

MIL-A-005090E (Wep)

22 April 1963

Used in lieu of

MIL-A-5090D

3 August 1960

MILITARY SPECIFICATION

ADHESIVES, HEAT RESISTANT, AIRFRAME STRUCTURAL, METAL TO METAL

This limited coordination military specification has been prepared by the Bureau of Naval Weapons based upon currently available technical information, but it has not been approved for promulgation as a revision of Military Specification MIL-A-5090D. It is subject to modification. However, pending its promulgation as a coordinated military specification, it may be used in procurement.

1. SCOPE

1.1 Scope - This specification covers the requirements for heat resistant adhesives for use in bonding primary and secondary structural and external metallic airframe parts which will be exposed to temperatures within the range of -67° to 500° F (-55° to 260° C). (See 6.1).

1.2 Classification - Adhesives covered by this specification shall be furnished in one of the following types and classes as specified by the procuring activity. (See 6.4).

Type I - For long-time (192 hours) exposures to temperatures from -67° to 180° F (-55° to 82° C).

Class 1 - High peel and tensile strength.

Class 2 - Normal peel and tensile strength.

Type II - For long-time (192 hours) exposures to temperatures from -67° to 300° F (-55° to 149° C).

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Type III - For long-time (192 hours) exposures to temperatures from -67° to 300° F (-55° to 149° C) and short-time (10 minutes) exposures to temperatures from 300° to 500° F (149° to 260° C).

Type IV - For long-time (192 hours) exposures to temperatures from -67° to 500° F (-55° to 260° C).

See 6.2 for definition of long-time and short-time exposures.

1.2.1 There shall be no restrictions, other than those imposed by the technical requirements of this specification, on the physical forms (such as liquid, film, powder, or multiple or mixed systems thereof) in which the adhesives are submitted. However, the manufacturer shall identify each product submitted under this specification according to its type number and physical form.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Federal

QQ-A-362 - Aluminum Alloy Plate and Sheet, Alclad 2024.

PPP-C-96 - Cans, Metal, 28 Gage and Lighter.

Military

MIL-S-3136 - Standard Test Fluids, Hydrocarbons.

MIL-F-5566 - Fluid, Anti-Icing (Isopropyl Alcohol).

MIL-H-5606 - Hydraulic Fluid, Petroleum Base, Aircraft and Ordnance.

MIL-J-5624 - Jet Fuel, Grades JP-3, JP-4, and JP-5.

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Military (continued)

- MIL-A-9067 - Adhesive Bonding, Process and Inspection Requirements for
- MIL-S-25043 - Steel Plate, Sheet, and Strip, 17-7 PH, Corrosion Resistant, Precipitation Hardening.

STANDARDS

Federal

- FED-STD-151 - Metals, Test Methods.
- FED-STD-175 - Adhesives, Methods of Testing.

Military

- MIL-STD-10 - Surface Roughness, Waviness and Lay.
- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 - Marking for Shipment and Storage.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications - The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply:

CONSOLIDATED CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules.

(Application for copies of the above publication should be addressed to the Consolidated Classification Committee, 202 Chicago Union Station, Chicago 6, Illinois.)

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3. REQUIREMENTS

3.1 Qualification - The adhesive furnished under this specification shall be a product which has been tested and has passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable Qualified Products List.

3.2 Materials - The adhesives shall be thermosetting. There shall be no restrictions on the chemical types or physical nature of materials used in the adhesives except those imposed by these and other technical requirements of this specification.

3.2.1 Specifications and standards for all materials and parts, and Government certification and approval of processes and equipment which are not specifically designated herein and which are necessary for the execution of this specification, shall be as designated by the procuring activity.

3.2.2 Liquid form - Adhesives in liquid form shall mix readily to a smooth solution or suspension of consistency suitable for application and shall be free of lumps. The components shall not settle out or separate during a normal working day.

3.2.3 Film form - Film adhesives shall consist either entirely of adhesive or adhesive with a carrier. The film thickness (in mils) and corresponding weight (in pounds per square foot to the nearest 0.001 pound) shall be stated. Film adhesives of a given type and composition manufactured in more than one weight range shall be submitted for separate testing and qualification approval. Films within a range of ± 20 percent of the medial weight shall be considered within one weight range when more than two weight ranges of a product are available. Approval of both the maximum and minimum weight products will then convey automatic approval of products of same type and composition with weights between the maximum and minimum.

3.2.4 Curing agents - If necessary, curing agents may be used and shall be supplied in powder or liquid form for mixing with the adhesive.

3.2.4.1 Curing agents and solvents (3.2.5) shall be noncorrosive to the surfaces bonded. Specimens tested in accordance with 4.3.5 shall not show corrosion attributable to the bonding materials.

3.2.5 Solvent - If a solvent is required as a separate thinner or activator, it shall be furnished by the adhesive manufacturer. The solvent shall be noncorrosive to the surfaces bonded.

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3.2.6 Filler - If necessary, a filler may be incorporated in or furnished for addition to the adhesive. Any such filler shall be considered as a part of the adhesive system and shall remain uniformly dispersed and suspended in the mixed adhesive during its normal pot life. If contained in the adhesive as furnished, the filler shall be readily dispersible throughout the adhesive during its entire usable storage life. The filler shall be highly moisture and corrosion resistant and shall withstand the maximum temperature to which the particular type of adhesive in which it is used is subjected both during cure and in end use.

3.2.7 Formulation changes - An adhesive shall be approved only for the formulation on which qualification tests are made. Approval of an adhesive as a type II, III, or IV adhesive does not convey automatic approval of same as an adhesive of lower type number nor does approval of a given form of adhesive within a given type convey automatic approval of another form of the same type even though the two forms may be of the same basic chemical composition. Film adhesives of a given basic chemical composition and type, but with different fillers or carriers, shall be considered as different forms of that adhesive and shall require specific and separate qualification approval. Any changes by the manufacturer, such as the adding of materials, pigments, hardeners, carriers, dyes, and fillers, or changing the type or form of the adhesive or the method of manufacture or changing the mixing application (including metal treatment) or curing procedures, or any other change, shall be cause for designating the adhesive as a new product which shall not be considered approved and which shall require specific and separate qualification testing and approval. The changed adhesive shall be given a new code number and shall be resubmitted for approval under this specification.

3.2.8 Identification of product -

3.2.8.1 Trade name and code number - The manufacturer shall designate each adhesive by a trade name and code number which shall be used to identify the adhesive.

3.2.8.2 Use of MIL designations - MIL designations shall not be applied to a product, except for qualification test samples, nor referred to in correspondence, until notice of approval has been received from the activity responsible for qualification.

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TABLE I. Mechanical properties of bonded joints

Test number	Property	Test conditions	Number of specimens to be tested ¹	Paragraph reference	Minimum average strength requirements (PSI) ¹			
					Type I adhesive ² Class 1 Class 2	Type II adhesive ²	Type III adhesive ²	Type IV adhesive ²
1	Tensile shear	Normal temperature, 75° ± 5° F	6	4.5.5.1	3,4,500	3,2,500	3,2,250	3,2,250
2	Tensile shear	10 minutes at 180° ± 5° F	6	4.5.5.2	3,2,500	3,1,250	.....	.....
3	Tensile shear	10 minutes at 300° ± 5° F	6	4.5.5.2	.....	.....	3,2,000	3,2,000
4	Tensile shear	192 hours at 300° ± 5° F	6	4.5.5.2	.....	.....	2,000	2,000
5	Tensile shear	10 minutes at 500° ± 5° F	6	4.5.5.2	.....	.....	.....	3,1,850
6	Tensile shear	192 hours at 500° ± 5° F	6	4.5.5.2	.....	.....	.....	.....
7	Tensile shear	10 minutes at -67° ± 5° F	6	4.5.5.3	4,900	2,500	2,250	2,250
8	Fatigue strength	Normal temperature, 75° ± 5° F	15	4.5.5.4	750 at 10 ⁶ or 600 at 10 ⁷ cycles			
9	Creep-rupture	1,600 PSI at normal temperature, 75° ± 5° F	6	4.5.5.5 and 4.5.5.7	192 hours, 0.015 inch (max) deformation			
10	Creep-rupture	800 PSI at 180° ± 5° F	6	4.5.5.6 and 4.5.5.8	192 hours	.....	.....	.....
11	Creep-rupture	800 PSI at 300° ± 5° F	6	4.5.5.6 and 4.5.5.8	0.015 inch (max) deformation	.....	192 hours	192 hours
					.....	.....	0.015 inch (max) deformation	0.015 inch (max) deformation

TABLE I. Mechanical properties of bonded joints - Continued

Test number	Property	Test conditions	Number of specimens to be tested ¹	Paragraph reference	Minimum average strength requirements (PSI) ¹				
					Type I adhesive ²		Type II adhesive ²	Type III adhesive ²	Type IV adhesive ²
					Class 1	Class 2			
12	Creep-rupture	800 PSI at 500° ± 5° F	6	4.5.5.6 and 4.5.5.8	.....	.....	.....	.....	192 hours 0.015 inch (max) de- formation 3 2,100
13	Tensile shear	Normal temperature, 75° ± 5° F after 30 days salt-water spray	6	4.5.5.9	3,600	3 2,250	3 2,100	3 2,100	3 2,100
14	Tensile shear	Normal temperature, 75° ± 5° F after 30 days at 120° ± 5° F, 95 to 100 percent relative hu- midity.	6	4.5.5.9	3,600	2,250	2,100	2,100	2,100
15	Tensile shear	Normal temperature, 75° ± 5° F after 7 days immersion in the respective fluids of table II, except 30 days immersion in tap water. ⁴	6	4.5.5.9	3,600	2,250	2,100	2,100	2,100
16	T-peel	Normal temperature, 75° ± 5° F	6	4.5.5.10	50	40	.....	.....	.....
17	Blister detection, tensile shear	Normal temperature, 75° ± 5° F	15	4.5.5.11	3,600	2,250	.....	.....	.....

¹ Of the 6 specimens, 2 shall be from each of the batches of adhesive (4.5.2). Of the 15 specimens, 5 shall be from each of the batches of adhesive (4.5.2). The average strength shall meet the respective minimum average requirement, and the strength of any individual specimen shall be not less than 80 percent of this minimum average requirement.

² Tests applicable to types I and II adhesives are to be made with aluminum-alloy specimens and tests applicable to types III and IV adhesives are to be made with corrosion-resisting steel specimens (see 4.4).

