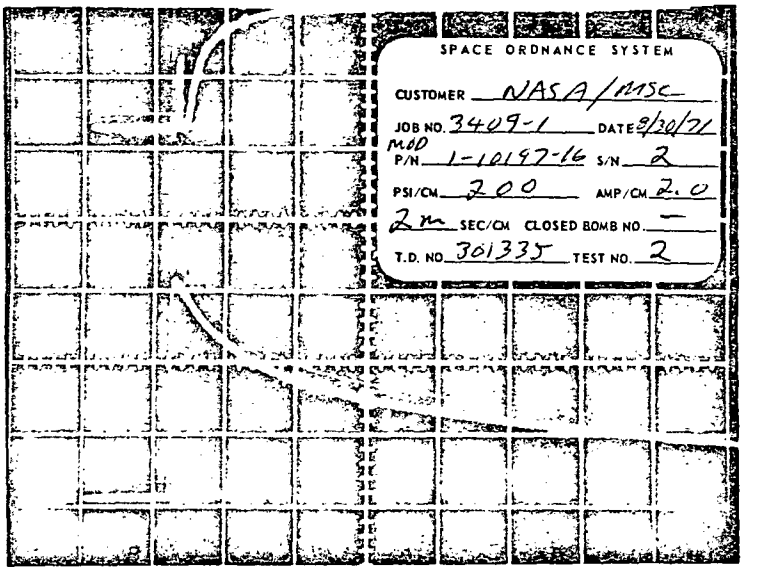
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/71
MOD P/N 1-10197-16 S/N CALIB
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. CALIB

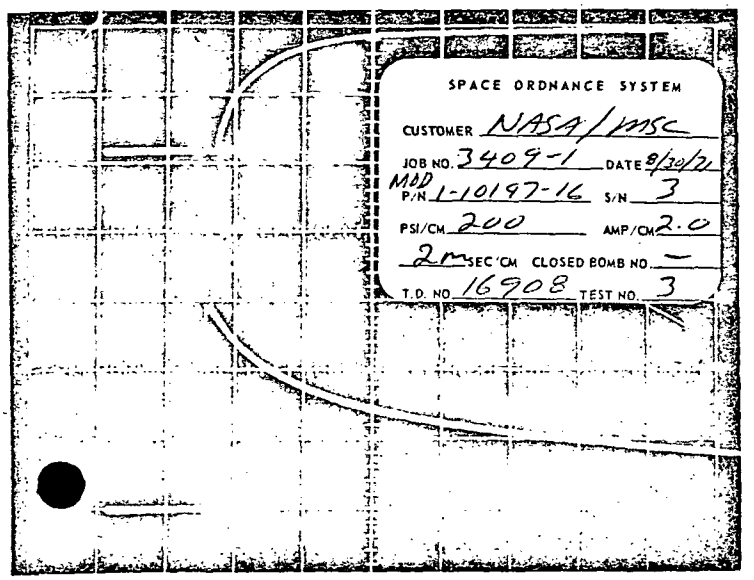

SPACE ORDNANCE SYSTEM
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/71
MOD P/N 1-10197-16 S/N CALIB
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 301335 TEST NO. CALIB


SPACE ORDNANCE SYSTEM
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/72
MOD P/N 1-10197-16 S/N 1
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. 1


SPACE ORDNANCE SYSTEM
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/72
MOD P/N 1-10197-16 S/N 1
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 301335 TEST NO. 1


SPACE ORDNANCE SYSTEM
