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Standard Guide for Selecting Aerospace and General Purpose Adhesives and Sealants[1]

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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:*[2]

D56 Test Method for Flash Point by Tag Closed Cup Tester

D896 Practice for Resistance of Adhesive Bonds to Chemical Reagents

D897 Test Method for Tensile Properties of Adhesive Bonds

D903 Test Method for Peel or Stripping Strength of Adhesive Bonds

D905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading

D907 Terminology of Adhesives

D950 Test Method for Impact Strength of Adhesive Bonds

D1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)

D1062 Test Method for Cleavage Strength of Metal-to-Metal Adhesive Bonds

D1084 Test Methods for Viscosity of Adhesives

D1144 Practice for Determining Strength Development of Adhesive Bonds

D1146 Test Method for Blocking Point of Potentially Adhesive Layers

D1151 Practice for Effect of Moisture and Temperature on Adhesive Bonds

D1183 Practices for Resistance of Adhesives to Cyclic Laboratory Aging Conditions

D1184 Test Method for Flexural Strength of Adhesive Bonded Laminated Assemblies

D1310 Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus

D1337 Practice for Storage Life of Adhesives by Viscosity and Bond Strength

D1338 Practice for Working Life of Liquid or Paste Adhesives by Consistency and Bond Strength

D1780 Practice for Conducting Creep Tests of Metal-to-Metal Adhesives

D1781 Test Method for Climbing Drum Peel for Adhesives

D1828 Practice for Atmospheric Exposure of Adhesive-Bonded Joints and Structures

D1875 Test Method for Density of Adhesives in Fluid Form

D1876 Test Method for Peel Resistance of Adhesives (T-Peel Test)

D1879 Practice for Exposure of Adhesive Specimens to Ionizing Radiation

[1] This guide is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.60 on Adhesive Material Classification System.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

D1916 Test Method for Penetration of Adhesives (Withdrawn 2005)[3]
D1994 Test Method for Determination of Acid Numbers of Hot-Melt Adhesives
D1995 Test Methods for Multi-Modal Strength Testing of Autohesives (Contact Adhesives)
D2093 Practice for Preparation of Surfaces of Plastics Prior to Adhesive Bonding
D2095 Test Method for Tensile Strength of Adhesives by Means of Bar and Rod Specimens
D2240 Test Method for Rubber Property—Durometer Hardness
D2293 Test Method for Creep Properties of Adhesives in Shear by Compression Loading (Metal-to-Metal)
D2294 Test Method for Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)
D2295 Test Method for Strength Properties of Adhesives in Shear by Tension Loading at Elevated Temperatures (Metal-to-Metal)
D2556 Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties Using Rotational Viscometry
D2557 Test Method for Tensile-Shear Strength of Adhesives in the Subzero Temperature Range from −267.8 to −55°C (−450 to −67°F)
D2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
D2651 Guide for Preparation of Metal Surfaces for Adhesive Bonding
D2674 Methods of Analysis of Sulfochromate Etch Solution Used in Surface Preparation of Aluminum
D2918 Test Method for Durability Assessment of Adhesive Joints Stressed in Peel
D2919 Test Method for Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading
D2979 Test Method for Pressure-Sensitive Tack of Adhesives Using an Inverted Probe Machine
D3111 Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method
D3121 Test Method for Tack of Pressure-Sensitive Adhesives by Rolling Ball (Withdrawn 2015)[3]
D3163 Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading
D3164 Test Method for Strength Properties of Adhesively Bonded Plastic Lap-Shear Sandwich Joints in Shear by Tension Loading
D3165 Test Method for Strength Properties of Adhesives in Shear by Tension Loading of Single-Lap-Joint Laminated Assemblies
D3166 Test Method for Fatigue Properties of Adhesives in Shear by Tension Loading (Metal/Metal)
D3167 Test Method for Floating Roller Peel Resistance of Adhesives
D3278 Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
D3310 Test Method for Determining Corrosivity of Adhesive Materials
D3433 Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Metal Joints
D3528 Test Method for Strength Properties of Double Lap Shear Adhesive Joints by Tension Loading
D3632 Test Method for Accelerated Aging of Adhesive Joints by the Oxygen-Pressure Method
D3762 Test Method for Adhesive-Bonded Surface Durability of Aluminum (Wedge Test)
D3807 Test Method for Strength Properties of Adhesives in Cleavage Peel by Tension Loading (Engineering Plastics-to-Engineering Plastics)
D3929 Test Method for Evaluating Stress Cracking of Plastics by Adhesives Using the Bent-Beam Method
D3931 Test Method for Determining Strength of Gap-Filling Adhesive Bonds in Shear by Compression Loading
D3933 Guide for Preparation of Aluminum Surfaces for Structural Adhesives Bonding (Phosphoric Acid Anodizing)
D3983 Test Method for Measuring Strength and Shear Modulus of Nonrigid Adhesives by the Thick-Adherend Tensile-Lap Specimen
D4027 Test Method for Measuring Shear Properties of Structural Adhesives by the Modified-Rail Test
D4317 Specification for Polyvinyl Acetate-Based Emulsion Adhesives
D4339 Test Method for Determination of the Odor of Adhesives
D4497 Test Method for Determining the Open Time of Hot Melt Adhesives (Manual Method)
D4498 Test Method for Heat-Fail Temperature in Shear of Hot Melt Adhesives
D4499 Test Method for Heat Stability of Hot-Melt Adhesives
D4501 Test Method for Shear Strength of Adhesive Bonds Between Rigid Substrates by the Block-Shear Method
D4562 Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen
D4689 Specification for Adhesive, Casein-Type
D4690 Specification for Urea-Formaldehyde Resin Adhesives
D4783 Test Methods for Resistance of Adhesive Preparations in Container to Attack by Bacteria, Yeast, and Fungi
D4800 Guide for Classifying and Specifying Adhesives
D5041 Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Joints
D5267 Test Method for Determination of Extrudability of Cartridge Adhesives
D5363 Specification for Anaerobic Single-Component Adhesives (AN)
D5573 Practice for Classifying Failure Modes in Fiber-Reinforced-Plastic (FRP) Joints
D5648 Test Method for Torque-Tension Relationship of Adhesives Used on Threaded Fasteners (Lubricity)
D5649 Test Method for Torque Strength of Adhesives Used on Threaded Fasteners

