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*JOINT
INDUSTRY
STANDARD*

Space Applications
Electronic Hardware
Addendum to
Requirements for
Soldered Electrical
and Electronic
Assemblies



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J-STD-001CS

Space Applications Electronic Hardware Addendum to Requirements for Soldered Electrical and Electronic Assemblies

Developed by the Space Electronic Assemblies J-STD-001 Addendum Task Group (5-22s) of the Assembly & Joining Processes Committee (5-20) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

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Any document involving a complex technology draws material from a vast number of sources. While the principal members of the Space Electronic Assemblies J-STD-001 Addendum Task Group (5-22s) of the Assembly & Joining Processes Committee (5-20) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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Space Requirements for Soldered Electrical and Electronic Assemblies: An Addendum Based on the Class 3 Requirements of IPC/EIA J-STD-001, Revision C

1 SCOPE

This addendum provides additional requirements over those published in IPC/EIA J-STD-001C to ensure the reliability of soldered electrical and electronic assemblies that must survive the vibration and thermal cyclic environments getting to and operating in space.

Where content criteria are not supplemented, the Class 3 requirements of IPC/EIA J-STD-001C apply.

1.1 Purpose When required by procurement documentation/drawings, this Addendum supplements or replaces specifically identified requirements of IPC/EIA J-STD-001, Revision C of March 2000.

1.2 Precedence The contract takes precedence over this Addendum, referenced standards and user-approved drawings (see IPC/EIA J-STD-001C 3.1.1). In the event of a conflict between this Addendum and the applicable documents cited herein, this Addendum takes precedence. Where referenced criteria of this addendum differ from the published IPC/EIA J-STD-001C, this addendum takes precedence.

1.3 Existing or Previously Approved Designs This Addendum **shall not** constitute the sole cause for the redesign of previously approved designs. When drawings for existing or previously approved designs undergo revision, they should be reviewed and changes made that allow for compliance with the requirements of this Addendum.

1.4 Use This addendum is not to be used as a stand-alone document.

Where criteria are not supplemented, the Class 3 requirements of IPC/EIA J-STD-001C apply. If an IPC/EIA J-STD-001C requirement is changed or added by this Addendum, the clause is identified and the entire IPC/EIA J-STD-001C clause is replaced by this addendum

The clauses modified by this Addendum do not include subordinate clauses unless specifically stated (e.g., 1.4 does not include 1.4.1). Clauses, Tables, Figures, etc. in IPC/EIA J-STD-001C that are not listed in this addendum are to be used as-published.

A description of the change is provided to describe the difference from the original requirement, and in most cases, an explanation for the change is provided.

Table 1 Space Applications Requirements

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
1.1	Purpose This standard describes materials, methods and acceptance criteria for producing soldered electrical and electronic assemblies. The intent of this document is to rely on process control methodology to ensure consistent quality levels during the manufacture of products. It is not the intent of this standard to exclude any procedure for component placement or for applying flux and solder used to make the electrical connection; however, the methods use shall produce completed solder joints conforming to the acceptability requirements described in this standard.	Delete the second paragraph. Without this change none of the requirements are enforceable.