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/72
MOD P/N 1-10197-16 S/N 2
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. 2


SPACE ORDNANCE SYSTEM
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/72
MOD P/N 1-10197-16 S/N 2
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 301335 TEST NO. 2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JOB NO. 3409-1 DATE 8/30/72
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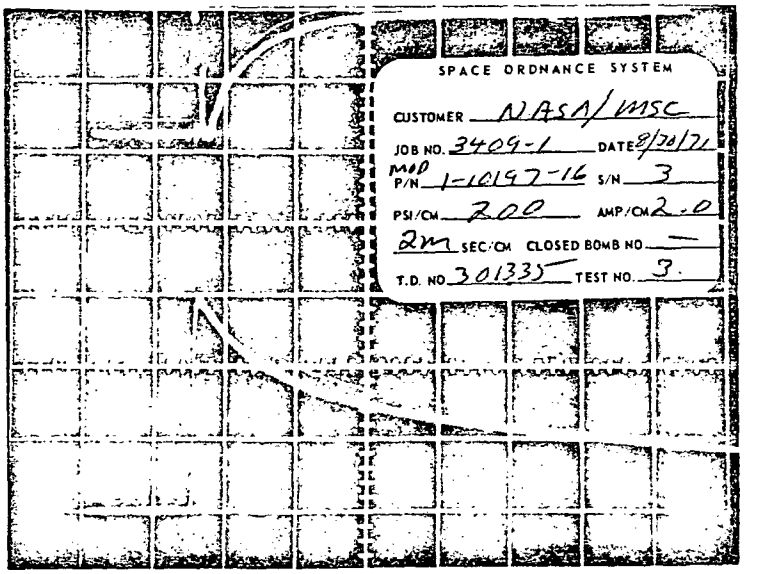
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. 3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JOB NO. 3409-1 DATE 8/30/72
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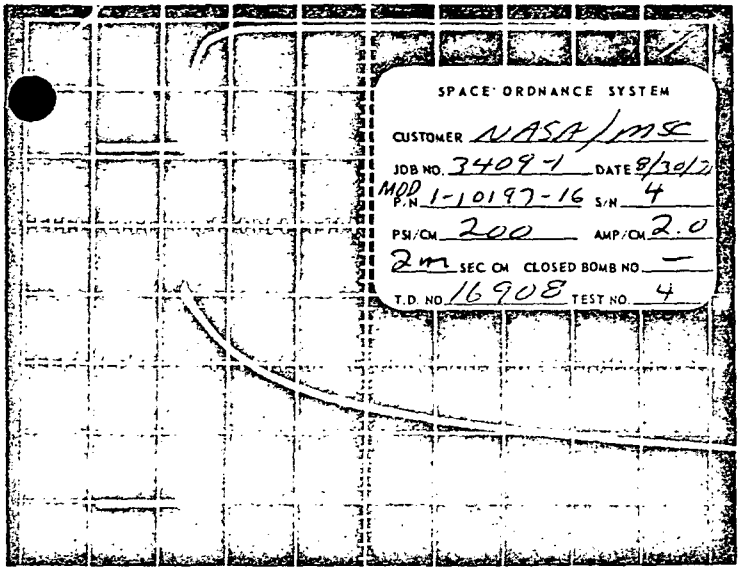