[3] The last approved version of this historical standard is referenced on www.astm.org.

D5656 Test Method for Thick-Adherend Metal Lap-Shear Joints for Determination of the Stress-Strain Behavior of Adhesives in Shear by Tension Loading
D5657 Test Method for Fluid Tightness Ability of Adhesives Used on Threaded Fasteners
D5868 Test Method for Lap Shear Adhesion for Fiber Reinforced Plastic (FRP) Bonding
D6195 Test Methods for Loop Tack
D6361 Guide for Selecting Cleaning Agents and Processes
E229 Test Method for Shear Strength and Shear Modulus of Structural Adhesives (Withdrawn 2003)[3]

3. Terminology

3.1 *Definitions*—For technical terms pertaining to adhesives and sealants, see Terminology D907.

3.2 *Classifications*—For the identification and classification system of adhesives and sealants, see Guide D4800. (Related documents: Specification D4317; Specification D4689; Specification D4690; Specification D5363; and Test Method D1994.)

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 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.

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

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

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

TABLE 3 Physical and Chemical Properties

Concern	ASTM Standard	Standard Title
Flash point	D56	Test Method for Flash Point by Tag Closed Tester
	D1310	Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Tester
	D3278	Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
Aging	D3632	Test Method for Accelerated Aging Adhesive Joints by the Oxygen-Pressure Method
Atmospheric and Exposure Effects	D1151	Practice for Effect of Moisture and Temperature on Adhesive Bonds
	D1828	Practice for Atmospheric Exposure of Adhesive-Bonded Joints and Structures
	D2557	Test Method for Tensile-Shear Strength of Adhesives in the Subzero Temperature Range from –267.8 to–55°C (–450 to –67°F)
	D4499	Test Method for Heat Stability of Hot-Melt Adhesives
	D4783	Test Methods for Resistance of Adhesive Preparations in Container to Attack by Bacteria, Yeast, and Fungi
Blocking Point	D1146	Test Method for Blocking Point of Potentially Adhesive Layers
Chemical Resistance	D896	Practice for Resistance of Adhesive Bonds to Chemical Reagents
Corrosivity	D3310	Test Method for Determining Corrosivity of Adhesive Materials
Density/Viscosity	D1084	Test Methods for Viscosity of Adhesives
	D1875	Test Method for Density of Adhesives in Fluid Form
	D2556	Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties
Extrudability	D5267	Test Method for Determination of Extrudability of Cartridge Adhesives
Flexibility	D3111	Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method
Hardness	D2240	Test Method for Rubber Property – Durometer Hardness
Impact Strength	D950	Test Method for Impact Strength of Adhesive Bonds
Odor	D4339	Test Method for Determination of Odor of Adhesives
Peel	D903	Test Method for Peel or Stripping Strength of Adhesive Bonds
	D1781	Test Method for Climbing Drum Peel Test for Adhesives
	D1876	Test Method for Peel Resistance of Adhesives (T-Peel Test)
	D3167	Test Method for Floating Roller Peel of Adhesives
Radiation Exposure	D1879	Practice for Exposure of Adhesive Specimens to High-Energy Radiation
Storage Life	D1337	Practice for Storage Life of Adhesives by Consistency and Bond Strength
Tack	D1995	Test Methods for Multi-Modal Strength Testing of Autoadhesives (Contact Adhesives)
	D2979	Test Method for Pressure-Sensitive Tack of Adhesives Using an Inverted Probe Machine
	D3121	Test Method for Tack of Pressure-Sensitive Adhesive by Rolling Ball
	D6195	Test Methods for Loop Tack
Working Life/Time	D1338	Practice for Working Life of Liquid of Paste Adhesives by Consistency and Bond Strength
	D4497	Test Method for Determining the Open-Time of Hot-Melt Adhesives (Manual Method)

