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Standard Guide for Selecting Aerospace and General Purpose Adhesives and Sealants¹

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1. Scope

1.1 This guide is intended to assist design engineers, manufacturing/industrial engineers, and production managers in selecting the best-fit adhesive/sealant or bonding/sealing process. The guide takes into account environmental pollution prevention and occupational health and safety factors in a selection process.

1.2 This guide is not to be considered as a database of acceptable materials. It will guide the engineers and managers through the adhesive/sealant material selection process, calling for engineers to customize their selection based on the bonding or sealing performance requirements for the specified application. A comprehensive selection process will allow for the establishment of a more efficient production process, and may eliminate unnecessary process steps. A total life cycle cost analysis or performance/cost of implementation study is recommended to compare the available alternatives.

1.3 This guide is for aerospace and general purpose operations. It is not intended to be used for automotive, carpet, construction, electronics, medical/dental, optical, or structural and nonstructural wood applications. Note that this guide is not specifically for these applications, but the general methodology may be used in the selection process for these applications.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 56 Test Method for Flash Point by Tag Closed Tester²
- D 896 Test Method for Resistance of Adhesive Bonds to Chemical Reagents³
- D 897 Test Method for Tensile Properties of Adhesive Bonds³

- D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds³
- D 905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading³
- D 907 Terminology of Adhesives³
- D 950 Test Method for Impact Strength of Adhesive Bonds³
- D 1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)³
- D 1062 Test Method for Cleavage Strength of Metal-to-Metal Adhesive Bonds³
- D 1084 Test Methods for Viscosity of Adhesives³
- D 1144 Practice for Determining Strength Development of Adhesive Bonds³
- D 1146 Test Method for Blocking Point of Potentially Adhesive Layers³
- D 1151 Test Method for Effect of Moisture and Temperature on Adhesive Bonds³
- D 1183 Test Methods for Resistance of Adhesives to Cyclic Laboratory Aging Conditions³
- D 1184 Test Method for Flexural Strength of Adhesive Bonded Laminated Assemblies³
- D 1310 Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus⁴
- D 1337 Test Method for Storage Life of Adhesives by Consistency and Bond Strength³
- D 1338 Test Method for Working Life of Liquid or Paste Adhesives by Consistency and Bond Strength³
- D 1780 Practice for Conducting Creep Tests of Metal-to-Metal Adhesives³
- D 1781 Test Method for Climbing Drum Peel Test for Adhesives³
- D 1828 Practice for Atmospheric Exposure of Adhesive-Bonded Joints and Structures³
- D 1875 Test Method for Density of Adhesives in Fluid Form³
- D 1876 Test Method for Peel Resistance of Adhesives (T-Peel Test)³
- D 1879 Practice for Exposure of Adhesive Specimens to

¹ This guide is under the jurisdiction of ASTM Committee D-14 on Adhesives and is the direct responsibility of Subcommittee D14.60 on Materials Classification. Current edition approved Oct. 10, 1999. Published December 1999.

² Annual Book of ASTM Standards, Vol 05.01.

³ Annual Book of ASTM Standards, Vol 15.06.

⁴ Annual Book of ASTM Standards, Vol 06.01.