T.D. NO. 301335 TEST NO. 3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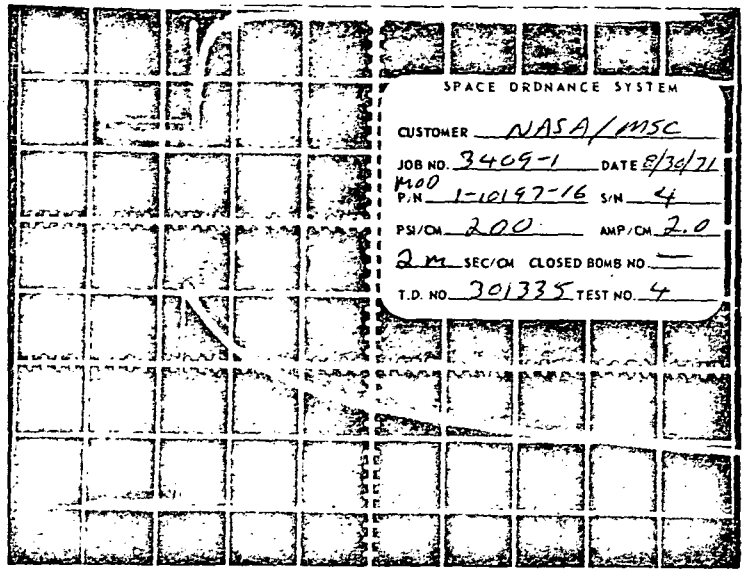
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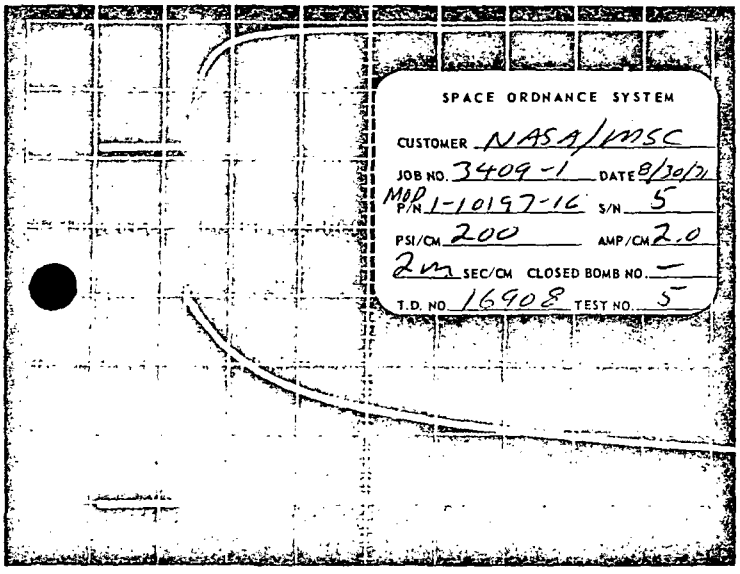
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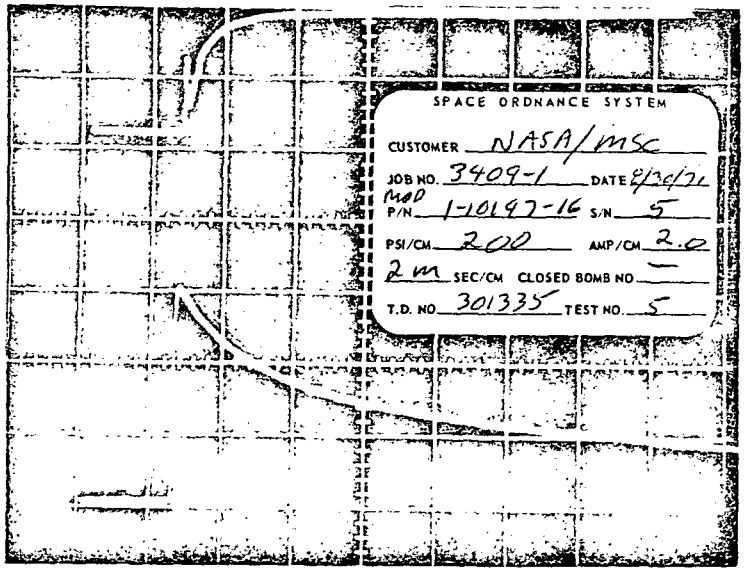
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JOB NO. 3409-1 DATE 8/30/71
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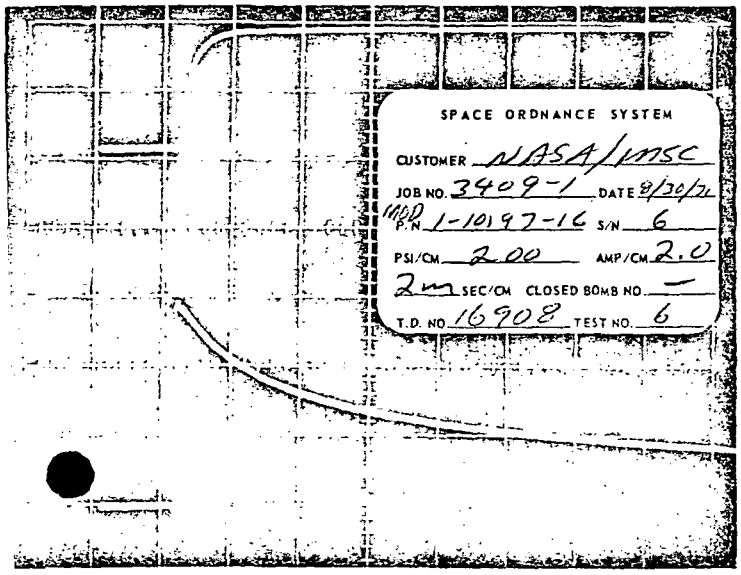
T.D. NO 301335 TEST NO. 5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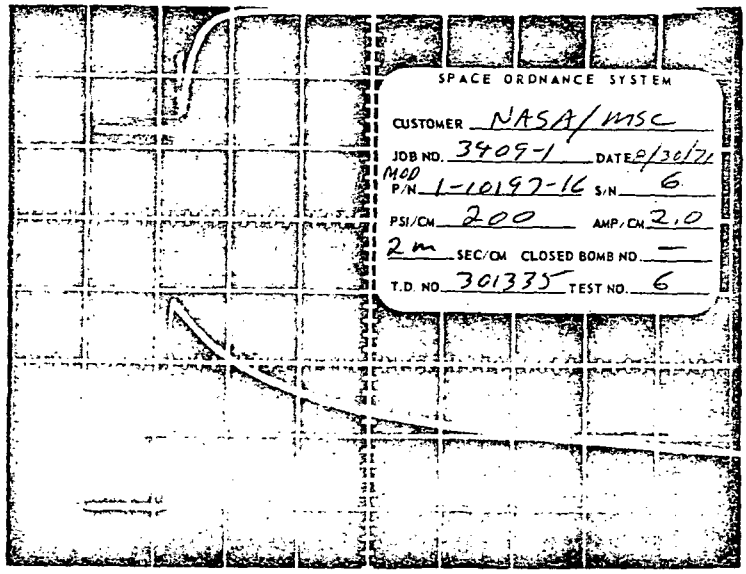
T.D. NO 16908 TEST NO. 6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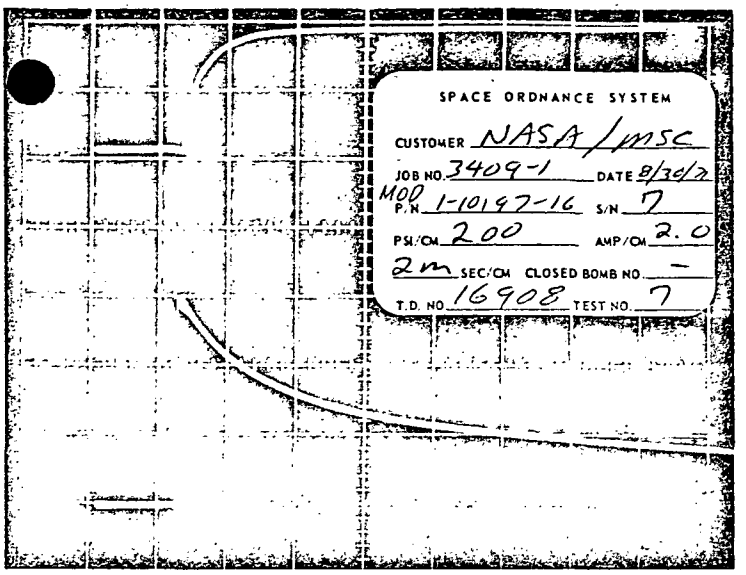
T.D. NO 301335 TEST NO. 6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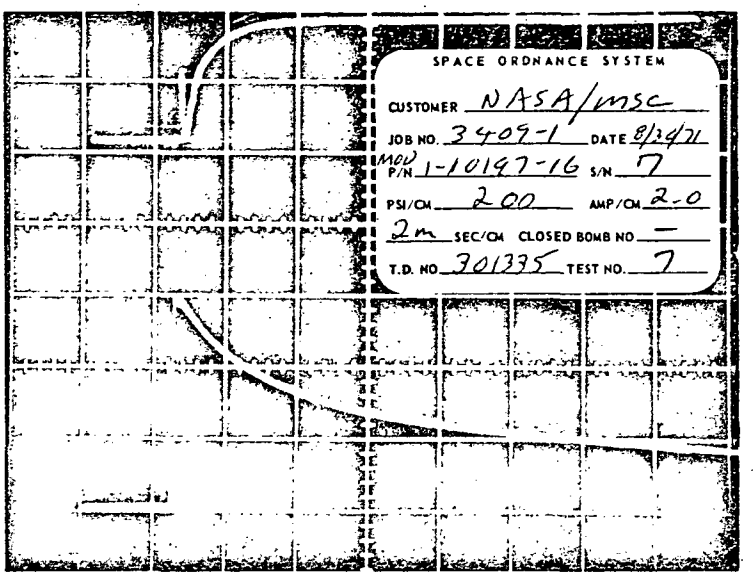