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
1.4	<p>Definition of Requirements When the word “shall” is used in this document, it expresses a requirement that is mandatory.</p> <p>Where the word “shall” leads to a hardware defect for at least one class, the requirements for each class are annotated in text boxes located adjacent to that occurrence in the text. These boxes are summarized in Table 11-1. Table 11-1 identifies each listed condition for each class as either “Defect,” “Process Indicator,” “Acceptable,” or “No Requirement Specified.” In case of a discrepancy between requirements in the text boxes and Table 11-1, requirements listed in the text boxes take precedence.</p> <p>Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this standard. When tables or figures provide details of the requirements, the tables or figures take precedence over the text of this standard.</p> <p>IPC-HDBK-001, a companion document to this specification, contains valuable explanatory and tutorial information compiled by IPC Technical Committees that is relative to this specification. Although the Handbook is not a part of this specification, when there is confusion over the specification verbiage, the reader is referred to the Handbook for assistance.</p> <p>Note: In previous revisions of this standard, the words “must” and “shall” had special meanings. In this revision (IPC/EIA J-STD-001C), the word “shall” has no special meaning beyond that commonly used in other IPC standards as stated above.</p>	<p>The first paragraph is reworded so that wherever the word “shall” is used, it expresses a requirement that is mandatory. There are many “shalls” in IPC/EIA J-STD-001C that are process indicators that would not need disposition. That is, there is no criteria established that identifies how to treat nonconformance. This change makes all “shalls” hard requirements that require disposition.</p>
1.4.1	<p>Hardware Defects and Process Indicators Hardware characteristics or conditions that do not conform to the requirements of this specification that are detectable by inspection or analysis shall be classified as hardware defects. Hardware defects listed in the applicable text boxes shall be identified and shall be dispositioned, e.g., rework, scrap, use as is, repair.</p> <p>It is the responsibility of the user (see 3.2.10) to define unique defect categories applicable to the product. It is the responsibility of the manufacturer (see 3.2.3) to identify defects and process indicators that are unique to the assembly.</p>	
3.1.2	<p>Specialized Processes and Technologies Mounting and soldering requirements for specialized processes and/or technologies not specified herein shall be performed in accordance with documented procedures that have been approved by the User prior to use.</p>	<p>The end of the sentence was changed to require User approval of specialized processes prior to their use, rather than having “documented procedures which are available for review.” The User may be more aware of special constraints or lessons learned. It is proactive to identify potential problems in the design stage, not the fabrication stage. The “prior to use” requirement is in place so that if for some reason the procedures are not approved, it will avoid having to scrap or rework production hardware.</p>
3.2.10	<p>User The User is defined as the individual, organization, company, contractually designated authority or agency responsible for the procurement of electrical / electronic hardware, and having the authority to define the class of equipment and any variation or restrictions to the requirements of this standard.</p>	<p>This definition was reworded to clarify that the procuring organization is the default authority for defining or approving any variations or restrictions to the requirements of IPC/EIA J-STD-001C or this Addendum unless explicitly authorized by contract.</p>
3.4	<p>Personnel Proficiency All instructors, operators, and inspection personnel shall be proficient in the tasks to be performed. Objective evidence of that proficiency shall be maintained and be available for review. Objective evidence should include records of training to the applicable job functions being performed, work experience, testing to the requirements of this standard, and/or results of periodic reviews of proficiency.</p> <p>Training to the IPC J-STD-001C Training and Certification Program with the Space Requirements for Soldered Electronic Assemblies (Module 6) or the Operator Program Module 1, Modules 2 through 5 as appropriate, and Module 6 shall be traceable to an IPC Master Instructor. Training, examinations, and demonstrations of proficiency shall be proctored by an IPC Master or Registered Instructor.</p>	<p>The last sentence of the published J-STD-001C paragraph was deleted to disallow supervised on the job training for fabricating space hardware.</p> <p>A new second paragraph was added requiring structured training in a classroom-type environment that is traceable to an IPC Master Instructor.</p>