³ These strength requirements also apply to storage life tests (see 4.5.5.12).

⁴ See table II.

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3.3 Working characteristics -

3.3.1 Application - The adhesives shall be capable of being readily applied to treated surfaces of the metals (see 6.1) in accordance with the manufacturer's instructions, at room temperatures at least between 60° and 100° F (16° and 38° C); and at relative humidities at least up to 75 percent.

3.3.2 Pot life - The minimum pot life of the mixed adhesive, ready and usable for bonding, shall be of practical length for production fabrication applications, preferably 8 hours or longer.

3.3.3 Curing conditions - Unless otherwise approved by the procuring activity, the curing time, temperature, and pressure shall be within the limitations specified herein.

3.3.3.1 Curing time and temperature - Type I and type II adhesives shall require not longer than 2 hours for curing at a temperature not to exceed 350° F (177° C) at the glue line, and type III and type IV adhesives shall require not longer than 2 hours for curing at temperature not to exceed 700° F (371° C) at the glue line. If lower curing temperatures are specified, increasingly longer curing periods may be used.

3.3.3.2 Curing pressure - The pressure required for curing the bonded test panels described in this specification shall not exceed 200 pounds per square inch (PSI) (see 6.1).

3.3.3.3. Post-curing - Post-curing (curing beyond the regular time-temperature-pressure cycle at a reduced temperature or pressure or both) is not desirable but will be acceptable for type III and type IV adhesives which attain all the respective minimum strength requirements of this specification only through such post-curing.

3.3.4 Storage life - The adhesive manufacturer shall determine and report the optimum temperature at which the adhesive and curing agents, when stored in airtight containers or wrapped in suitable vapor barrier material, will retain their capabilities of conforming to the applicable minimum strength requirements of table I (see also 4.5.5.12) for the longest period of time from date of manufacture. Both temperature and time shall be reported (see 3.5). The maximum time during which the adhesive, packaged as specified above, will retain such capabilities when stored at 75° ± 2° F (24° ± 1.1C) shall also be determined and reported. The two so reported conditions of storage temperature and time shall then constitute the respective conditions under which

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the submitted adhesive shall be stored in preparation for the storage life tests specified in 4.5.5.12.

3.4 Mechanical properties - Mechanical properties of test specimens prepared and tested as specified in section 4 shall conform to the respective requirements listed in table I.

3.5 Instruction sheet - The manufacturer shall provide a dated, coded, and titled instruction sheet with the test report supplied when requesting qualification (see 4.5.4) and also with each shipment of adhesive (see 5.1.3) outlining instructions for its use on aluminum alloy or corrosion-resisting steel alloy sheets, or both. The instruction sheet shall include the following information:

- (a) The general chemical type of the base resin used in the adhesive, such as phenolic-neoprene, epoxy, or vinyl-phenolic. The carrier (for a film adhesive), if used, shall also be identified. Each part of a multiple-part adhesive system shall be separately and fully described.
- (b) Instructions on the use of a thinner or solvent with the adhesive, including minimum, optimum, and maximum amounts to be used.
- (c) Mixing instructions, including type and percentage of curing agents, filler, and temperature controls necessary during mixing, and maximum pot life of the mixed adhesive.
- (d) Complete processes and treatments for preparing the metal faying surfaces prior to their bonding with the submitted adhesive. These shall include a parts-by-weight listing of all ingredients of mixed cleaning media and etches, and full details of mixing and using procedures, temperatures, times, rinsing media, and drying requirements; also maximum allowable storage time and necessary temperature - humidity controls and protective measures necessary during storage before application of the adhesive. (See also 3.5 (i).)
- (e) Application instructions including spread method, number of coats, spread rate, weight range, application

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temperature and relative humidity (if other than those specified 3.3.1) and acceptable glue-line (bond) thickness range before and after cure. (See also 3.5.(1).)

TABLE II. Fluids for panel immersion tests

Fluids	Specifications	Immersion
Water	Distilled or not containing more than 200 parts per million of total solids	30 days \pm 2 hours
Jet engine fuel JP-4	MIL-J-5624	7 days \pm 2 hours
Anti-icing fluid	MIL-F-5566	7 days \pm 2 hours
Hydraulic oil	MIL-H-5606	7 days \pm 2 hours (for types I and II adhesives)
Standard test fluids	MIL-S-3136, type III	7 days \pm 2 hours

- (f) Drying time between coats and after last coat. If a force dry is required, the time and temperature shall be stated.
- (g) Maximum allowable open assembly time and temperature-humidity controls and protective measures necessary during storage for adhesive-coated metal prior to assembly.
- (h) Maximum allowable closed assembly time and temperature-humidity controls and protective measures necessary during storage for adhesive-coated and assembled parts prior to cure.
- (i) Typical time, temperature, and pressure for each segment of the complete curing cycle giving maximum and minimum limits for each condition.

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- (j) Information required by 3.3.4.
- (k) Necessary safety precautions to be observed throughout all operations.
- (l) Any other pertinent information relative to the use and storage of the adhesive or curing agent, or both.

3.6 Workmanship - Liquid adhesives shall be free of foreign matter and shall be prepared in accordance with the best commercial practices for this material. Film adhesives shall be substantially free of folds, foreign matter, wrinkles, and shall have not more than two holes of 1/8-inch maximum diameter per square inch which penetrate through the film.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection responsibility - The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests - The inspection and testing of the adhesives shall be classified as follows:

- (a) Qualification tests (see 4.5).
- (b) Acceptance tests (see 4.6).

4.3 Test conditions -

4.3.1 Normal (room temperature conditions) - Strength properties shall be determined for types I, II, III, and IV adhesives at $75^{\circ} \pm 5^{\circ} F$ ($24^{\circ} \pm 2.8C$), no sooner than 10 minutes after specimens have reached equilibrium at such temperature. If the validity of property values determined within this range is questionable, the test shall then be repeated under a standard $73.4^{\circ} \pm 2^{\circ} F$ ($23^{\circ} \pm 1^{\circ} C$), and 50 ± 4 percent relative humidity. Specimens shall then be tested only after being exposed for 4 days to this temperature and humidity.

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4.3.2 Elevated temperature conditions - Strength properties of type I adhesives shall be determined at $180^{\circ} \pm 5^{\circ} \text{F}$ ($82^{\circ} \pm 2.8^{\circ} \text{C}$), dry heat; those of types II, III, and IV adhesives shall be determined at $300^{\circ} \pm 5^{\circ} \text{F}$ ($149^{\circ} \pm 2.8^{\circ} \text{C}$), dry heat; and those of types III and IV shall be determined at $500^{\circ} \pm 5^{\circ} \text{F}$ ($260^{\circ} \pm 2.8^{\circ} \text{C}$), dry heat, 10 minutes after the specimens have reached equilibrium at those respective temperatures. No less than 3 minutes nor more than 10 minutes shall be required to bring the bonded area of the test specimen to the required temperature after the specimen has been placed in the conditioning chamber. Strength properties of types II, III, and IV adhesives shall be determined at $300^{\circ} \pm 5^{\circ} \text{F}$ ($149^{\circ} \pm 2.8^{\circ} \text{C}$), dry heat; and those of type IV adhesives shall be determined at $500^{\circ} \pm 5^{\circ} \text{F}$ ($260^{\circ} \pm 2.8^{\circ} \text{C}$), 192 hours after the specimens for these long-time elevated temperature strength tests (tests Nos. 4 and 5 of table I) have reached equilibrium at those respective temperatures. These specimens for the long-time elevated temperature tests may be placed in circulating air ovens for the 192-hour period, after which they shall be transferred to the preheated unit of the testing machine. Specimens should not be subjected to thermal shock while being transferred between test ovens. The final testing temperatures of all elevated temperature test specimens shall be of the surface of the metal in the approximate center of the bonded area and shall be determined with a thermocouple attached to the specimen in order to insure accuracy of testing temperature and reproducibility of data. The junction of the thermocouple shall be firmly attached to the specimen in immediate contact with the metal in the position shown in figure 1. A prototype specimen, located as near to the test specimen as is practicable, may be used as an alternate method to establish specimen temperature. In this alternate method, thermocouples shall be bonded in the joint in the area shown in figure 1, in both prototype specimen and a specimen located in normal test position in the test fixture. Correlation between the two temperature readings shall then be determined as a guide for subsequent tests.

4.3.3 Low temperature condition - Strength properties shall be determined at $-67^{\circ} \pm 5^{\circ} \text{F}$ ($-55^{\circ} \pm 2.8^{\circ} \text{C}$) for types I, II, III, and IV adhesives, 10 minutes after specimens have reached equilibrium at the temperature. The surface of the metal of the bonded area shall be $-67^{\circ} \pm 5^{\circ} \text{F}$ ($-55^{\circ} \pm 2.8^{\circ} \text{C}$) as determined with a thermocouple attached to the specimen. The junction of the thermocouple shall be firmly attached to the specimen in immediate contact with the metal in the position shown in figure 1. The prototype specimen technique described in 4.3.2 may be used for these temperature measurements. No longer than 10 minutes shall be required to bring the bonded area to the required temperature after the specimen has been placed in the conditioning chamber.

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4.3.4 Salt water spray condition - Resistance to salt spray shall be determined by exposure of the panels for 30 days, ± 2 hours in accordance with the requirements of Federal Test Method Standard No. 151, except as hereby modified. The bonded test panels shall be vertically suspended from the top by means of glass hooks, waxed strings, or other nonmetallic materials through holes as indicated in figure 2 with the plane of the panel parallel to the principal direction of flow of the salt spray through the chamber. Individual panels shall not contact each other or any metallic material.

4.3.5 High humidity condition - Resistance to humidity exposure shall be determined after 30 days ± 2 hours exposure of the panels in a humidity cabinet in which the exposure zone of the closed humidity chamber is maintained at $120^{\circ} \pm 5^{\circ}$ F ($49^{\circ} \pm 2.8^{\circ}$ C) and 95 to 100 percent relative humidity. The temperature in the chamber shall be recorded at least twice each working day. Condensate from one panel shall not drip upon any other panel. Distilled water or water containing not more than 200 parts per million of total solids shall be used to maintain the humidity. The test shall be continuous for the duration of the 30 day period. Continuous operation means that the chamber shall be closed and the humidity maintained continuously except for short daily interruptions necessary to inspect, rearrange, or remove test panels, or to check or replenish the water in the reservoir. The panels shall be suspended as specified in 4.3.4 and shall not contact the water used to maintain the humidity; each other, any metallic material, or any material that may act as a wick.