T.D. NO. 16908 TEST NO. 7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JOB NO. 3409-1 DATE 8/30/71
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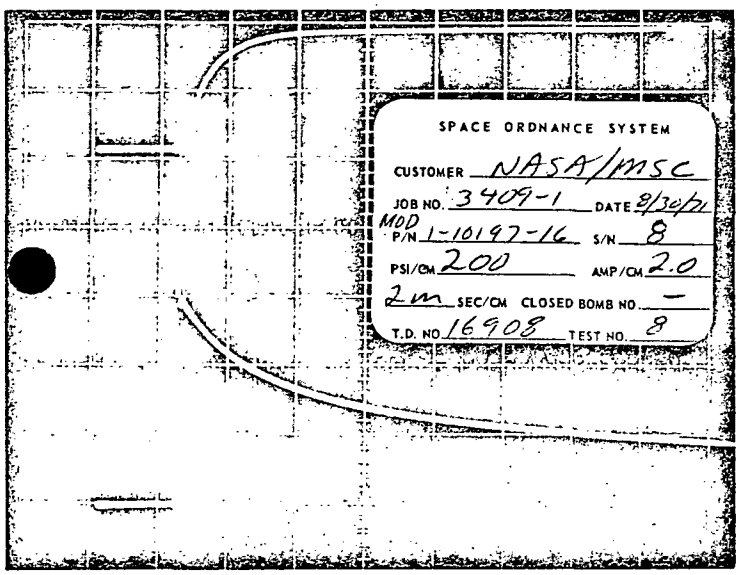
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 301335 TEST NO. 7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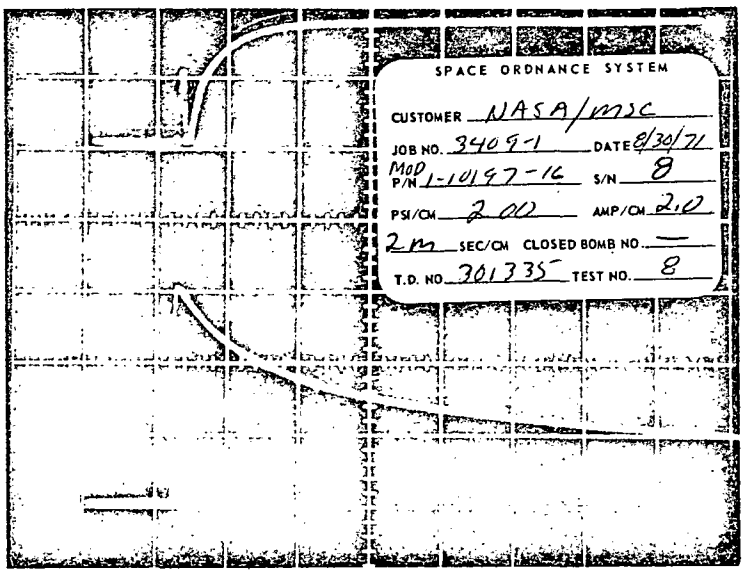
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. 8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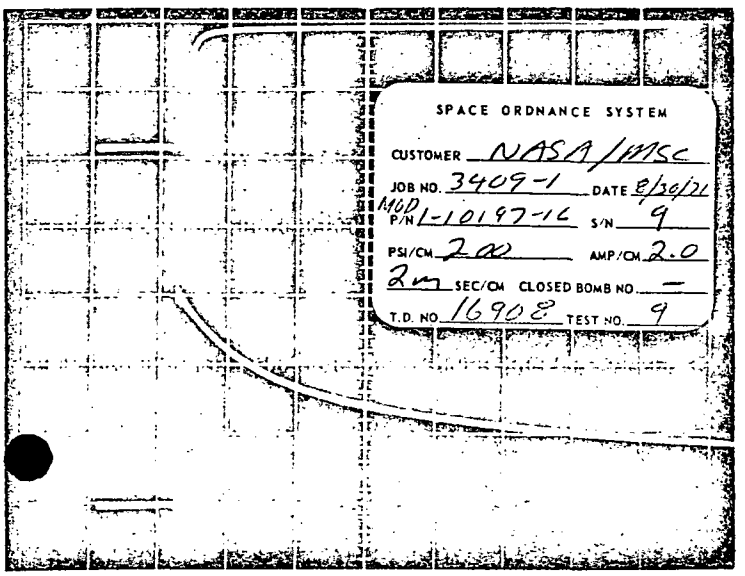
T.D. NO. 301335 TEST NO. 8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CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/71
MOD P/N 1-10197-16 S/N 9
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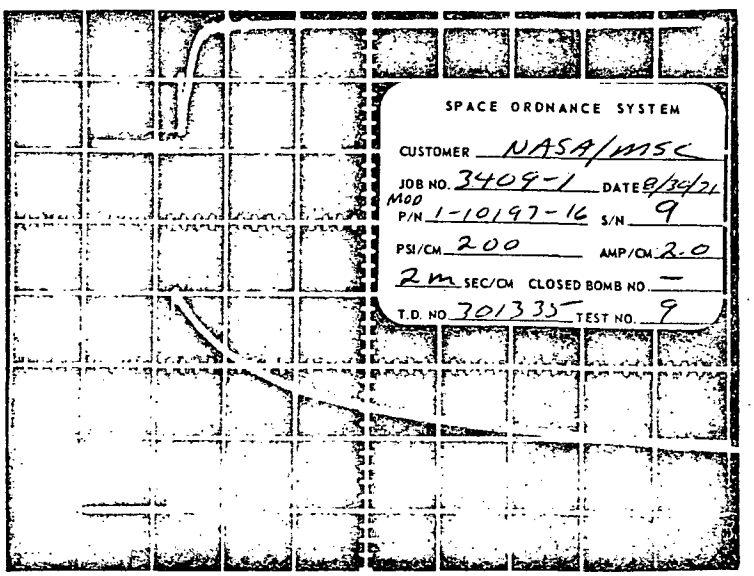