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
3.7	Soldering Tools and Equipment Tools and equipment shall be selected, used, and maintained such that no damage or degradation that would be detrimental to the designed function of parts or assemblies result from their use. Soldering irons, equipment, and systems shall be chosen and employed to provide temperature control and isolation from electrical overstress or ESD (see 3.5), and be calibrated in accordance with ISO 17025 or ANSI/NCSL-Z540-1-1994. A tool used to cut leads shall not impart shock that damages a component lead seal or internal connection. See Appendix A for guidelines on tool selection and maintenance.	The word "used" was moved to make a requirement that the right tools are used and that they are used as they are intended to be. Calibration to a known standard is a vital control in the manufacture of space hardware. Although recommended in Appendix A, the appendices in IPC/EIA J-STD-001C are informational and are not considered requirements unless otherwise specified.
4	MATERIALS The materials and processes used to assemble/manufacture electronic assemblies shall be selected such that their combinations produce products acceptable to this standard. Objective evidence of this compatibility shall be maintained and available for review. When major elements of the proven processes are changed (e.g., flux, solder paste, cleaning media or system, solder alloy or soldering system), validation of the acceptability of the changes shall be performed and documented in accordance with Appendix B and approved by the User prior to use. These process changes can involve a change in one of the process steps. They can also pertain to a change in bare board supplier, solder resist or metallization. Limited shelf life items shall be stored and controlled in accordance with material manufacturers' recommendations.	Since changes to major elements of a process can affect reliability, the 3rd sentence was reworded to make it a requirement that any major changes to proven processes are validated and approved by the User prior to use. The last sentence was added to ensure control over limited shelf life items.
4.1	Solder Solder alloys (Sn60A, Pb36B, and Sn63A) shall be in accordance with J-STD-006 or equivalent. High temperature solder alloys, e.g., Sn96, shall only be used where specifically indicated by approved drawings. Other solder alloys that provide the service life, performance, and reliability required of the product may be used if all other conditions of this standard are met and objective evidence of such is reviewed and approved by the User prior to use. Flux that is part of flux-cored solder wire shall meet the requirements of 4.2. Flux percentage is optional.	Reworded to require that the compatibility of alternate solder alloys be substantiated, with data, to ensure the performance of the alternate solder alloy for the expected environment. Also, high-temperature alloys such as Sn96 can only be used where specifically required.
4.2.a	Flux shall conform to flux activity levels L0 or L1 of flux materials rosin (RO) or resin (RE) unless clause 4.2.b applies.	First sentence was reworded to remove the allowance for using fluxes other than those shown on space hardware without prior User approval.
4.2.b	When other activity levels or flux materials are used, data demonstrating compliance with testing of Appendix B shall be approved by the User prior to use. Note: Flux or solder paste soldering process combinations previously tested or qualified in accordance with other specifications do not require additional testing.	Reworded the end of the sentence to require User approval, prior to use, for higher activity level fluxes which can leave residues that are difficult to remove, or can lead to corrosion or growth.
4.2.d (new)	For all fluxing applications where adequate cleaning is not practical, only flux types RO or RE of the L0 flux activity level, or equivalent, shall be used. Liquid flux used with flux-cored solder shall be chemically compatible with the solder core flux and with the materials with which it will come in contact.	Added as a new sub-paragraph because some type L0 and L1 fluxes may present reliability problems in a no-clean process.
4.6	Chemical Strippers Chemical solutions, pastes, and creams used to strip solid wires shall not cause degradation to the wire. Chemical stripping materials shall be completely neutralized and be cleaned such that there are no residues from the stripping, neutralizing, or cleaning steps.	A new last sentence was added to ensure there are no residues from the stripping or cleaning processes.
5.4.1	Gold Removal Gold shall be removed: From at least 95% of the surface to-be-soldered of the through-hole component leads. From 95% of all surfaces of surface mount components to-be-soldered regardless of gold thickness. From the to-be-soldered surface of solder terminals. A double tinning process or dynamic solder wave may be used for gold removal. These requirements may be eliminated if there is documented objective evidence available for review that there are no gold related solder embrittlement problems associated with the soldering process being used.	To address concerns over gold embrittlement, the first bullet was reworded to remove the allowance for soldering to gold thicknesses of less than 2.5 μm [0.0984 mil]. The third bullet was reworded to include the words "to-be-soldered" to clarify that the entire terminal does not need the gold removed; and to remove the allowance for soldering to gold thicknesses of less than 2.5 μm [0.0984 mil].