4.3.6 Fluid immersion conditions - Panels shall be immersed in the respective fluids listed in table II for 7 days ± 2 hours, except that 30 days ± 2 hours shall be used for the water immersions. The temperature of these fluids should be maintained at 70° to 80° F (21° to 27° C). The water immersion panels shall also be suspended from the edge of a hole as shown in figure 2. The remaining panels need not be so suspended. However, all panels must be so suspended or set in the containers as to insure full contact of the respective fluids with the bonded area of the test panels. Faces of panels immersed in the same container of fluid shall not contact each other; panels shall contact the container only at the panel corners or the 9-inch edges.

4.3.7 All panels to be exposed to the conditions specified in 4.3.4, 4.3.5, and 4.3.6, except those specimens taken from the ends of the panels for control-strength test purposes (4.4.2.3), shall be immersed as bonded (complete, preslotted, or prepunched) (see 4.4 and figures 3 and 4) edges unprotected and prior to being cut into specimens.

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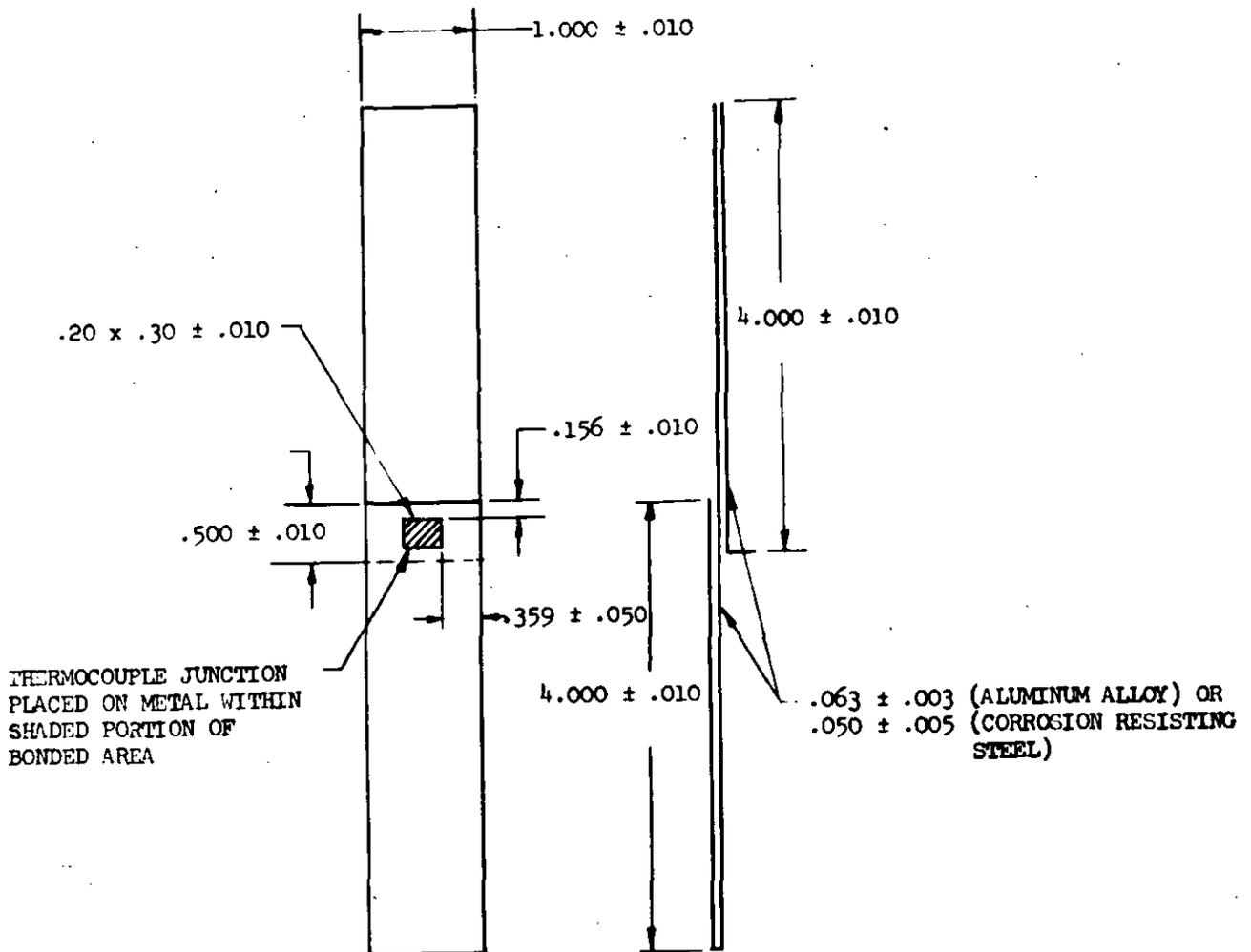
4.4 Preparation of test panels and specimens - Panels as shown in figures 2 through 7 shall be prepared in sufficient quantities (see 4.4.2), from a given type of adhesive to furnish the necessary number of specimens for all the tests applicable to that particular type of adhesive listed in table I. Panels for testing types I and II adhesives for all applicable table I properties shall be prepared from 0.063-inch clad 2024-T3 aluminum-alloy sheet conforming to Specification QQ-A-362 (2024-T3 clad aluminum alloy is the same material formerly designated as 24S-T3). Panels for testing types III and IV adhesives for all applicable table I properties shall be prepared from 0.050 inch 17-7 PH corrosion-resisting steel, condition TH-1050, conforming to Specification MIL-S-25043, with finish equivalent to No. 2 dull of type 301 corrosion-resisting steel. These corrosion-resisting steel specimens shall be made either in the form of complete lap joint panels (figures 2 and 3) or prepunched panels of the general type shown in figure 5 to eliminate sawing of the specimens after bonding (see 4.4.1 and 6.3).

4.4.1 All edges of the metal panels and specimens which will be within (or which will bound) the joints shall be machined true (without burrs or bevels and at right angles to faces) and smooth (RHR 140 maximum, in accordance with Standard MIL-STD-10) before the panels are surface treated and bonded. The metal treating and bonding procedures employed shall be in accordance with the adhesive manufacturer's instruction sheet. All test panels shown in figures 2 and 3 shall have an overlap of 0.500 ± 0.010 inch except the figure 3 fatigue test panels, which shall have an overlap of 0.375 ± 0.010 inch. Panels so prepared shall be cut into 1-inch wide specimens for testing in accordance with the provisions of applicable tests. Panels shall not be cut into specimens until at least 24 hours after bonding. Aluminum-alloy panels may be sawed with a band-saw, with the setting and spacing of teeth and operational speed adjusted to hold frictional heating of the bond to a minimum. Corrosion-resisting steel panels (figures 2 and 3) may be cut with a water-cooled abrasive wheel, bandsaw, or a staggered-tooth milling tool with suitable cutting fluid at such operational speed as will hold frictional heating of the bond to a minimum (see 6.3). All panels and specimens shall be so marked that each specimen can be identified at any time with the particular panel from which it was cut and with the particular batch of adhesive with which it was bonded so that any failure may be properly traced to either the adhesive or the mechanics or equipment of bonding.

4.4.2 Number of panels and specimens required for test -

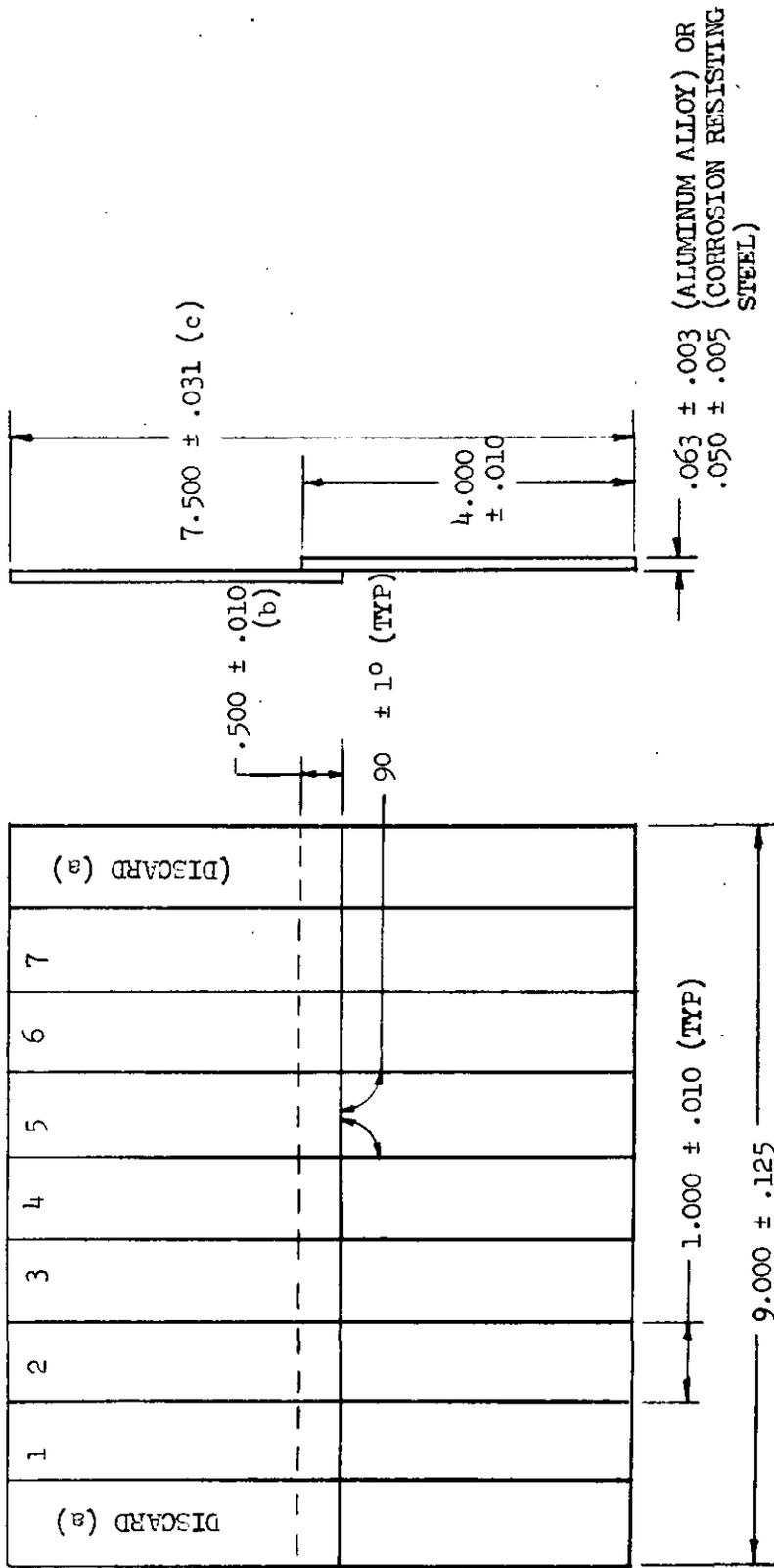
4.4.2.1 Tensile shear and creep-rupture strength (tests Nos. 1 through 7, and 9 through 12 of table I) - Three panels conforming to the dimensions and marking shown in figure 3 (with 1/2-inch lap joint) shall be prepared

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DIMENSIONS IN INCHES.