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. 9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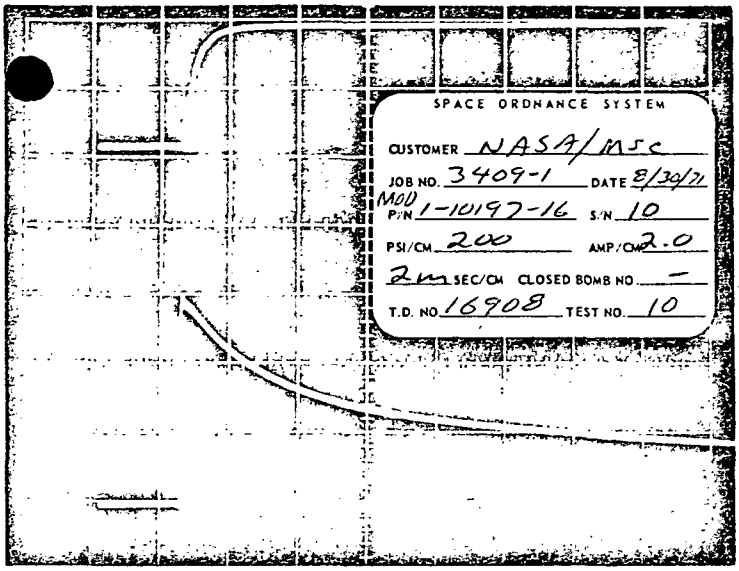
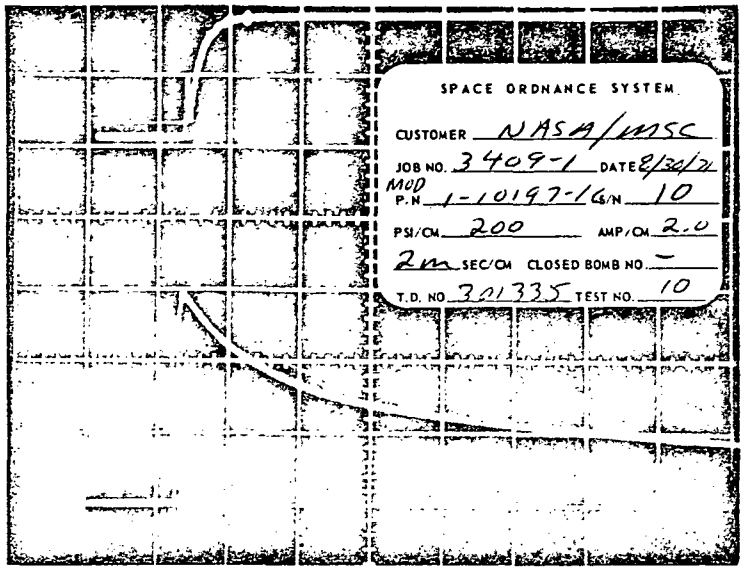
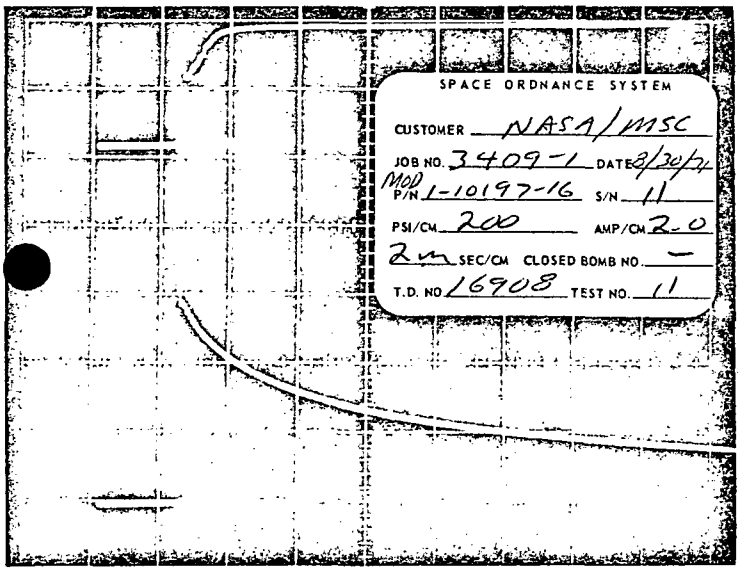
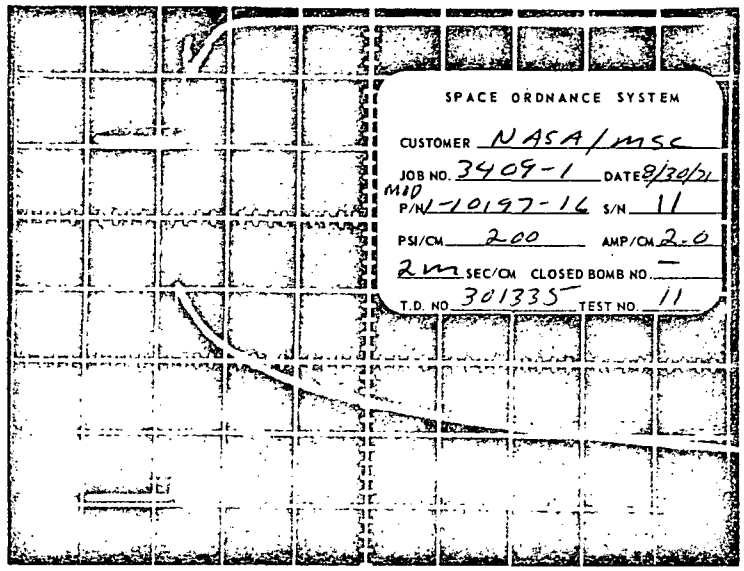
CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/71
MOD P/N 1-10197-16 S/N 9
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 301335 TEST NO. 9

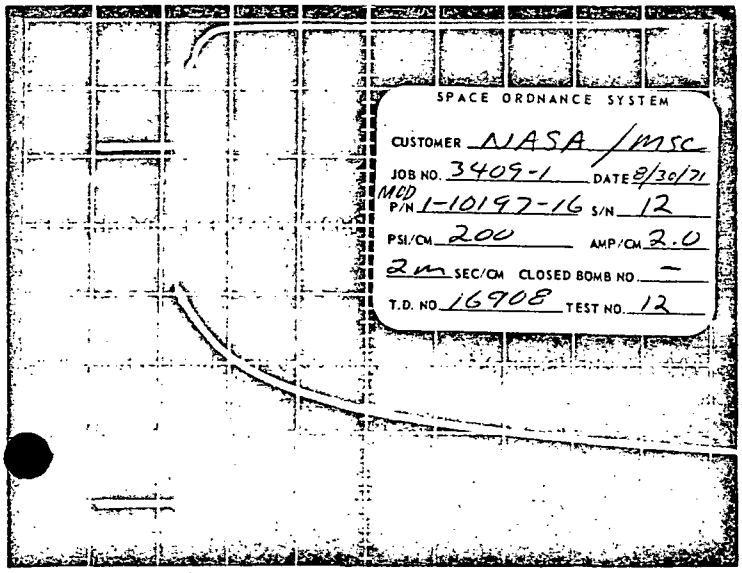
SPACE ORDNANCE SYSTEMS, INC.

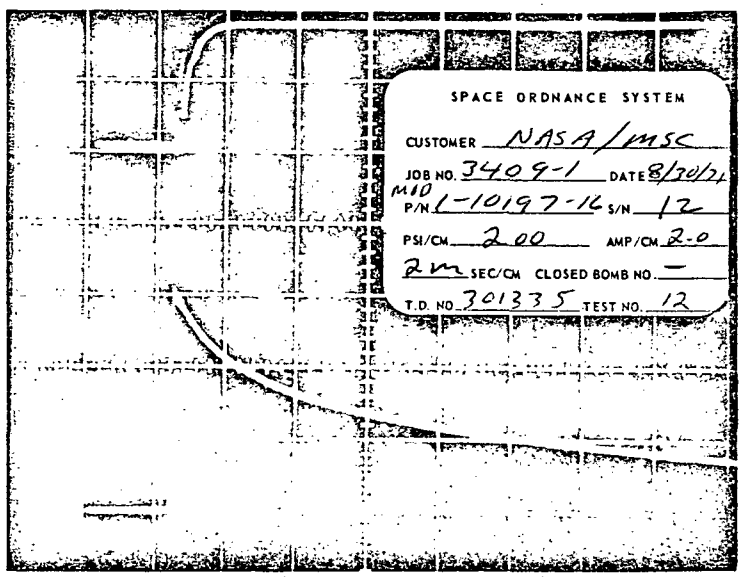


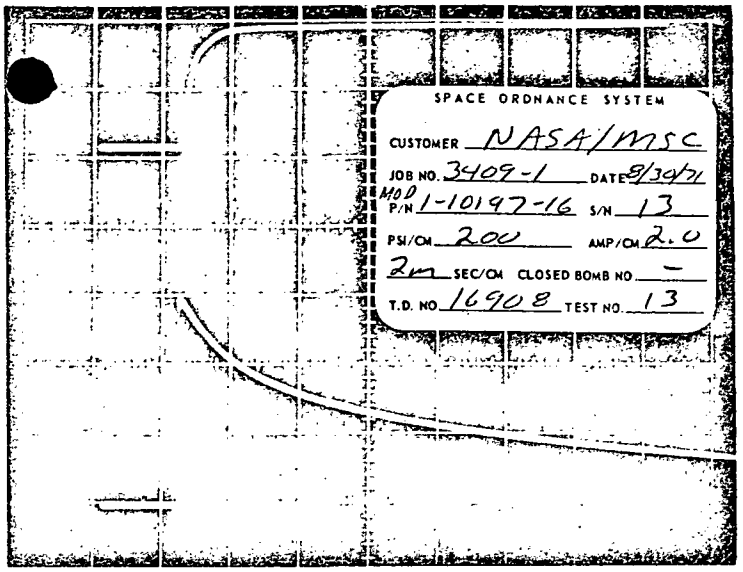








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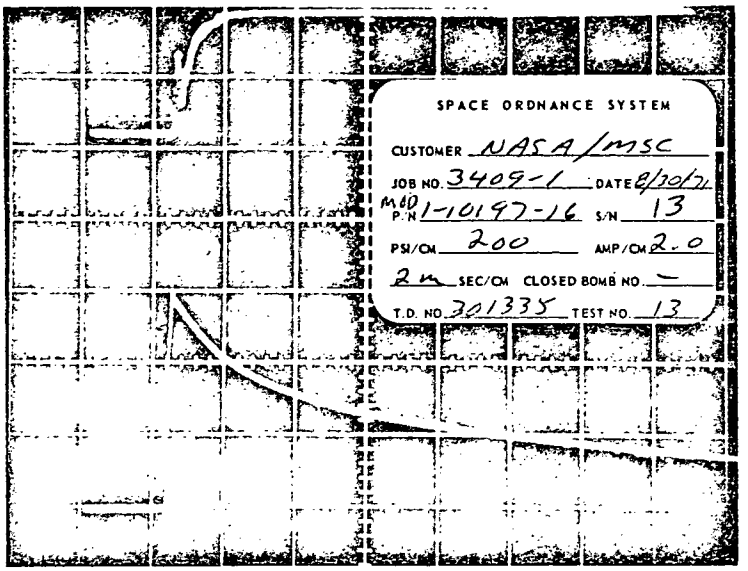