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
6.1	<p>General Part Mounting Requirements When design restrictions mandate mounting components incapable of withstanding soldering temperatures incident to a particular process, such components shall be mounted and soldered to the assembly as a separate operation. Parts shall be mounted with sufficient clearances between the body and the PWB to assure adequate cleaning and cleanliness testing (if required). Assemblies should be cleaned after each soldering operation so that subsequent placement and soldering operations are not impaired by contamination (see 8, Cleanliness Requirements).</p> <p>On assemblies using mixed component mounting technology, through-hole components should be mounted on one side of the printed board. Surface mounted components may be mounted on either or both sides of the assembly.</p> <p>Where component marking visibility and legibility is desired the contract or drawing shall so state. Parts should be mounted such that part markings and reference designators are visible.</p> <p>Rigid adhesives or coatings (e.g., epoxies) shall not be applied directly to glass bodied components.</p>	The [new] fourth paragraph was added because glass is prone to cracking due to the rigidity of these types of materials.
6.1.2	<p>Lead Forming Part and component leads should be preformed to the final configuration, excluding the final clinch or retention bend, before assembly or installation. The lead forming process shall not damage connections internal to components. Leads shall not be reformed except for minor adjustments to bend angles.</p>	The last sentence was added because lead forming cold works metals. Multiple forming can result in fatigue failure of the lead.
6.1.2.1	<p>Lead Deformation Limits Whether leads are formed manually or by machine or die, parts or components shall not be mounted if the part or component lead has any nicks, scrapes or gouges. Smooth indentations up to 10 percent, except as allowed for flattened leads (see 6.1.2.6), of the diameter, width, or thickness of the lead are acceptable. Exposed basis metal is acceptable if deformation does not exceed the limits defined by this paragraph.</p>	<p>The first sentence was reworded to disallow "nicks or deformation exceeding 10% of the diameter, width, or thickness of the lead..." and the last sentence was reworded to maintain continuity with the changed requirement in the first sentence.</p> <p>Stresses are concentrated in the "V" of nicks, scrapes, or gouges. This type of damage, even of only 5 percent of the lead diameter, have caused lead fracture during vibration testing.</p>
6.1.2.2.a	Two lead widths for flat leads.	For severe operational environments, extra consideration is given to the minimum available contact length.
6.1.2.5	<p>Surface Mount Device Lead Deformation There shall be no unintentional lead deformation beyond the limits defined in Paragraph 6.1.2.1.</p>	This entire paragraph (including its sub-paragraphs a-e) is deleted and replaced with the Addendum requirement. Unintentional bending can affect stress relief and lead to fatigue fractures.
6.1.3	<p>Wire and Cable Preparation Insulation discoloration resulting from thermal stripping is permissible, however, the insulation shall not be charred. Chemical insulation stripping agents shall be used only for solid wire and are to be neutralized or removed prior to soldering.</p> <p>Table 6-1 does not apply; there shall be no nicked or broken wire strands. Birdcaging shall not extend beyond the insulation outside diameter. Wires that exhibit minor deformation shall comply with the deformation limits defined in paragraph 6.1.2.1 of this Addendum.</p>	<p>This was changed to disallow any severed strands; and to define deformation limits as those allowed for components in clause 6.1.2.1 of this Addendum.</p> <p>Birdcaged, nicked, or gouged wires are easily broken and can result in conductive debris, open circuits, or electrical overstress (EOS) because of reduced wire size.</p>