- High-Energy Radiation³
- D 1916 Test Method for Penetration of Adhesives³
- D 1994 Test Method for Determination of Acid Numbers of Hot-Melt Adhesives³
- D 1995 Test Method for Multi-Modal Strength of Autoadhesives (Contact Adhesives)³
- D 2093 Practice for Preparation of Surfaces of Plastics Prior to Adhesive Bonding³
- D 2095 Test Method for Tensile Strength of Adhesives by Means of Bar and Rod Specimens³
- D 2240 Test Method for Rubber Property – Durometer Hardness⁵
- D 2293 Test Method for Creep Properties of Adhesives in Shear by Compression Loading (Metal-to-Metal)³
- D 2294 Test Method for Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)³
- D 2295 Test Method for Strength Properties of Adhesives in Shear by Tension Loading at Elevated Temperatures (Metal-to-Metal)³
- D 2556 Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties³
- D 2557 Test Method for Tensile-Shear Strength of Adhesives in the Subzero Temperature Range from –267.8 to –55°C (–450 to –67°F)³
- D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of Barcol Impressor⁶
- D 2651 Practice for Preparation of Metal Surfaces for Adhesive Bonding³
- D 2674 Methods of Analysis of Sulfochromate Etch Solution Used in Surface Preparation of Aluminum³
- D 2918 Practice for Durability Assessment of Adhesive Joints Stressed in Peel³
- D 2919 Test Method for Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading³
- D 3111 Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method³
- D 3121 Test Method for Tack of Pressure-Sensitive Adhesives by Rolling Ball³
- D 3163 Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading³
- D 3164 Test Method for Strength Properties of Adhesively Bonded Plastic Lap Shear Sandwich Joints in Shear by Tension Loading³
- D 3165 Test Method for Strength Properties of Adhesives in Shear by Tension Loading of Laminated Assemblies³
- D 3166 Test Method for Fatigue Properties of Adhesives in Shear by Tension Loading (Metal/Metal)³
- D 3167 Test Method for Floating Roller Peel Resistance of Adhesives³
- D 3278 Flash Point of Liquids by Small Scale Closed-Cup Apparatus⁴
- D 3310 Test Method for Determining Corrosivity of Adhesive Materials³
- D 3433 Practice for Fracture Strength in Cleavage of Adhesives in Bonded Metal Joints³
- D 3528 Test Method for Strength Properties of Double Lap Shear Adhesive Joints by Tension Loading³
- D 3632 Test Method for Accelerated Aging of Adhesive Joints by the Oxygen-Pressure Method³
- D 3762 Test Method for Adhesive-Bonded Surface Durability of Aluminum (Wedge Test)³
- D 3807 Test Method for Strength Properties of Adhesives in Cleavage Peel by Tension Loading (Engineering Plastics-to-Engineering Plastics)³
- D 3929 Test Method for Evaluating the Stress Cracking of Plastics by Adhesives Using the Bent-Beam Method³
- D 3931 Test Method for Determining Strength of Gap-Filling Adhesive Bonds in Shear by Compression Loading³
- D 3933 Guide for Preparation of Aluminum Surfaces for Structural Adhesives Bonding (Phosphoric Acid Anodizing)³
- D 3983 Test Method for Measuring Strength and Shear Modulus of Nonrigid Adhesives by the Thick-Adherend Tensile-Lap Specimen³
- D 4027 Test Method for Measuring Shear Properties of Structural Adhesives by the Modified-Rail Test³
- D 4317 Specification for Polyvinyl Acetate-Based Emulsion Adhesives³
- D 4339 Test Method for Determination of the Odor of Adhesives³
- D 4497 Test Method for Determining the Open Time of Hot Melt Adhesives (Manual Method)³
- D 4498 Test Method for Heat-Fail Temperature in Shear of Hot Melt Adhesives³
- D 4499 Test Method for Heat Stability of Hot-Melt Adhesives³
- D 4501 Test Method for Shear Strength of Adhesive Bonds Between Rigid Substrates by the Block-Shear Method³
- D 4562 Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen³
- D 4689 Specification for Adhesive, Casein-Type³
- D 4690 Specification for Urea-Formaldehyde Resin Adhesives³
- D 4783 Test Methods for Resistance of Adhesive Preparations in Container to Attack by Bacteria, Yeast, and Fungi³
- D 4800 Guide for Classifying and Specifying Adhesives³
- D 5041 Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Joints³
- D 5267 Test Method for the Determination of Extrudability of Cartridge Adhesives³
- D 5363 Specification for Anaerobic Single-Component Adhesives (AN)³
- D 5573 Practice for Classifying Failure Modes in Fiber-Reinforced-Plastic (FRP) Joints³
- D 5648 Test Method for Torque-Tension Relationship of Adhesives Used on Threaded Fasteners (Lubricity)³
- D 5649 Test Method for Torque Strength of Adhesives Used on Threaded Fasteners³
- D 5656 Test Method for Thick Adherend Metal Lap-Shear Joints for Determination of the Stress-Strain Behavior of Adhesives in Shear by Tension Loading³

⁵ Annual Book of ASTM Standards, Vol 09.01.

⁶ Annual Book of ASTM Standards, Vol 08.02.

- D 5657 Test Method for Fluid Tightness Ability of Adhesives Used on Threaded Fasteners³
- D 5868 Test Method for Lap Shear Adhesion for Fiber Reinforced Plastic (FRP) Bonding³
- D 6195 Test Methods for Loop Tack³
- D 6361 Guide for Selecting Cleaning Agents and Processes³
- E 229 Test Method for Shear Strength and Shear Modulus of Structural Adhesives³

3. Terminology

3.1 *Definitions*—For technical terms pertaining to adhesives and sealants, see Terminology D 907.