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. 13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JOB NO. 3409-1 DATE 8/30/71
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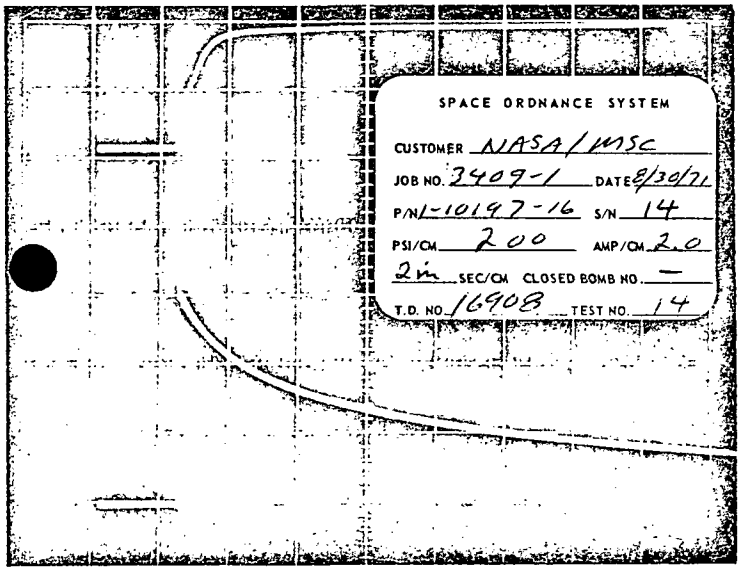
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 301335 TEST NO. 13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CUSTOMER NASA/MSC
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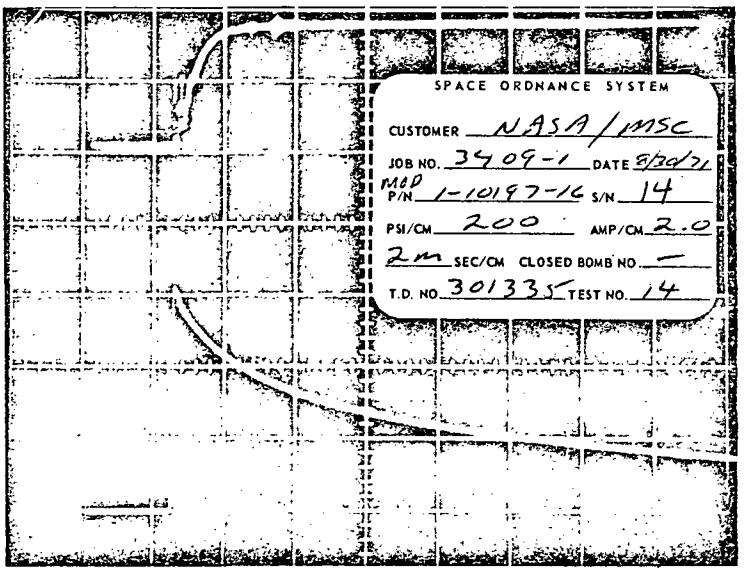
P/N 1-10197-16 S/N 14
PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO. —
T.D. NO. 16908 TEST NO. 14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CUSTOMER NASA/MSC
JOB NO. 3409-1 DATE 8/30/71
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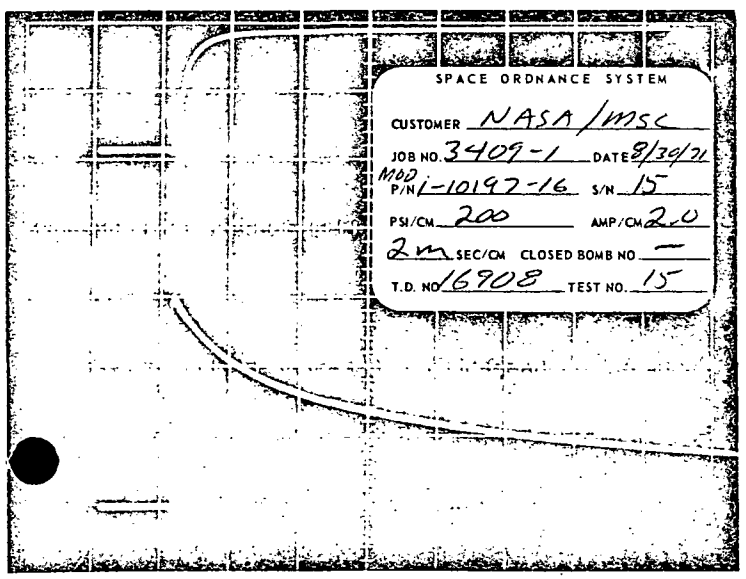