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
6.4.3	Leaded Component Body Positioning The maximum clearance between the bottom of a leaded component body and the printed wiring surface should be 2.0 mm [0.0787 in]. Parts insulated from circuitry or over surfaces without exposed circuitry may be mounted flush. Parts having conductive cases mounted over printed conductors or which are in close proximity with other conductive materials shall be separated by suitable insulation.	An air gap is not suitable dielectric.
6.5.2	Lead Termination Requirements Component leads in through-hole connections may be terminated using a straight through, partially clinched, or clinched configuration. The clinch should be sufficient to provide mechanical restraint during the soldering process. The orientation of the clinch relative to any conductor is optional. DIP leads should be partially bent outward from the longitudinal axis of the body. Tempered leads shall be terminated only using a straight through termination and shall not be clinched, formed or bent. Lead protrusion shall not violate minimum electrical clearance requirements. Lead protrusion shall be in accordance with Table 6-3.	The second paragraph was reworded to disallow any bending of tempered leads. Bending tempered leads can damage the lead-to-body seal and there are the same cold-worked metal fatigue issues described earlier in this Addendum - but even more importantly for this paragraph because of the metallurgy of tempered leads.
7.1.7	Drying/Degassing Prior to soldering, the assembly shall be treated to remove detrimental moisture and other volatiles.	Printed wiring boards that are not demoisturized are susceptible to board damage and solder defects when exposed to soldering temperatures.
7.3.2	Solder Bath The period of exposure of any printed board to a solder bath shall be limited to a duration that will not degrade the board or parts mounted thereon. The solder bath using Sn60A, Pb36B, or Sn63A solder should be maintained at a temperature within the range of 230 degrees C [446 degrees F] to 290 degrees C [554 degrees F]. For other alloys, other temperature ranges may be required. For all alloys, the nominal temperature should have a tolerance of ± 5 degrees C [9 degrees F]. For Class 3, this tolerance shall not put the bath temperature outside the established limits.	To correct typographical errors in the second and third sentences of IPC/EIA J-STD-001C, the "[554 degrees C]" was changed to "[554 degrees F]." Additionally, a global change to use the word "degrees" instead of its symbol is used in this Addendum.
8.3.1	Particulate Matter Assemblies shall be free of dirt, lint, solder splash, dross, wire clippings, solder balls or other metal particles, etc.	"Solder balls and other metal particles" was added to the first sentence to emphasize that they are not allowed. The second sentence of the published IPC/EIA J-STD-001C paragraph was deleted because it allowed solder balls or other metal particles that were not "loose (i.e., be dislodged in the normal service environment of the product) nor violate minimum electrical clearance." Conductive particles can dislodge during ascent vibrations and float in micro-gravity environments causing short circuits.
8.3.2	Flux Residues and Other Ionic or Organic Contaminants Unless specified otherwise on engineering documentation approved by the User, cleanliness designator C-22 as described in the following paragraphs and the visual requirements for cleanliness (per 8.3.2.2) shall apply.	The published IPC/EIA J-STD-001C paragraph was replaced in its entirety to require that cleanliness designator C-22 is the minimum cleanliness level used for flight hardware.
8.3.2.2	Visual Requirements Surfaces cleaned shall be inspected between four and ten times magnification and shall be free of visual evidence of residue or contaminants. Surfaces not cleaned may have evidence of flux residues.	The first sentence was reworded to require visual inspection of cleaned surfaces to be performed at between four and ten times magnification. Many types of debris or contamination are hard to see without magnification, particularly when trying to see under quad-packs, DIP's, etc.

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
9.1	<p>Acceptance Requirements All soldered connections shall meet the applicable product class acceptance requirements of 9.2.</p> <p>Manufacturers shall perform 100 percent inspection using either visual inspection or a nondestructive evaluation technique except for solder connections as specified in 9.2.4.3 and 9.2.6.15. Nondestructive verification techniques shall be approved by the User prior to use.</p>	<p>The second paragraph and its bullets were replaced to require 100 percent inspection on all products and that NDE methods are approved by the User prior to use (see 3.1.2).</p>
9.2.1.1	<p>Printed Wiring Board Damage The following printed wiring board defects shall be rejected:</p> <ol style="list-style-type: none"> Any evidence of blistering or delamination between plated-through holes or internal conductors for printed wiring boards or assemblies. Measling or crazing that reduces the distance between adjacent noncommon conductors to less than 50%. <p>Note: Measling is NOT the same as blistering and/or delamination. See IPC-T-50 for clarification.</p> <ol style="list-style-type: none"> When areas of weave exposure reduce the clearance between noncommon conductive patterns to less than the minimum electrical clearance. When haloing or edge delamination reduces the edge clearance more than 50% of that specified, or more than 2.5 mm [0.0984 in], if none is specified. Before soldering, any evidence of lifted lands or circuitry. After soldering, when the outer, lower edge of land areas are lifted or separated more than the thickness (height) of the land. Reduction in minimum width of printed conductors by more than 20%. Reduction in width or length of lands by more than 20%. Any separation or bubbles in the cover layer of flexible printed wiring boards or assemblies. Any evidence of blistering, charring, or melting of the insulation on flexible printed wiring boards or assemblies. <p>Note: Mechanically created indentions caused by contact between the cover-layer of flexible printed wiring boards or assemblies and molten solder are not rejectable. Additionally, care should be taken to avoid bending or flexing conductors during inspection.</p> <ol style="list-style-type: none"> Burns that physically damage the surface of the assembly. Solder on contact area of gold edge connector contact lands (i.e., "gold fingers"). 	<ul style="list-style-type: none"> - Clause 9.2.1.1 was reworded to cover only Class 3 and addendum requirements. - "a" was modified so that flexible printed circuits are not exempt from any of the rejection criteria that apply. - After soldering, the IPC/EIA J-STD-001C criteria remains as originally published.
9.2.1.2	<p>Component Damage Minor surface flaws, discoloration, coating meniscus cracks, or chips are acceptable. However, they shall not expose the component substrate or active element nor affect structural integrity and reliability. There shall not be any damage to components in excess of component specification limits. Components shall not be charred.</p> <p>Note: Visual aids can be found in IPC-A-610.</p>	<p>The words "glass bodied" were removed from the third sentence because damage to components is harmful whether they're glass bodied or not. Most component specifications allow for the "minor damage" described in 9.2.1.2, but the published IPC/EIA J-STD-001C words may or may not comply with a particular part type's acceptable limits of damage. This Addendum requirement drives all component damage limits to parts' specifications which are defined in more measurable terms than the words in IPC/EIA J-STD-001C.</p>