FIGURE 1. LOCATION OF THERMOCOUPLES ON THE SHEAR TEST SPECIMENS

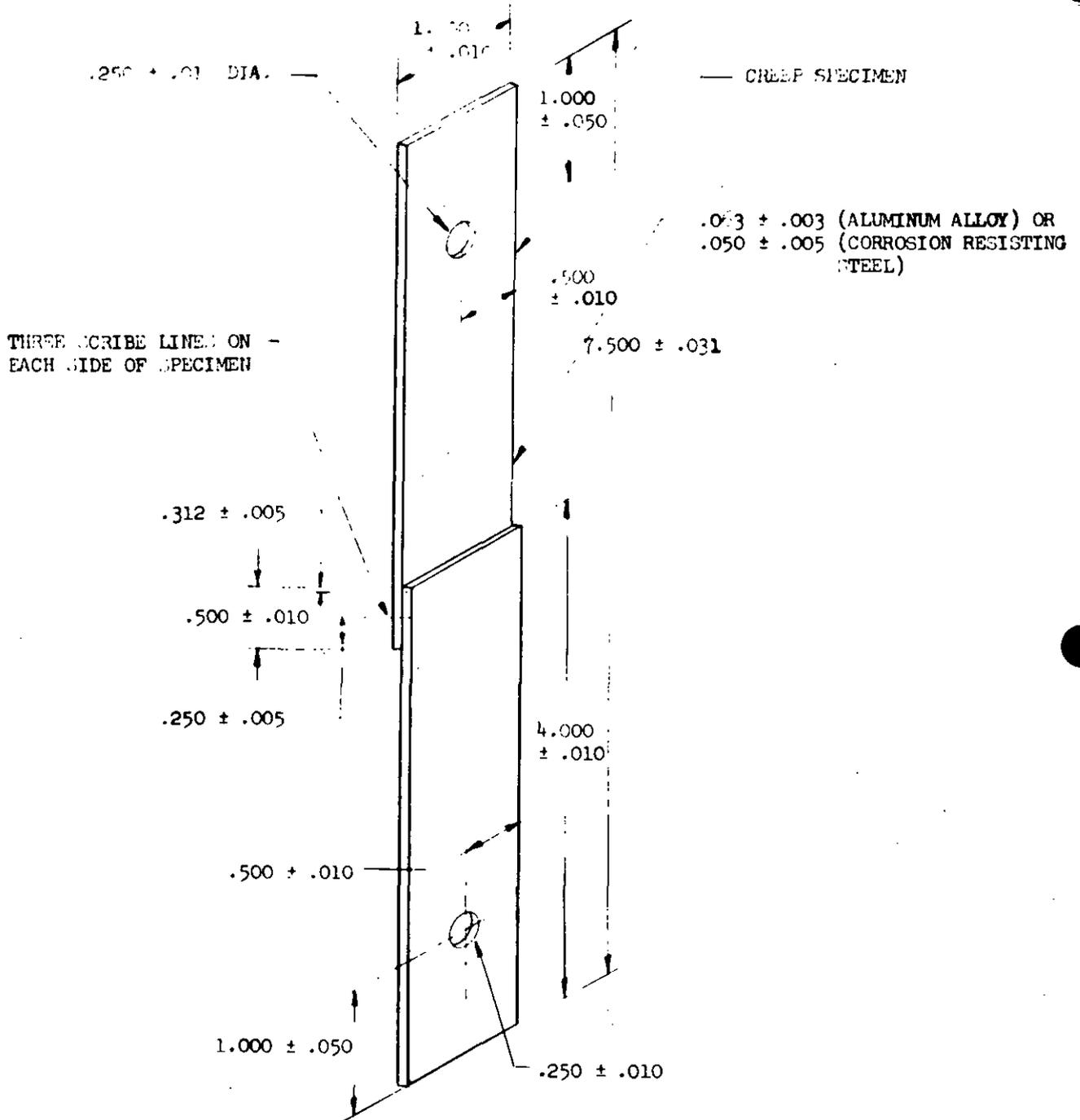


- (a) ALL DISCARDS TO BE OF COMMON WIDTH AS DETERMINED BY WIDTH OF CUTTING TOOL.
- (b) $.375 \pm .010$ FOR FATIGUE SPECIMEN PANEL.
- (c) $7.625 \pm .031$ FOR FATIGUE SPECIMEN PANEL.

DIMENSIONS IN INCHES.

FIGURE 3. STANDARD TEST PANEL

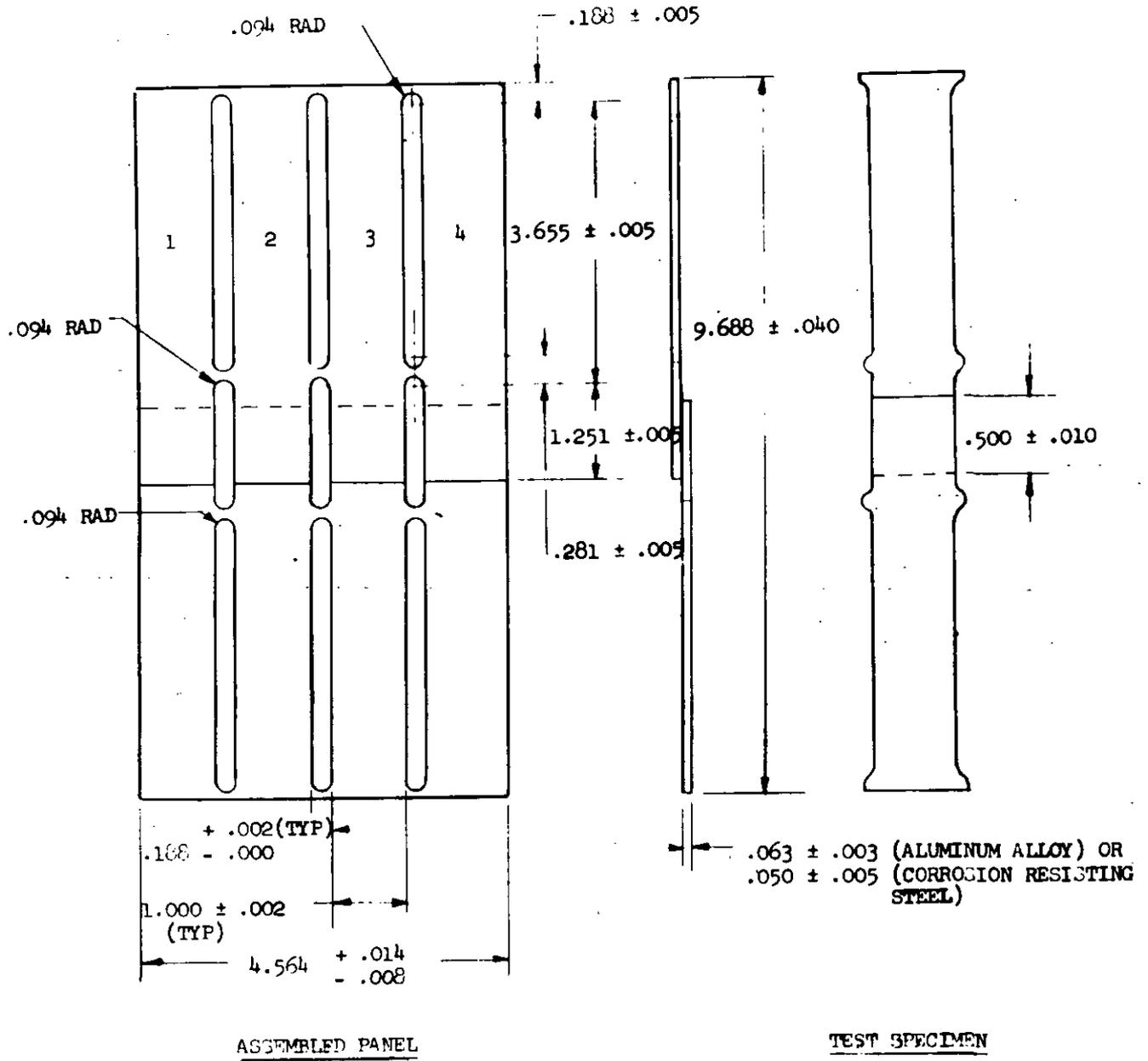
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DIMENSIONS IN INCHES.