T.D. NO. 301335 TEST NO. 14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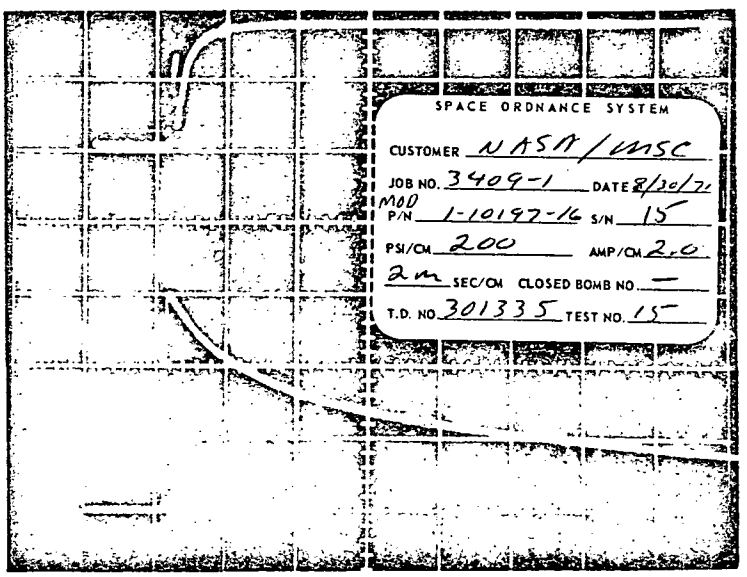
T.D. NO. 16908 TEST NO. 15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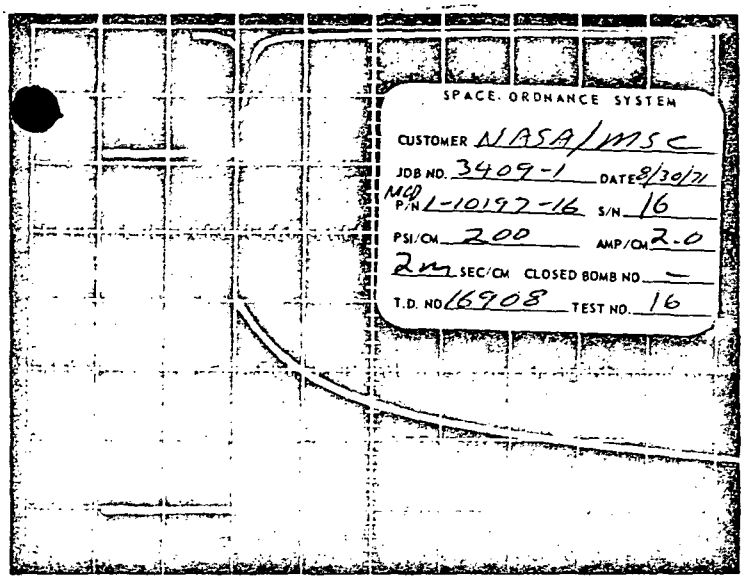
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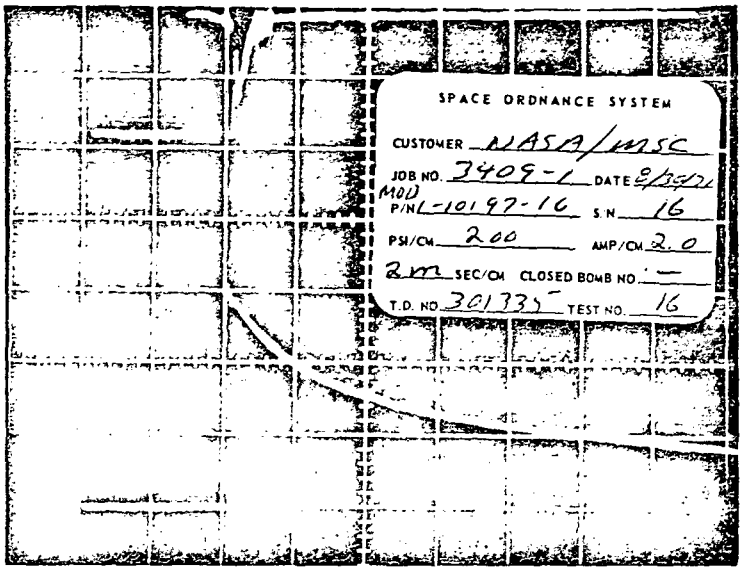
T.D. NO. 16908 TEST NO. 16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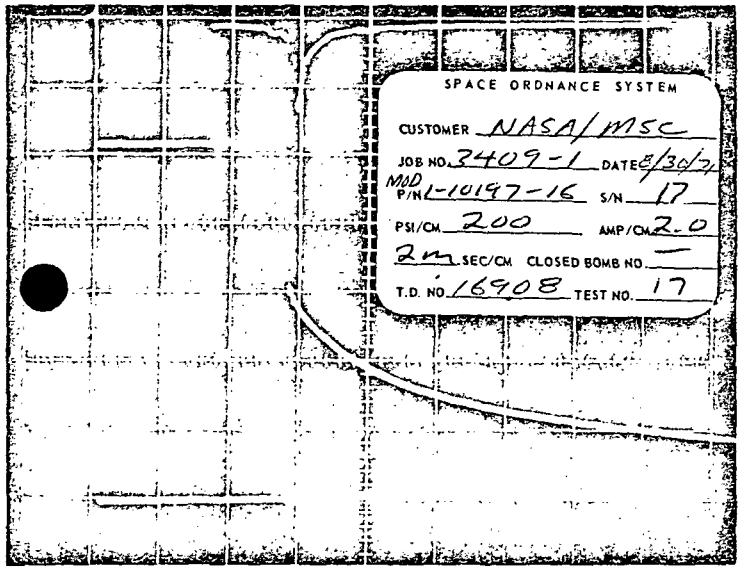
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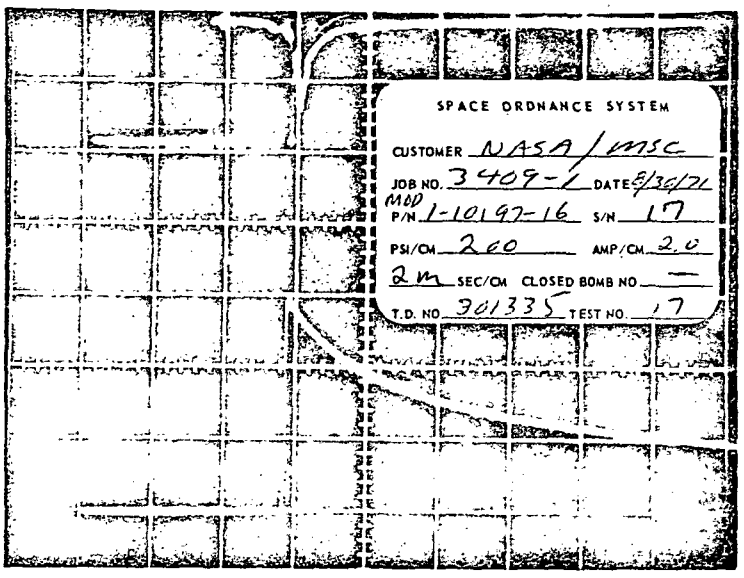
T.D. NO. 16908 TEST NO. 17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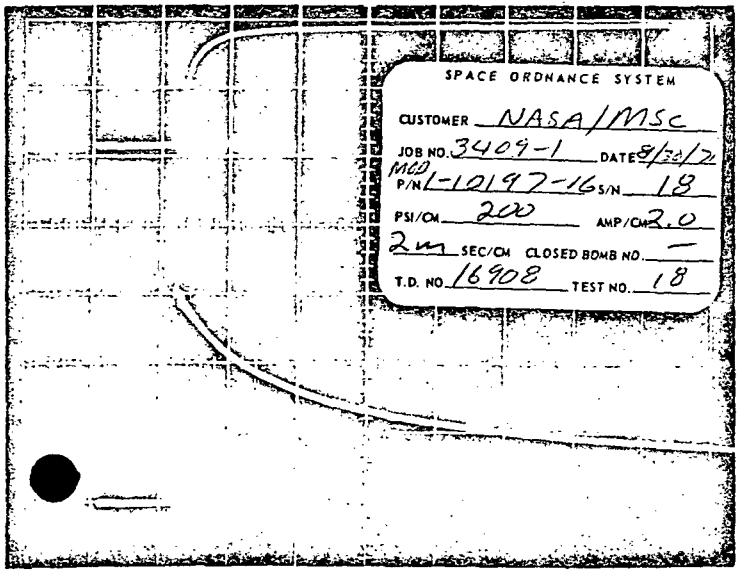
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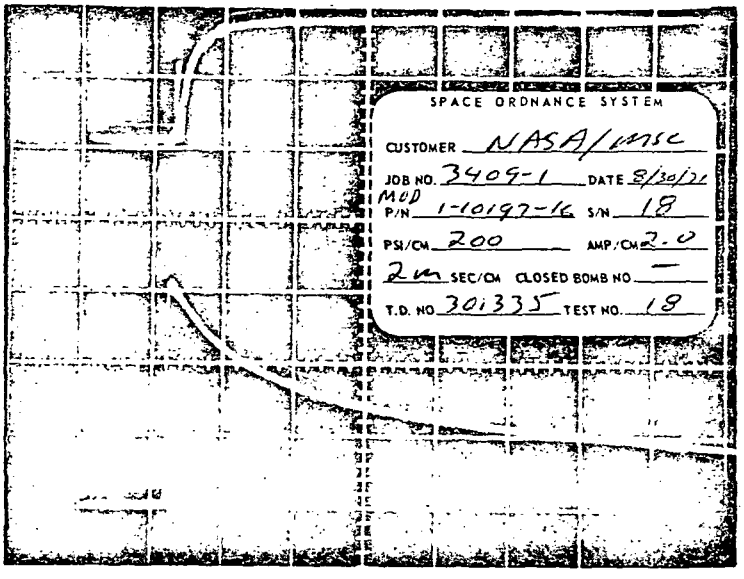