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
9.2.4	<p>Solder Connection All solder connections shall indicate evidence of wetting and adherence where the solder blends to the soldered surface, forming a contact angle of 90° or less, except when the quantity of solder results in a contour which extends over the edge of the land or solder resist (see Figure 9-1). The solder joints should have a generally smooth appearance. A satin luster is permissible.</p> <p>There are solder alloy compositions, component lead and terminal finishes, or printed board platings and special soldering processes (e.g., slow cooling with large mass PWB's) that may produce dull, matte, gray, or grainy appearing solders that are normal for the material or process involved. These solder joints are acceptable.</p> <p>A smooth transition from land to connection surface or component lead should be evident. A line of demarcation or transition zone where applied solder blends with solder coating, solder plate, or other surface material is acceptable provided that wetting is evident. Marks or scratches in the solder joint shall not degrade the integrity of the connection.</p>	The third sentence of the third paragraph* was deleted in order to make Table 9-1 apply to all assemblies.
9.2.4.2	<p>Solder Connection Defects The following solder joint conditions shall be considered defects:</p> <ol style="list-style-type: none"> Fractured solder connections. Disturbed solder connections. Cold solder connections. Solder that violates minimum electrical clearance (e.g., bridges), or contacts the component body (except as noted in 9.2.6.8 and 9.2.6.9). Fails to comply with wetting criteria of 9.2.4. Solder bridging between joints except when path is present by design. Overheated solder connection. Blowholes, pinholes, and voids (where the bottom and all sides are not visible). Excessive solder (solder in the bend radius of axial leaded parts in PTH's is not cause for rejection provided the lead is properly formed, the topside bend radius is discernible, and the solder does not extend to within 1 lead diameter of the part body or end seal). Insufficient solder. Rosin solder joint. Contamination (e.g., lint, flux, dirt, extraneous solder/metal). 	Items "g" through "l" were added to the originally published IPC/EIA J-STD-001C criteria for solder connection defects.
9.2.4.3	<p>Partially Visible or Hidden Solder Connections Partially visible or hidden solder connections are acceptable provided that the following conditions are met:</p> <ol style="list-style-type: none"> The design does not restrict solder flow to any connection element on the solder destination side lands (e.g., PTH component) of the assembly. The visible portion, if any, of the connection on either side of the PTH solder connection (or the visible portion of the SMD connection) is acceptable. Process controls are maintained in a manner assuring repeatability of assembly techniques. If interim inspection does not occur, then NDE shall be used. The User shall approve the NDE method prior to use. 	Item "d" was added to ensure that if a partially visible or hidden solder connection cannot be inspected at some interim step in the process, the connection is verified using a nondestructive evaluation technique that is approved by the User prior to use. The NDE method selected needs to be approved prior to use because the User may be more aware of potential damage to the assembly (e.g., maximum radiation levels the assembly can withstand).