3.2 *Classifications*—For the identification and classification system of adhesives and sealants, see Guide D 4800. (Related documents: Specification D 4317; Specification D 4689; Specification D 4690; Specification D 5363; and Test Method D 1994.)

4. Summary of Guide

4.1 Table 1 is a summary of the five step approach for selecting adhesives/sealants and bonding or sealing processes for use in aerospace and general purpose operations. This guide is based on adhesive/sealant performance in accordance with specific adherends and substrates. The user's performance requirements play a key role in the process, along with the environmental, and safety and health parameters. Adherend/substrate material surface preparation and cleaning also play a key role in the performance of adhesives/sealants, and are factored-in as part of this selection process. For each step the user of the guide will provide specific information on a particular aspect of their process. Then the user should consult the guide, which will provide appropriate guidance on evaluation criteria that should be followed in order to evaluate the potential adhesive or sealant. Table 1 provides a summary of

TABLE 1 Summary of Guide

Step	Defined User Requirements	Procedure
1	Define the Environmental, Safety, & Health, Physical and Chemical Requirements of the Application	Physical and Chemical Properties Tests – Verify that the prospective adhesive or sealant is acceptable
2	Define the Reason for Bonding or Sealing	Performance Requirements – Determine the required performance levels for the specific application and prospective adhesive/sealant
3	Define the Material(s) to be Bonded or Sealed	Performance/Material Compatibility Test(s) – Verify that the prospective adhesive/sealant will not harm the component(s) being bonded or sealed and will perform to the desired level of bonding or sealing for the particular application
4	Determine Configuration, Cleaning, and Preparation Requirements	Applicable processes and equipment. Cleaning levels and preparation of the adherend and substrate critical to the performance of the adhesive or sealant
5	Select Adhesive or Sealant	Validate performance, environment, cost, preparation, and worker health and safety

the user-defined requirements information and the procedures to be provided by the guide. The order of the steps presented in Table 1 is suggested, but not crucial to the successful use of the guide. Section 6 will provide greater details on both the user input and the guidance provided.

5. Significance and Use

5.1 The guide is to be used by anyone developing bonding or sealing requirements for specifications for manufacturing, maintenance or overhaul. This guide has been designed to be application specific for each bonding or sealing application, and allows the design engineer to rest assured that the product(s) or process(es) selected by the industrial or manufacturing engineer will be compatible with both the part material and the subsequent processes, such as adherend/substrate cleaning and preparation. It allows the industrial or manufacturing engineer to customize the selection of the adhesive or sealant product based on the materials of the parts being bonded or sealed, the conditions required for the subsequent process(es), environmental, cost, and health and safety concerns.

6. Procedure

6.1 *Step 1—Define the Requirements of the Application*—The first step taken in selecting an adhesive/sealant is to determine the requirements of the application. These requirements include environmental, safety and health, and the physical and chemical properties of the adhesive/sealant itself, the application's performance levels, and surface preparation/cleaning.

6.1.1 *Environmental, Safety, and Health Requirements*—Table 2 presents some of the more common concerns regarding adhesive and sealant and their effects on the environment, and worker safety and health. To use Table 2, the engineer should find their concerns on the left-hand column of the table, and ensure that the adhesive/sealant meets the requirements listed in the right-hand column.

6.1.2 *Physical, Chemical, and Performance Properties*—Table 3 presents some of the more common concerns regarding adhesives/sealants and their physical, chemical, and performance properties, and the corresponding tests required to evaluate those properties. To use Table 3, the engineer should find their concern(s) on the left-hand column of the table, and require the data from evaluations of the specifications listed in the remainder of the row. Please note that the guide does not

TABLE 2 Environmental, Safety and Health Requirements

Concern	Requirement
Environment	Compliance with all federal, state, and local laws and regulations, and manufacturer's recommendations concerning the procurement, use and disposal of the adhesive or sealant and associated materials
Worker Safety and Health	Compliance with OSHA and other regulatory & non-regulatory sources including manufacturer's exposure recommendations ACGIH, etc.; provide sufficient personal protective equipment to ensure the health and safety risks of using the adhesive or sealant are minimized