FIGURE 4. CREEP RUPTURE TEST SPECIMEN SHOWING LOCATION OF SCRIBE LINES

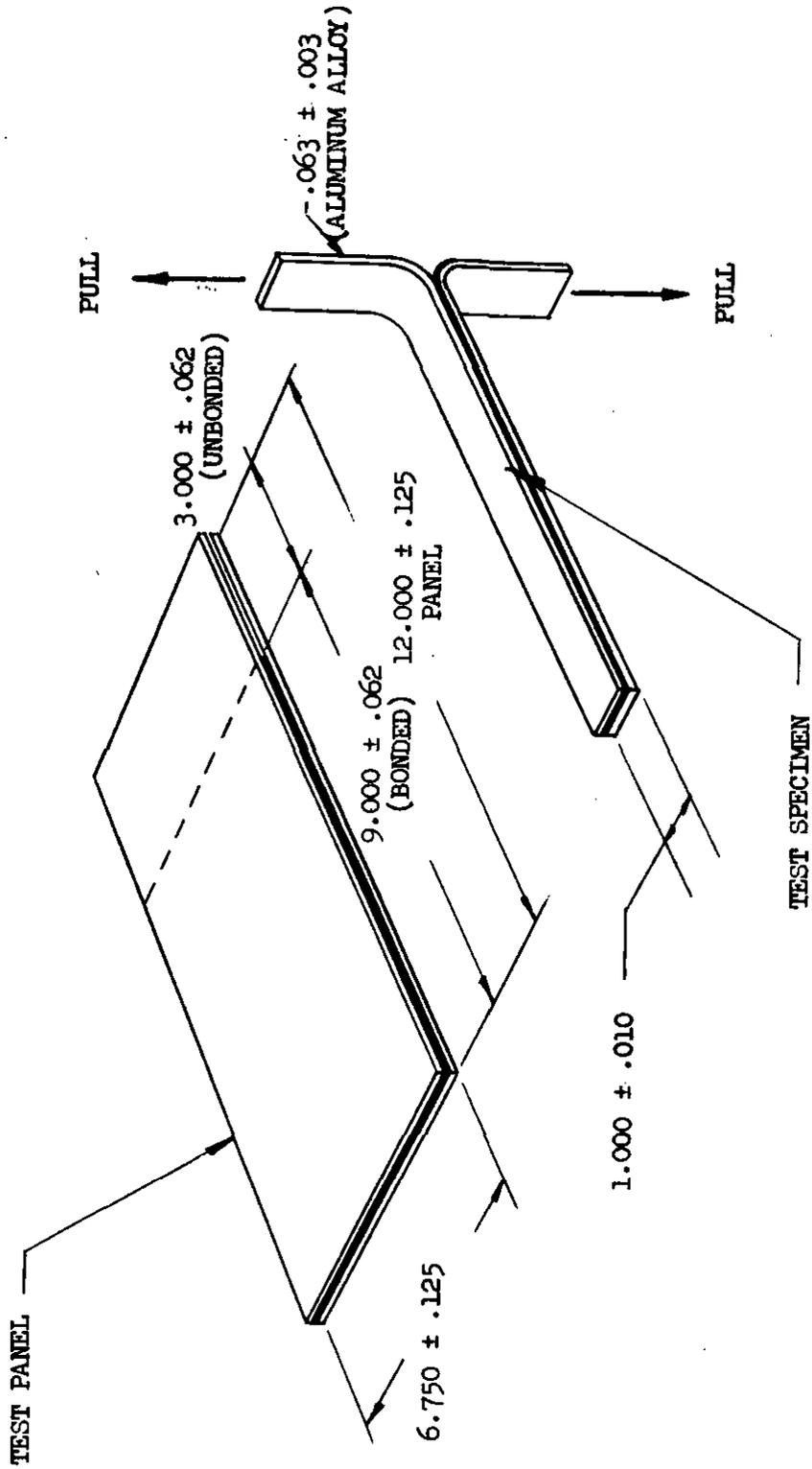
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DIMENSIONS IN INCHES.

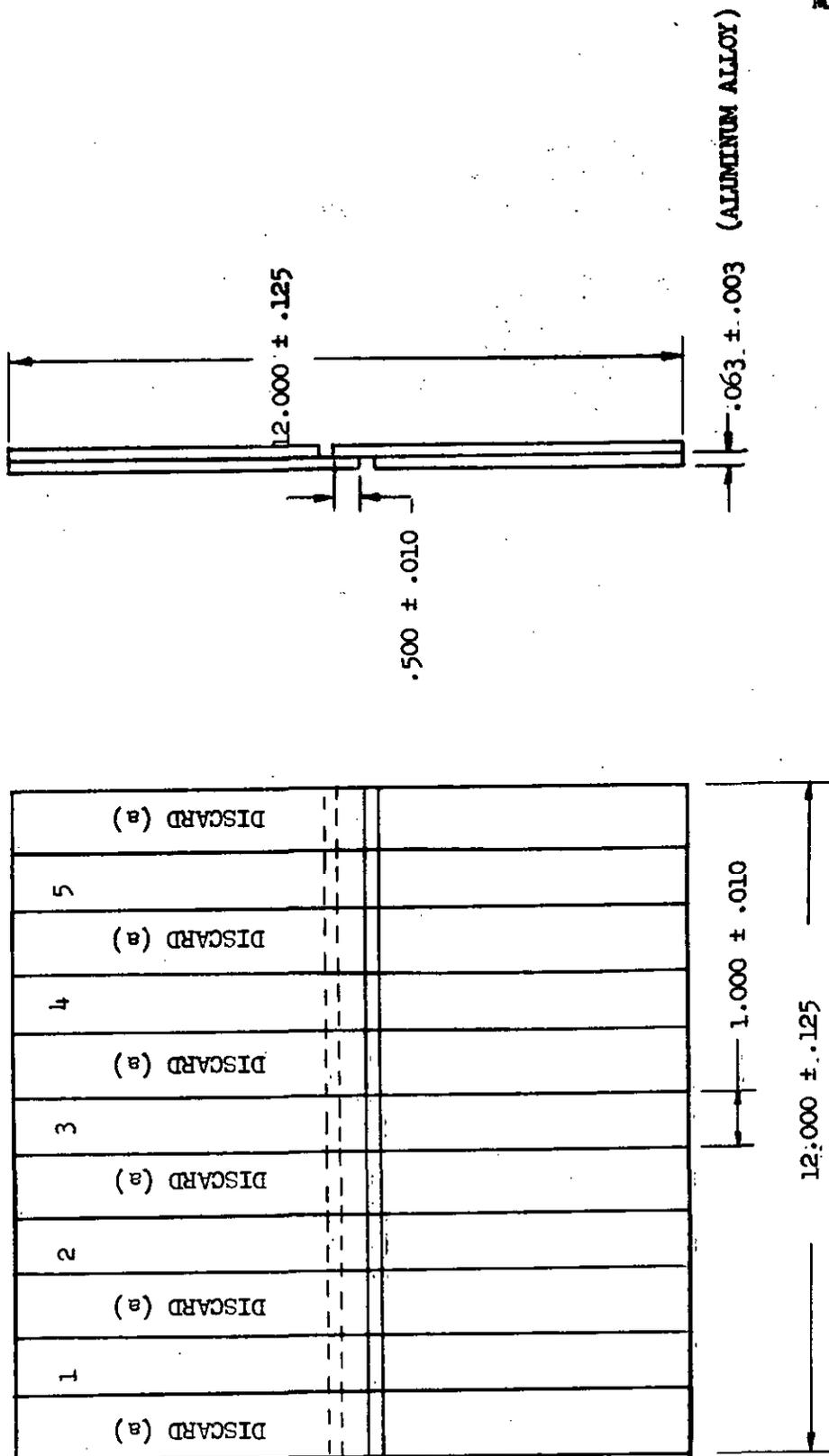
FIGURE 5. OPTIONAL PANEL

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DIMENSIONS IN INCHES.

FIGURE 6. T - PEEL TEST SPECIMEN



(a) ALL DISCARDS TO BE OF COMMON WIDTH AS DETERMINED BY WIDTH OF CUTTING TOOL.
DIMENSIONS IN INCHES.

FIGURE 7. BLISTER DETECTION TEST PANEL

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from each of three different batches of the adhesive being presented for qualification. Each of the resultant 9 panels shall be cut as shown in figure 3 into seven 1-inch-wide specimens. Each of the resultant 63 specimens shall be identified with the particular panel from which it was cut and with the particular batch of adhesive with which it was bonded so that any failure may be traced to either the adhesive or the mechanics or equipment of bonding. Specimens for each of tests Nos. 1 through 7, and 9 through 12, when applicable, of table I and necessary retest specimens shall be taken from the 63 specimens. Respective test procedures and numbers of specimens to be tested by each procedure are specified in 4.5.5.1 to 4.5.5.3 and in 4.5.5.5 to 4.5.5.8. If prepunched panels of corrosion-resisting steel (figure 5) having less than seven specimens per panel are used, the number of panels will need to be modified to have an equivalent total number of specimens.

4.4.2.2 Fatigue (test No. 8 of table I) - One panel conforming to the dimensions and marking shown in figure 3 shall be prepared with a 3/8-inch lap joint from each of the same three batches of the adhesive used in the preparation of the panel specified in 4.4.2.1. Each of these panels shall be cut as shown in figure 3 into seven 1-inch-wide (± 0.010 inch) (after machining) specimens. The edges of the specimens shall be machined smooth. Selection and testing of these specimens shall be as specified in 4.5.5.4.

4.4.2.3 Salt water spray, high humidity, and fluid immersion (tests Nos. 13 through 15 of table I) - Eight panels shall be prepared as shown in figure 2 with each of the same three batches of adhesive used in the preparation of the panels specified in 4.4.2.1 and 4.4.2.2. Control specimens Nos. 1 and 7 shall be cut according to the procedure specified in 4.4.1 from each panel and shall be identified as to panel number as well as specimen number. These control specimens shall be tested at the applicable elevated temperature, 180° F (82° C) for type I adhesive, 300° F (149° C) for type III adhesive, and 500° F (260° C) for types III and IV adhesives after 10 minutes of temperature conditioning as specified in 4.5.5.2. Failure of any one control specimen to meet the specified minimum elevated temperature shear strength requirement of test No. 2, 3, or 5 (as applicable) shall void the panel from which that specimen was cut for use in these exposure tests and a replacement panel shall be prepared. The resultant 24 panels (part-panels) shall then be exposed at the conditions specified in 4.3.4 through 4.3.7, three panels (one panel representative of each batch of adhesive) shall be exposed at each of the conditions. After exposure, the panels shall be cut into individual specimens and tested in accordance with 4.5.5.9. If prepunched panels of corrosion-resisting steel (figure 5) having less than seven specimens per panel are used, the number of panels exposed will need to be changed to have an equivalent total number of specimens.

4.4.2.4 T-peel (test No. 16 of table I) - One panel conforming to the dimensions and marking shown in figure 6 shall be prepared from each of the same three batches of the adhesive used in 4.4.2.1. Each of these panels shall be cut as indicated in figure 6 into six 1-inch-wide (± 0.010 inch) (after machining) specimens. The edges of the specimens shall be machined smooth. Selection and testing of these specimens shall be as specified in 4.5.5.10.

4.4.2.5 Blister detection, tensile shear (test No. 17 of table I) - Three panels conforming to the dimensions and marking shown in figure 7 shall be prepared from each of the same three batches of the adhesive used in the preparation of the panel specified in 4.4.2.1. Each of these panels shall be cut as shown in figure 7 into five 1-inch-wide (± 0.010 inch) (after machining) specimens. The edges of the specimens shall be machined smooth. Testing of these specimens shall be as specified in 4.5.5.11.