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 provide values for specific performance requirements. These values are to be determined by the design engineer, based on the specific requirements of the application.

6.2 *Step 2—Define the Reason for Bonding or Sealing to Determine Performance Requirements*—The next step in selecting an adhesive/sealant is to define the reason for bonding or sealing. Different bonding or sealing applications require varying criteria for bonding or sealing. The reason for bonding or sealing (that is, structural, non-structural, thread-fastening) will direct the user to determine and utilize a set of performance criteria tailored to the requirements of their particular application. The individual user must set the performance requirements for each individual bonding and sealing application according to the specific usage and materials being utilized in the application. Then, use the data obtained in the performance and material compatibility phase of this guide (see 6.3), to assess the adhesive's or sealant's performance against the required performance.

6.3 *Step 3—Determine Materials of the Parts to be Bonded or Sealed to Ascertain Performance and Material Compatibility Requirements*—The third step in using this guide is to determine the material, or materials of the parts being bonded or sealed. The information will provide the engineer with the performance and material compatibility test data required to ensure that the adhesive or sealant achieves the required performance levels and will not damage the parts being bonded or sealed. The material compatibility factors are not based on adherend/substrate material degradation, as is usually the understood definition. For this guide, material compatibility

TABLE 4 Performance and Material Compatibility Requirements

Material (Adherend/Substrate)	ASTM Standard	Standard Title
Metals - Similar & Dissimilar Types of Metals	D897	Test Method for Tensile Properties of Adhesive Bonds
	D905	Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading
	D1002	Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
	D1062	Test Method for Cleavage Strength of Metal-to-Metal Adhesive Bonds
	D1144	Test Method for Determining Strength Development of Adhesive Bonds
	D1184	Test Method for Flexural Strength of Adhesive Bonded Laminated Assemblies
	D1780	Practice for Conducting Creep Tests of Metal-to-Metal Adhesives
	D1916	Test Method for Penetration of Adhesives
	D2293	Test Method for Creep Properties of Adhesives in Shear by Compression Loading (Metal-to-Metal)
	D2294	Test Method for Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)
	D2295	Test Method for Strength Properties of Adhesives in Shear by Tension Loading at Elevated Temperatures (Metal-to-Metal)
	D2918	Practice for Durability Assessment of Adhesive Joints Stressed in Peel
	D2919	Test Method for Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading
	D3165	Test Method for Strength Properties of Adhesives in Shear by Tension Loading of Single-Lap Joint Laminated Assemblies
	D3166	Test Method for Fatigue Properties of Adhesives in Shear by Tension Loading (Metal/Metal)
	D3433	Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Metal Joints
	D3528	Test Method for Strength Properties of Double Lap Shear Adhesive Joints by Tension Loading
	D3762	Test Method for Adhesive-Bonded Surface Durability of Aluminum (Wedge Test)
	D3983	Test Method for Measuring Strength and Shear Modulus of Nonrigid Adhesives by the Thick-Adherend Tensile-Lap Specimen
	D4027	Test Method for Measuring Shear Properties of Structural Adhesives by the Modified-Rail Test
	D4501	Test Method for Shear Strength of Adhesive Bonds Between Rigid Substrates by the Block-Shear Method
	D4562	Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen
	D5041	Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Joints
	D5656	Test Method for Thick-Adherend Metal Lap-Shear Joints for Determination of the Stress-Strain Behavior of Adhesives in Shear by Tension Loading
	E229	Test Method for Shear Strength and Shear Modulus of Structural Adhesives
Plastics - Similar & Dissimilar Types of Plastics	D897	Test Method for Tensile Properties of Adhesive Bonds
	D905	Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading
	D1144	Test Method for Determining Strength Development of Adhesive Bonds
	D1184	Test Method for Flexural Strength of Adhesive Bonded Laminated Assemblies
	D1916	Test Method for Penetration of Adhesives
	D2918	Practice for Durability Assessment of Adhesive Joints Stressed in Peel