T.D. NO. 16908 TEST NO. 18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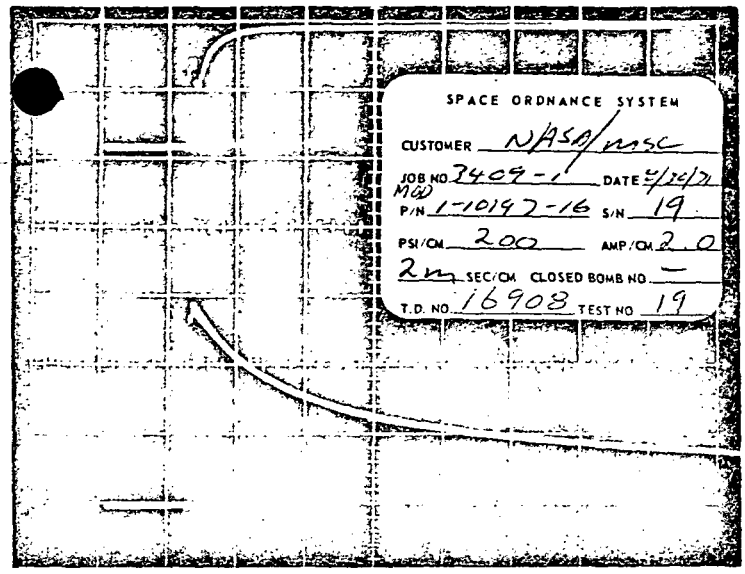
T.D. NO. 301335 TEST NO. 18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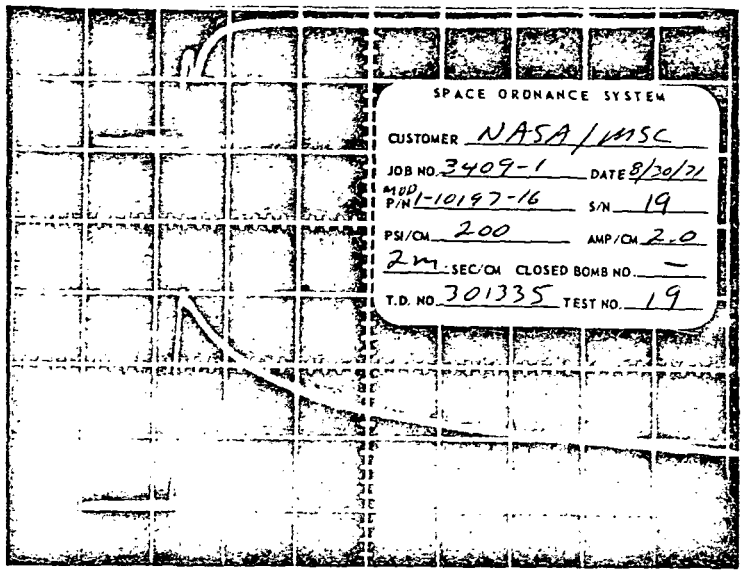
T.D. NO. 16908 TEST NO. 19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JOB NO. 3409-1 DATE 8/30/71
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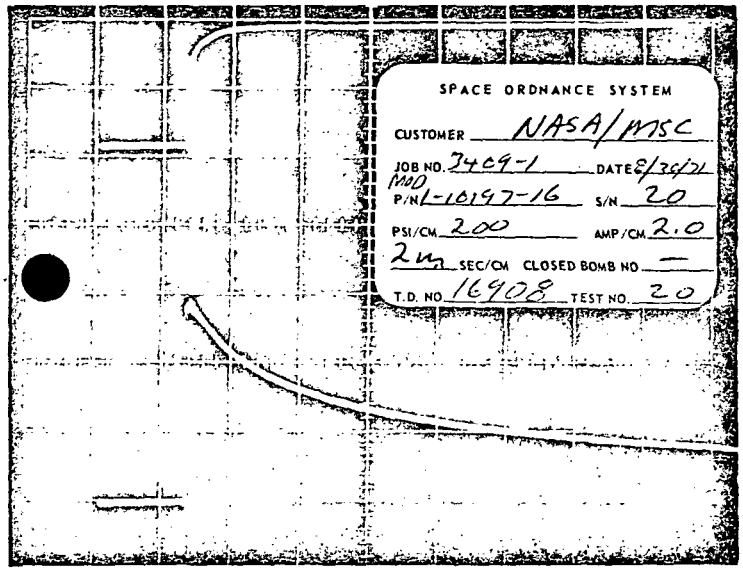
2m SEC/CM CLOSED BOMB NO —
T.D. NO. 301335 TEST NO. 19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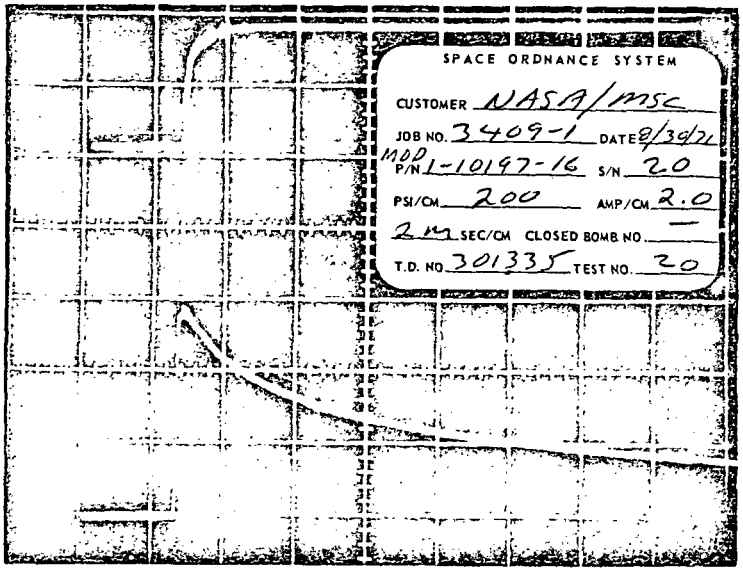
T.D. NO. 16908 TEST NO. 20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JOB NO. 3409-1 DATE 8/30/71
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PSI/CM 200 AMP/CM 2.0
2m SEC/CM CLOSED BOMB NO —
T.D. NO. 301335 TEST NO. 20