4.5 Qualification tests -

4.5.1 Prior qualification - Unless otherwise specified by the procuring activity, adhesives which have not passed the qualification tests, or adhesives which have passed the qualification tests and have been modified in any manner, shall satisfactorily pass the qualification tests prior to acceptance of any adhesive. Qualification tests may be repeated on material previously found satisfactory at any time at the option of the activity responsible for qualification approval.

4.5.2 Sampling instructions - The manufacturer shall submit a duplicate set of bonded panels and specimens which shall be prepared as specified in 4.4 and subparagraphs thereto. These panels shall be prepared with adhesive samples from the same three batches of adhesive and shall be code marked the same as the panels upon which the data given in the test report (4.5.3) were obtained. The manufacturer shall also submit four 1-pint samples of liquid adhesive together with necessary thinners and curing agents, or an equivalent amount of material in weight or measure if of another form, from each of three different numbered batches of the adhesive being presented for qualification. These adhesive samples shall each be from batches of most recent production-scale manufacture, and may be from different batches than those used in preparing the above specified set of duplicate panels. Part of the adhesive samples from each batch will be used in preparing test panels for qualification tests and the balance will be used for storage life tests (4.5.5.12). All samples shall be identified as to name of manufacturer, manufacturer's designation, date of manufacture, base polymer and curing agents (as applicable), the date of submittal, and identification of the activity submitting the

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samples, and forwarded to the Naval Air Material Center (see 6.6). In addition, a statement indicating that the products have not been rebranded shall accompany the samples. If rebranded, the names of the original manufacturers and original designations of the products shall be indicated. All information submitted will be treated as confidential.

4.5.3 Test report - Prior conducting the qualification tests (4.5.5), a dated and numbered report, certified by notarized affidavit, shall be furnished giving the results of all applicable tests listed in table I. The individual specimen and average values for each test shall be reported (see 6.6.2). Each value reported shall be shown as being for a definitely numbered specimen, the numbering of which shall be coded in the report in such a manner as to definitely establish the particular panel from which the specimen was cut and the particular batch of adhesive with which said panel was bonded and the date of bonding. Coded identification of the adhesive batches shall include the respective dates of manufacture and sizes of batch. Dates on which the different tests were performed shall be shown in the test report. The test report shall also cover all the requirements of paragraphs in section 3 (except 3.5). The actual pressure, temperature, and time of curing used in the preparation of the test panels shall be reported. The preparation of the adhesive and of the test panels shall conform to the description given in the instruction sheet and the report shall so state.

4.5.4 Instruction sheet - The manufacturer shall submit attached to the test report, (4.5.3) an instruction sheet in accordance with 3.5.

4.5.5 Tests - The qualification tests shall consist of all the tests of this specification, and shall include approval of the manufacturer's instructions. These tests will be conducted by the Naval Air Material Center (see 6.6.1). Any changes shall be subject to the approval of that activity.

4.5.5.1 Normal temperature tensile shear test (test No. 1 of table I)
The test specimen shall be gripped tightly and uniformly across the ends in the jaws of the testing machine with the jaws and specimen so aligned that the jaws are directly opposite each other, and in such a position that an imaginary straight line will pass through the center of the bonded area and through the points of suspension. The specimen shall be gripped 2 inches \pm 1/4 inch from each edge of the lap joint. The load shall then be applied at a rate of 1,200 to 1,400 pounds per square inch per minute or at an equivalent head speed per minute until failure. The load at failure shall be recorded. The testing machine accuracy shall be within 1 percent. Length and width of shear area shall be measured to the nearest 0.01 inch and shall be recorded. All failing loads shall

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be expressed in pounds per square inch of actual shear area, calculated to the nearest 0.01 square inch. The nature and percent of failure, such as cohesive failure (failure within the adhesive), adhesion failure (adhesive peeling from the metal), or contact failure (lack of complete adhesive-to-metal contact during bonding), and the adhesive thickness shall also be recorded for each specimen. Adhesive thickness shall be the micrometer thickness, measured to the nearest 0.001 inch, of the overall thickness of lap joint less the combined micrometer thickness of the individual pieces of surface-treated metal or the adhesive thickness can be measured with a traveling comparator microscope or an equivalent measuring apparatus. A total of 6 specimens, 2 specimens representative of each of the three batches of adhesive from the lots of specimens prepared as specified in 4.4.2.1, shall be tested. The average and minimum strengths of these 6 specimens shall equal or exceed that specified for test No. 1 in table I. If the strengths, either average or minimum, are less than that specified in table I, two more specimens from each of the three batches of adhesive shall be tested as a retest. If both specimens from the same batch of the adhesive fail to meet the minimum requirements in this retest and those from the other two batches of adhesive are satisfactory, a retest using 3 specimens from that same batch of adhesive shall be run. Like failure in the retest shall cause rejection of the adhesive. The normal temperature shear strengths of all 1/2-inch lap joint specimens tested in accordance with the qualification tests of this specification, except values voided and replaced by retest values, shall be averaged for use in determining the acceptance-test-required normal temperature shear strength (4.6.3.1).

4.5.5.2 Elevated temperature tensile shear test (tests Nos. 2 through 6 of table I) - The 180° F (82° C), 300° F (149° C), and 500° F (260° C) tensile shear tests shall be in accordance with 4.5.5.1 with the added requirement that a suitable oven or furnace shall be provided to maintain the specimens at the specified test temperature (see 4.3.2). Six specimens, selected as specified in 4.5.5.1, shall be tested for tensile shear strength at 180° F (82° C), 300° F (149° C), or at 500° F (260° C), as applicable, for each elevated temperature shear test listed in table I (tests Nos. 2 to 6). The average and minimum shear strength of each set of specimens tested shall equal or exceed that specified in the applicable test of table I. Retest provisions shall be as specified in 4.5.5.1.

4.5.5.3 Low temperature tensile shear test (test 7 of table I) - The low temperature tensile shear test shall be in accordance with 4.5.5.1, with the added requirement that a suitable chamber shall be provided for maintaining the specimen at $-67^{\circ} \pm 5^{\circ} \text{ F}$ ($-55^{\circ} \pm 2.8^{\circ} \text{ C}$) (see 4.3.3). Six specimens, selected as specified in 4.5.5.1, shall be tested for tensile shear strength at $-67^{\circ} \pm 5^{\circ} \text{ F}$ ($-55^{\circ} \pm 2.8^{\circ} \text{ C}$). The average and minimum shear strength of these specimens

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shall equal or exceed that specified for test No. 7 in table I. Like failure in the retest shall cause rejection of the adhesive.

4.5.5.4 Normal temperature fatigue test (test No. 8 of table I) - This test shall be performed in accordance with the general provisions of Method 1061 of Federal Test Method Standard No. 175. Specimens having 3/8-inch overlap (see 4.4.2.2) shall have cyclic axial loads applied by a testing machine at a rate not to exceed 3,600 cycles per minute. The specimens shall be held tightly and in alignment as the load is applied by suitable grips, and these grips shall extend to within $1 \pm 1/8$ inch from the edge of the lap joint. The applied cyclic load shall always be in tension and shall range from the maximum selected to 10 percent of the maximum. The loads shall be accurate to ± 1 percent. Length and width of the shear area shall be measured to the nearest 0/01 inch and shall be recorded. The test shall be run until the specimen fails or until the maximum required number of repeated stresses have been applied (see 4.5.4.1). The number of cycles to failure shall be recorded. The nature and percent of failure, such as cohesive failure (failure within the adhesive), adhesion failure (adhesive pulling from metal), contact failure (lack of complete adhesive-to-metal contact), or tensile metal failure, and the adhesive thickness shall be recorded for each specimen. Adhesive thickness shall be micrometer thickness, measured to the nearest 0.001 inch, of the overall thickness of the lap joint less the combined micrometer thickness of the individual pieces of surface-treated metal, or the adhesive thickness can be measured with a traveling comparator microscope.

4.5.5.4.1 From each panel prepared as specified in 4.4.2.2, two properly identified control specimens shall be taken, one from the center and one from the end, and these specimens shall be subjected to the normal temperature shear test specified in 4.5.5.1. The normal temperature shear strength results obtained on these fatigue control specimens with 3/8-inch overlap shall be reported with the fatigue data. A total of 15 specimens, 5 from each panel, shall be tested in fatigue using maximum selected loads such that failures occur, with approximately regular spacing over a range from 10,000 to 10,000,000 cycles.

Note. The number of cycles of testing to failure at the upper end of the range (10 million) may be reduced, in order to simplify the testing procedure, to 1 million cycles providing the applicable fatigue strength, as determined, conforms to test No. 8 of table I.

The number of cycles to failures and corresponding loads calculated in pounds per square inch, shall be recorded on stress-log cycle coordinates and a smooth curve drawn. The point at which the smooth curve intercepts the 10-million

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cycle ordinate or 1-million cycle ordinate (see note above), is the fatigue strength. This fatigue strength shall equal or exceed that specified for test No. 8 in table I. If the fatigue strength value fails below that specified, another set of 6 specimens shall be prepared and tested, each with a 600-pound-per-square-inch maximum alternating stress. If any one of these specimens fails to conform to the 10-million cycle requirement, the adhesive shall be rejected.

4.5.5.5 Normal temperature creep-rupture test (test No. 9 of table I -
The lap joint specimens (see 4.4) shall be tested in a deadweight loading test apparatus capable of applying loads accurate within 1 percent. The specimens shall be gripped or suspended by means of 0.250-inch-diameter pins placed through drilled holes in the ends of specimens. The drilled hole shall be centered (± 0.01 inch) in the width of the specimen and placed with its center 1 inch from the end of the specimen. Care must be exercised to avoid eccentricity in the loading of the adhesive joint. The entire assembly of specimen and loading mechanism must be checked for alignment prior to test. Long pull rods will facilitate obtaining proper alignment. Specimens shall remain loaded with a 1,600-pound-per-square-inch stress until rupture occurs or until the stress has been applied for 192 hours. The length and width of the shear area shall be measured to the nearest 0.01 inch and shall be recorded. The specimen bond areas shall be calculated to the nearest 0.01 square inch. Creep shall be measured during test in accordance with 4.5.5.7. The time to failure and the amount of creep of each specimen shall be recorded, as well as the nature and percent of joint failure, if any, and the adhesive film thickness. The type of failure shall be determined and the adhesive film thickness measured as specified in 4.5.5.1 and 4.5.5.4. Six specimens, selected as specified in 4.5.5.1, shall be tested at the 1,600-pound-per-square-inch stress. If one or more of these specimens fails the 192-hour test No. 9 of table I, another set of specimens shall be selected and tested. If any one of these retest specimens fails the test, the adhesive shall be rejected.