	D2919	Test Method for Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading
	D3163	Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading
	D3164	Test Method for Strength Properties of Adhesively Bonded Plastic Lap-Shear Sandwich Joints in Shear by Tension Loading
	D3165	Test Method for Strength Properties of Adhesives in Shear by Tension Loading of Laminated Assemblies
	D3528	Test Method for Strength Properties of Double Lap Shear Adhesive Joints by Tension Loading
	D3807	Test Method for Strength Properties of Adhesives in Cleavage Peel by Tension Loading (Engineering Plastics-to-Engineering Plastics)
	D3929	Test Method for Evaluating the Stress Cracking of Plastics by Adhesives Using the Bent-Beam Method
	D3983	Test Method for Measuring Strength and Shear Modulus of Nonrigid Adhesives by the Thick-Adherend Tensile-Lap Specimen
	D4027	Test Method for Measuring Shear Properties of Structural Adhesives by the Modified-Rail Test
	D4501	Test Method for Shear Strength of Adhesive Bonds Between Rigid Substrates by the Block-Shear Method
	D4562	Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen
	D5041	Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Joints
	E229	Test Method for Shear Strength and Shear Modulus of Structural Adhesives
Fiber Reinforced Plastics (FRP)– Similar & Dissimilar Types of FRP	D897	Test Method for Tensile Properties of Adhesive Bonds
	D905	Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading
	D1144	Test Method for Determining Strength Development of Adhesive Bonds
	D1184	Test Method for Flexural Strength of Adhesive Bonded Laminated Assemblies
	D1916	Test Method for Penetration of Adhesives
	D2918	Practice for Durability Assessment of Adhesive Joints Stressed in Peel
	D2919	Test Method for Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading
	D3165	Test Method for Strength Properties of Adhesives in Shear by Tension Loading of Laminated Assemblies
	D3528	Test Method for Strength Properties of Double Lap Shear Adhesive Joints by Tension Loading
	D3983	Test Method for Measuring Strength and Shear Modulus of Nonrigid Adhesives by the Thick-Adherend Tensile-Lap Specimen
	D4027	Test Method for Measuring Shear Properties of Structural Adhesives by the Modified-Rail Test
	D4501	Test Method for Shear Strength of Adhesive Bonds Between Rigid Substrates by the Block-Shear Method
	D4562	Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen
	D5041	Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Joints
	D5573	Practice for Classifying Failure Modes in Fiber-Reinforced-Plastic (FRP) Joints
	D5868	Test Method for Lap Shear Adhesion for Fiber Reinforced Plastic (FRP) Bonding
	E229	Test Method for Shear Strength and Shear Modulus of Structural Adhesives

TABLE 4 *Continued*

Material (Adherend/Substrate)	ASTM Standard	Standard Title
Dissimilar Types of Materials – Metals/Plastics, Metals/FRP, & Plastics/FRP Combinations	D897	Test Method for Tensile Properties of Adhesive Bonds
	D905	Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading
	D1144	Test Method for Determining Strength Development of Adhesive Bonds
	D1184	Test Method for Flexural Strength of Adhesive Bonded Laminated Assemblies
	D1916	Test Method for Penetration of Adhesives
	D2918	Practice for Durability Assessment of Adhesive Joints Stressed in Peel
	D2919	Test Method for Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading
	D3165	Test Method for Strength Properties of Adhesives in Shear by Tension Loading of Laminated Assemblies
	D3528	Test Method for Strength Properties of Double Lap Shear Adhesive Joints by Tension Loading
	D3762	Test Method for Adhesive-Bonded Surface Durability of Aluminum (Wedge Test)
	D3983	Test Method for Measuring Strength and Shear Modulus of Nonrigid Adhesives by the Thick-Adherend Tensile-Lap Specimen
	D4027	Test Method for Measuring Shear Properties of Structural Adhesives by the Modified-Rail Test
	D4501	Test Method for Shear Strength of Adhesive Bonds Between Rigid Substrates by the Block-Shear Method
	D4562	Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen
	D5041	Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Joints
	E229	Test Method for Shear Strength and Shear Modulus of Structural Adhesives
Threaded Fasteners	D5363	Specification for Anaerobic Single-Component Adhesives (AN)
	D5648	Test Method for Torque-Tension Relationship of Adhesives Used on Threaded Fasteners (Lubricity)
	D5649	Test Method for Torque Strength of Adhesives Used on Threaded Fasteners
	D5657	Test Method for Fluid Tightness Ability of Adhesives Used on Threaded Fasteners

refers to the ability of the adherend and substrate to create the necessary interphasal properties by which to form and perpetuate the bond or seal. In essence, the material compatibility becomes an interdependent part of the performance criteria.

6.3.1 Table 4 presents information to be used to determine the required performance and material compatibility tests. To use Table 4, select the material(s) type(s) from the left-hand column of the table. The remaining information in the corresponding row provides the title and the specification number for each of the tests that must be performed in order to ensure that the performance levels and material compatibility with the adhesive or sealant are met. All tests may not be required for every application. The engineer must evaluate which tests are pertinent to the performance in their specific application. It is important to note that alloys behave differently than pure metals and different alloys behave differently than other alloys. The same is true for varying plastics formulas. Therefore, specific alloys or type of plastics must be utilized when conducting these compatibility tests. If data are not available on your specific alloy or plastic with a specific adhesive or sealant, the data must be developed, by testing, prior to the use of the adhesive or sealant.

6.4 *Step 4—Analyze Configuration to Determine Acceptable Adhesive/Sealant, Cleaning, and Surface Preparation Processes*—Once the engineer has determined that an adhesive/sealant will meet the performance and material compatibility application requirements, the next step is to determine the overall process. The configuration of the part(s) to be bonded or sealed will be a critical parameter in determining the types of operations for which the part can be subjected with satisfactory results. Some shapes are not conducive to certain types of adhesive or sealant preparation processes, such as cleaning or etching. Cleaning and surface preparation of the adherend and substrate are also very critical in the performance of the adhesive or sealant for most types of bonding and sealing applications. Without properly cleaned or prepared surfaces, the adhesive/sealant will not produce the required interphasal characteristics to enable the optimum bonding of the adherend and substrate. Engineers should refer to Guide D6361 in order to establish acceptable cleaning processes and equipment. Please note that processing equipment material compatibility with the adhesive or sealant and cleaning agent, must also be performed in the same manner as for parts to be bonded or sealed (see 6.3). Table 5 provides additional surface preparation and cleaning requirements.

6.5 *Step 5—Make Final Selection*—After completing the first four steps of this guide, the user may be faced with choosing between several adhesives/sealants that meet the requirements. At this point the user should consider economic and other business-related choices in making the final decision. The user may want to also take a look at the application requirements of Step 1 to determine whether any of the candidate adhesive/sealant better complies with the requirements of the application (for example, lower flash point, less personal protective equipment needed, etc.). If after completing the first four steps, there are no adhesives, sealants, or processes, or combination thereof, that meet the material compatibility and performance requirements for the particular bonding or sealing application, the user must go back to Step 1, and re-evaluate the requirements of the application. This will allow for a larger universe of potential adhesives or sealants. Once chosen, the new set of adhesives/sealants must also be evaluated in Steps 2 through 4. This cycle must be repeated

TABLE 5 Preparation and Cleaning Requirements

Standard	Title
D2093	Practice for Preparation of Surfaces of Plastics Prior to Adhesive Bonding
D2651	Guide for Preparation of Metal Surfaces for Adhesive Bonding
D2674	Methods of Analysis for Sulfochromate Etch Solution Used in Surface Preparation of Aluminum
D3933	Guide for Preparation of Aluminum Surfaces for Structural Adhesive Bonding (Phosphoric Acid Anodized)

until an acceptable adhesive/sealant is found. There can be no compromises made on the material compatibility or performance requirements.

7. Other Emerging Technology Considerations

7.1 New products are being developed and added to the adhesives and sealants marketplace constantly. This is due to constantly changing performance requirements, environmental regulations, and worker safety and health issues. As each adhesive or sealant is considered for use in a new application or as a replacement, it must undergo both performance and life cycle cost evaluations for the application in which it will be used.

8. Keywords

8.1 adhesives; aerospace; glue; sealants