4.5.5.6 Elevated temperature creep-rupture test (tests Nos. 10 to 12 of table I) - The 180° F (82° C), 300° F (149° C), and 500° F (260° C) creep-rupture tests shall be in accordance with 4.5.5.5, with the added requirement that a suitable furnace or oven, which does not influence the application of load, shall be provided to maintain the temperature as required. Creep shall be measured on the specimen under stress in accordance with 4.5.5.8. Six specimens, selected as specified in 4.5.5.1, shall be tested with an 800-pound-per-square-inch stress. If one or more of these specimens fails the 192-hour tests Nos. 10 to 12, as applicable, of table I, 6 more specimens (2 specimens from each of the 3 adhesive batches) shall be tested as a retest. Like failure in the retest shall cause rejection of the adhesive.

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4.5.5.7 Normal temperature total creep deformation - As a part of the creep-rupture tests specified in 4.5.5.5, measurements of total deformation (including that due to initial loading) shall be made while the specimen is under stress. The deformation shall be measured to an accuracy of 0.0001 inch at such intervals of time that a smooth time deformation curve may be plotted. The exact time intervals will depend upon the adhesive being tested and the creep rate of the joint. The deformation may be measured directly by observing the displacement of fine scribe lines across both edges of the specimen near each end and at the center of the lap joint (figure 4), using a traveling comparator microscope capable of measuring displacement, as required, to the nearest 0.0001 inch or an equivalent measuring apparatus. The deformation of each specimen shall be determined by averaging the deformation measurements at the six prescribed points on the joint. If an extensometer is used, the gage length multiplied by a value equal to the stress in the metal, divided by modulus of the metal used (10.5 times 10^6 pounds per square inch for aluminum alloy or 26.0 times 10^6 pounds per square inch for corrosion-resisting steel) shall be subtracted from all extensometer readings. The average total deformation of the 6 specimens at 192 hours shall be no greater than that specified in table I. All measurements shall be reported. Rejection and retest provisions shall be as specified in 4.5.5.5.

4.5.5.8 Elevated temperature total creep deformation - The elevated temperature total deformation tests shall be made during the elevated temperature creep-rupture tests, 4.5.5.5. The procedure for deformation measurements shall be as specified in 5.5.5.7, except that the testing temperature shall be $180^\circ \pm 5^\circ \text{ F}$ ($82^\circ \pm 2.8^\circ \text{ C}$), $300^\circ \pm 5^\circ \text{ F}$ ($149^\circ \pm 2.8^\circ \text{ C}$), and $500^\circ \pm 5^\circ \text{ F}$ ($260^\circ \pm 2.8^\circ \text{ C}$) (see 4.5.5.2), as required in table I. Care shall be taken to insure that these temperatures have no effects on the accuracy of the method of measuring the deformation. Rejection and retest provisions shall be as specified in 4.5.5.6.

4.5.5.9 Salt spray, humidity, and fluid exposure (tests Nos. 13 through 15 of table I) - The partial panels (figure 2) which have been exposed to high humidity or salt spray conditions or immersed in fluids as specified in 4.3.4, 4.3.5, and 4.3.6 shall each be cut into four individual specimens as shown in figure 2. The cutting and marking of these specimens shall be done as specified in 4.4.1. Two specimens randomly selected from each panel (3 panels per exposure condition, 1 panel being prepared with each of the 3 batches of adhesive, see 4.4.2.3) shall be tested in tensile shear at normal temperature (tests 13, 14, and 15 of table I) following the procedures specified in 4.5.5.1. Tests shall be made within 6 hours after removal from the exposure condition. The strengths of the specimens tested at each condition shall equal or exceed that specified in tests Nos. 13 through 15 of table I, as applicable. If original test set fails in this

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regard, another group of 3 test panels may be exposed at the particular condition at which the quality was found to be less than that required. Six specimens shall be tested as retest. Like failure in the retest shall cause rejection of the adhesive.

4.5.5.10 Normal temperature T-peel (test No. 16 of table I) - The bent, unbonded ends of the test specimen shall be clamped in the test grips of the tensile test machine with the jaws and the specimen so aligned that the jaws are directly opposite each other, and in such a position that the center line of the unbonded area of the specimen passes through the points of suspension. The machine shall be equipped with suitable grips capable of clamping the specimens firmly and without slippage throughout the test. The load shall be applied at a constant head speed of 10 inches per minute (this will cause separation of the bond at a rate of 5 inches per minute). An autographic recording of load versus head movement or load versus distance peeled shall be made during the peel test. The peel resistance shall be determined over at least a 5-inch length of bond line after the initial peak. T-peel strength is defined as the average load per unit width of bond line required to produce progressive separation of two laminated flexible adherends, under conditions designated in this test method. (The term flexible, as used here, indicates that the adherends shall have such dimensions and physical properties as to permit bending them through any angle up to 180° without breaking.) The machine and loading range shall be so selected that the maximum load on the specimen falls between 15 and 85 percent of the upper limit of the loading range. The machine shall be autographic, giving a chart that can read in terms of having inches of separation as one coordinate and applied load as the other coordinate. Average, maximum, and minimum peeling load values for each individual specimen shall be recorded, as well as the average T-peel strength in pounds per inch of width. The width of peel area shall be measured to the nearest 0.001 inch. The nature and percent of failure, such as cohesive failure (failure within the adhesive), adhesion failure (adhesive peeling from the metal), or contact failure (lack of complete adhesive-to-metal contact during bonding), and the adhesive thickness shall also be recorded for each specimen. Adhesive thickness shall be measured in the same manner as for the tensile shear specimens (4.5.5.1). A total of six specimens, two specimens representative of each of the three batches of adhesive from the lots of specimens prepared, as specified in 4.4.2.4, shall be tested. The average and minimum strengths of these six specimens shall equal or exceed that specified for test No. 16 of table I. If the strengths, either average or minimum, are less than that specified in table I, two more specimens from each of the three batches of adhesive shall be tested as a retest. If both specimens from the same batch of the adhesive fail to meet the minimum requirements in this retest and those from the other two batches of adhesive are satisfactory, a retest using three specimens from that same batch of adhesive shall be run. Like failure in the retest shall

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cause rejection of the adhesive. The normal temperature peel strengths of all T-peel specimens tested in accordance with the qualification tests of this specification, except values voided and replaced by retest values, shall be averaged for use in determining the acceptance-test-required normal temperature peel strength (4.5.5.10).

4.5.5.11 Blister detection, normal temperature, tensile shear (test No. 17 of table I) - The blister detection tensile shear test shall be in accordance with 4.5.5.1, except that the specimens shall be taken from 12 inch by 12 inch panels as specified under 4.4.2.5. Fifteen specimens, selected as specified in 4.4.2.5, shall be tested for tensile shear strength (test No. 17 of table I). The average and minimum shear strength of the specimens tested shall equal or exceed that specified for test No. 17 of table I. Retest provisions shall be as specified in 4.5.5.1, except that five more specimens shall be taken from each of the three batches of adhesives and tested as a retest.

4.5.5.12 Storage life tests - One pint package of liquid adhesives, or equivalent amount properly packaged (see 5.1), if of another form, of each of the 3 batches of adhesive being submitted for qualification under this specification shall be stored under each of the two temperature and time conditions specified in 3.3.4. At the ends of the respective storage periods, these samples shall be used in the preparation of bonded lap joint panels as required by tests Nos. 1, 2, 3, 5, and 13 of table I, which are applicable to the particular type of adhesive being submitted. Six specimens, 2 specimens from each of the 3 adhesive batches, shall be tested at each of the applicable test conditions, except for test No. 13 for which 1 partial panel (figure 2) from each of the 3 adhesive batches shall be exposed and tested. The strengths of these specimens shall equal or exceed that specified for the applicable tests in table I. If the original test set fails in this regard, another set of specimens may be prepared with the remainder of the sample and tested. Like failure in the retest shall cause rejection of the adhesive or a modification of maximum storage life statement as furnished by the adhesive manufacturer. (See 3.3.4 and 6.6.3).

4.6 Acceptance tests -

4.6.1 Sampling -

4.6.1.1 Adhesive - A single sample of not less than 2 quarts of liquid adhesive or an equivalent amount in weight or measure, if of another form, shall be taken at random from each lot and tested. Each sample shall be divided into two equal parts; one part shall be available for required acceptance tests and the other part shall be retained for retests, if necessary. The storage condition

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for the retained sample shall be that recommended by the adhesive manufacturer (see 3.3.4), and samples shall not be retained beyond the storage life, as recommended by the adhesive manufacturer. Additional samples may be taken if considered necessary by the Government inspector to determine conformance of the product to this specification.

4.6.1.2 Filled containers - A random sample of filled containers shall be selected from each lot by the Government inspector in accordance with Standard MIL-STD-105 at inspection level I, and at acceptance quality level (AQL) of 2.5 percent defective, to verify conformance to all requirements of this specification regarding fill, closure, and marking.

4.6.2 Lot - A lot shall consist of 500 pounds or fraction thereof of adhesive of one type, manufactured at one time in one batch, forming part of one contract or order, and submitted for inspection at the same time and place. A batch shall be defined as that quantity of material which has been manufactured at one time or subjected to some unit chemical or physical mixing process intended to make the final product homogeneous.

4.6.3 Tests - Samples of each submitted lot of adhesive delivered on contract or order shall be subjected to the following acceptance tests. Test reports, in duplicate, shall be furnished for all acceptance tests specified in this specification, and shall be signed by an authorized representative of the laboratory making the tests. Acceptance or approval of material during course of manufacture shall in no case be construed as a guaranty of the acceptance of the finished products.

4.6.3.1 Normal temperature tensile shear test (acceptance) - The normal temperature tensile shear test shall be in accordance with 4.5.5.1. Two panels as shown in figure 3 (except the panel width shall be 6 inches instead of 9 inches) or two panels as shown in figure 5 shall be prepared. The cleaning and bonding of these panels shall be done in accordance with the approved manufacturer's instructions. All available specimens therefrom shall be tested. The average normal temperature shear strength value shall equal or exceed the applicable acceptance requirements of this specification or the process specification prepared by the processing activity in accordance with Specification MIL-A-9067, whichever is higher.

4.6.3.2 Elevated temperature tensile shear tests (acceptance) - The elevated temperature tensile shear tests shall be in accordance with 4.5.5.2. Two panels as specified in 4.6.3.1, shall be prepared for each of tests Nos. 2 through 6 of table I as applicable to the type of adhesive being tested. All available specimens therefrom shall be tested. The respective average test values

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shall equal or exceed the applicable acceptance requirements of this specification prepared by the processing activity in accordance with Specification MIL-A-9067, whichever is higher.

4.6.3.3 Filled containers - Each sample-filled container, selected in accordance with 4.6.1.2, shall be examined by the Government inspector for defects of the container and closure for evidence of leakage, and for unsatisfactory markings. Each sample-filled container shall also be weighed to determine the amount of the contents. Any container in the sample having one or more defects or under required fill, shall be rejected, and if the number of defective containers in any sample exceeds the acceptance number for the specified sampling plan of Standard MIL-STD-105, the lot represented by the sample shall be rejected. Rejected lots may be resubmitted for acceptance tests provided that the contractor has removed or repaired all nonconforming containers.

4.6.4 Packaging, packing and marking - Preparation for delivery shall be examined for conformance with section 5.

4.6.5 Rejection and retest - If the results of the acceptance tests show failure to conform to 4.6.3.1 or 4.6.3.2, another set of specimens for both normal and elevated temperature tests shall be made with the remaining adhesive sample held for retest (4.6.1.1). Both types of tests shall be repeated. Failure of the retest specimens to conform to the respective requirements shall then be cause for rejection of the adhesive. Adhesive which has been rejected may be reworked to correct the defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection, and the action taken to correct the defects found in the original shall be furnished the Government inspector. Material rejected after retest shall not be resubmitted without specific approval of the procuring activity.

5. PREPARATION FOR DELIVERY

5.1 Packaging -

5.1.1 Level A - Liquid adhesives for metals shall be packaged in metal containers conforming to Specification PPP-C-96. The type, class, shape, and size of the container and type of closure, when required, shall be as specified by the procuring activity (see 6.5). Film adhesive shall be packaged, using a suitable membrane to prevent deterioration. Packaging shall be accomplished in accordance with the appendix to Specification PPP-C-96.

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5.1.2 Level C - Adhesives shall be packaged in accordance with manufacturer's commercial practice.

5.1.3 Three copies of the manufacturer's instruction sheet (see 3.5) shall be included with each shipment, unless more are requested by the procuring activity.

5.2 Packing -

5.2.1 Level A - Adhesive packaged as specified in 5.1.1 shall be packed in accordance with overseas shipment requirements of the appendix to Specification PPP-C-96.

5.2.2 Level B - Adhesives packaged as specified in 5.1.1 shall be packed in accordance with the domestic shipment requirements of the appendix to Specification PPP-C-96.

5.2.3 Level C - Adhesives packaged as specified in 5.1.2 shall be packed in exterior-type shipping containers in a manner that will insure safe transportation at the lowest rate to the point of delivery. Containers shall meet Uniform Freight Classification Rules or other common carrier regulations, as applicable to the mode of transportation.

5.3 Marking of shipments - Interior and exterior containers shall be marked in accordance with Standard MIL-STD-129. Exterior containers shall also be marked with a note relative to storage, such as:

"Adhesives conforming to this specification should be stored at a temperature of less than 86° F (30° C) in the absence of direct sunlight. If transit or normal storage conditions, or both, necessitate exposure of the adhesive to temperatures in excess of 86° F (30° C) the life of the adhesive will be proportionally reduced."

6. NOTES

6.1 Intended use - Adhesives conforming to this specification are intended for use in bonding airframe structural components. However, fabricators are required by the procuring activity to obtain approval of the component and of a process specification applicable to the adhesive and component prior to use of the adhesive on parts procured on contract. Fabrication and inspection must be made in accordance with the requirements of Specification MIL-A-9067. Types I and II adhesives are intended principally for use on clad aluminum alloys,

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and types III and IV adhesives are intended principally for use on corrosion-resisting steel alloys. Use of either on other metals or combination of metals must be substantiated by tests. Parts or assemblies requiring the use of adhesives covered by this specification should be designed with consideration for the heat and pressure required during the bonding operations. The maximum curing pressure specified in 3.3.3.2 is a necessary requirement for determining the suitability of an adhesive for general production use, however, shop facilities permitting higher pressures in accordance with the manufacturer's instructions may be used whenever practicable.

6.1.1 Some of the adhesives covered by this specification can be used for bonding other constructions such as metal-to-plastic or plastic-to-plastic, provided the use of the adhesive is substantiated by the tests specified herein, using the combination of the materials in question.

6.1.2 Adhesives covered by this specification are not intended for use in bonding sandwich constructions unless they conform to Specification MIL-A-25463.

6.2 Definition - The terms "long-time exposures" and "short-time exposures" as used 1.2 and other paragraphs are relative terms, which for the purpose of this specification are defined as 192-hours duration and 10-minutes duration, respectively. Adhesives are not qualified in this specification on the basis of their ability to withstand extremely high temperatures for "ultra short-time exposures," as 1,000° F (538° C) for 2 minutes, because testing techniques under these conditions have not been satisfactorily standardized. Fabricators concerned with elevated temperature exposures for these ultra short periods will need to provide substantiating data of the adequacy of the adhesives for the intended use.

6.3 Precaution - Severe damage has been obtained in cutting corrosion-resisting steel specimens from bonded panels using saws and lubricating fluids. Certain of the fluids penetrate adhesive bonds under these conditions. Damage might also be caused by vibration or heating from the cutting operation. Shop tests should be made to determine that the sawing techniques used will not harm the bonds. If satisfactory sawing techniques are not readily available, pre-slotted or prepunched specimens of type shown in figure 5 should be used.

6.4 It should be noted that type IV adhesives, although maintaining substantial strength properties for 192 hours at 500° F (260° C), may not retain adequate properties very much beyond that time, and therefore they may not be, and in general are not suitable for continuous use at 500° F (260° C). Their strengths and serviceability for periods beyond 192 hours must be determined by

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tests by the user. In general, type II adhesives will be suitable for use beyond the 192-hour period, and possibly will be suitable for continuous use at 300° F (149° C), depending on stress conditions. However, this must also be determined by actual tests by the user.

6.5 Ordering data - Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type and class of adhesive (see 1.2), adhesive code number (see 3.2.8.1).
- (c) Capacity and kind of container and quantity desired.
- (d) Applicable levels of packaging and packing (see section 5).

6.6 Qualification testing -

6.6.1 Qualification - With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the supplier is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Bureau of Naval Weapons, Navy Department, Washington 25, D. C.; however, information pertaining to qualification may be obtained from the Naval Air Material Center, Philadelphia 12, Pennsylvania, Attention: Director, Aeronautical Materials Laboratory.

6.6.2 In authorizing qualification tests, it should be stated in the Letter of Authorization that the following information and samples should be furnished at no cost to the Government:

- (a) Notarized test report (4.5.3) listing all data obtained with three separate batches of the adhesive in evaluation tests performed in accordance with this specification.

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- (b) A duplicate set of bonded test panels prepared with the same three batches of adhesive and under the same bonding conditions as used to obtain the data given in the test report. Twelve lap-joint panels (11 with a 1/2-inch overlap and one with a 3/8-inch overlap), two T-peel panels, and two blister detection panels with each of the three batches of adhesive will be required. (See 4.4, 4.4.2, and 4.5.2 for panel construction and identification of panels with adhesive batch.)
- (c) Instruction sheet (4.5.4) listing all of the information as required in 3.5 and including storage life recommendations (3.3.4).
- (d) Four 1-pint samples of liquid adhesive together with necessary thinners and curing agents, or an equivalent amount of material in weight and measure if of another form, from each of three different batches of adhesive. These adhesive samples shall be from batches of recent production scale manufacture and may be from different batches from those used in preparing the above test panels. These samples should each be properly packaged for storage (see section 5) and shall be properly identified (see 4.5.2).
- (e) If the recommended method of preparing the metal surface for bonding requires the use of chemicals other than standard commercial acids, solvents, or sodium chromate, the manufacturer shall include enough of such chemicals to make 2 gallons of solution.
- (f) The manufacturer shall pay the transportation charges to and from the designated point where tests are to be made. In the case of failure of the sample or samples submitted, consideration will be given to the request of the manufacturer for additional test only after it has been clearly shown that changes have been made in the product which the Government considers sufficient to warrant additional tests.

6.6.3 Adhesives conforming to the other requirements of this specification may, at the option of the qualifying activity, be placed on Qualified Products List QPL-5090 (see 6.6.1) prior to the completion of the storage life

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tests. Modification of the manufacturer's storage life recommendations or removal of the adhesive from the Qualified Products List will be necessary, if subsequently, the adhesive does not pass the life storage test.

Notice. When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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BUREAU OF NAVAL WEAPONS
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Chief, Bureau of Naval Weapons (RREN-5)
Navy Department
Washington 25, D. C.

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SPECIFICATION ANALYSIS SHEET
NAVWEPS FORM 9121/3 (9-62)

 FORM APPROVED
 BUREAU BUREAU NO. 49-8309

INSTRUCTIONS

This sheet is to be filled out by Government or contractor personnel involved in the use of this specification in procurement of products for ultimate use by the activity shown on the reverse of this sheet.

of this specification suitable products can be procured with a minimum amount of delay and at the least cost.

Comments and the return of this sheet will be appreciated.

This sheet is provided for obtaining information which will aid the activity shown in insuring that through use

Fold on dotted lines on reverse side, staple in corner, and send to the activity shown.

SPECIFICATION (No. and abbrev. title)

ORGANIZATION		CITY	STATE
CONTRACT NUMBER	QUANTITY OF ITEMS PROCURED		DOLLAR AMOUNT
			\$
MATERIAL PROCURED UNDER A DIRECT GOVERNMENT CONTRACT		OR A SUBCONTRACT	

1. HAS ANY PART OF THIS SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
 (If so, give paragraph number and wording, and recommendations for correcting the deficiencies.)

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

YES

NO

IF YES, IN WHAT WAY?

4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If additional papers are attached, send this form and papers in an envelope. This form is addressed for use in window envelope when appropriate.)

SUBMITTED BY (Print name and title)

DATE