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
9.2.5.1	<p>Plated-Through Holes with Component Leads, Minimum Acceptable Conditions (see Note 1)</p> <p>Table 9-1</p> <p>Feature A – Circumferential wetting on solder destination side of lead and barrel shall be 360 degrees.</p> <p>Feature B – Vertical fill of solder shall be at least 75 percent. See Note 3.</p> <p>Feature C – Circumferential fillet and wetting on solder source side of lead and barrel shall be 360 degrees.</p> <p>Feature D – Minimum percentage of original land area covered with wetted solder on solder destination side shall comply with Note 4.</p> <p>Feature E – Minimum percentage of original land area covered with wetted solder on solder source side shall be 75 percent.</p> <p>NOTES:</p> <ol style="list-style-type: none"> 1. Wetted Solder refers to solder applied by the solder process. 2. The 25% unfilled height includes both source and destination side depressions. 3. Up to 25 percent recession or shrinkback of the solder into the PTH below the solder pad is acceptable, provided the solder has flowed onto, and wetted to, the lead and solder pad before receding, and the recession or shrinkback cannot be construed to be a solder void or blowhole. 4. The solder quantity shall, as a minimum, exhibit flow-through and bonding of the lead or conductor to the solder pad; but not necessarily wetting out to or around the entire periphery of the solder pad. 	<p>Since the lack of complete circumferential wetting around the lead, barrel, or pad indicates solderability problems that must be addressed, Features A, and C in Table 9-1 were changed and Notes 3 and 4 were added. Features D and E, and Notes 1 and 2, are the same as published in IPC/EIA J-STD-001C.</p>
9.2.6.4	<p>Table 9-4 Change Dim. A to 25% W maximum. Change Dim. J to 50% of termination length.</p>	
9.2.6.7	<p>Castellated Terminations Castellated part package types are not recommended for space hardware. If chosen by design, engineering documentation shall define acceptance criteria. Acceptance criteria shall be approved by the User prior to use.</p>	<p>Castellated parts have little or no stress relief, and since they are most often quad-packs, the corner leads are prone to failure because of mechanical shear stresses. If for some reason their use is mandated by design, the design activity must provide acceptance criteria.</p>
9.2.6.8	<p>Table 9-8 Change Dim. D to 100% available lead/land interface.</p>	
9.2.6.9	<p>Table 9-9 Change Dim. D to 100% available lead/land interface.</p>	
9.2.6.15	<p>Surface Mount Area Array Packages With ball grid arrays and column grid arrays, minimal visual inspection is possible. Where features are not inspectable by visual techniques, the requirements are related to inspection by through transmission or laminography x-ray with the limitations of the technique employed. When assembly includes this technology, the manufacturer shall document the material and process parameters, acceptance criteria and verification technique. The material and process parameters, acceptance criteria, and verification technique shall be approved by the User prior to use.</p>	<p>The last sentence was added to ensure appropriate choice of nondestructive inspection techniques for the application, and to prevent damage to parts due to radiation.</p>
Table 9-15	<p>Terminal Soldering Requirements</p> <p>Feature A – Circumferential fillet and wetting - solder source side shall be 360 degrees.</p> <p>Feature B – Percentage of original land area covered with wetted solder shall be 75 percent.</p>	<p>Feature A was changed from 330 degrees to 360 degrees to prevent flux entrapment and seal joints.</p>

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
10	<p>Coating, Encapsulation and Staking (Adhesive)</p> <p>a. A mix record shall be created for each mixed batch of multi-part polymers used for conformal coating, encapsulating, or staking. At a minimum, this record shall include the date mixed, manufacturer's part number and date/lot code, shelf-life expiration date (of all parts of the mix), and the mix ratio for all constituents used.</p> <p>b. For one-part polymers, the manufacturer's part number and lot/date code, and shelf life expiration date shall be documented.</p> <p>c. Materials shall be cured in accordance with the manufacturer's recommended cure schedule and within the thermal limitations of the hardware. Objective evidence of full cure shall be documented (e.g., Shore Durometer hardness test or as otherwise recommended by the material's manufacturer).</p> <p>d. When coating, encapsulation, or staking materials are applied to through-hole glass, ceramic body, or hermetic components, the components shall be sleeved to prevent cracking, unless the material has been selected so as not to damage the components/assembly in its service environment.</p> <p>e. Equipment used for curing silicones shall not be used for curing other materials.</p> <p>f. Prior to conformal coating, encapsulating, staking, the assembly and any fillers used (e.g., thickening agents, thermal property enhancers, etc) shall be treated to remove detrimental moisture and other volatiles.</p>	<p>Title changed to reflect addition of staking (adhesive) requirements. New paragraphs a - f added as new process requirements in four general categories: traceability, cure, part protection, and moisture removal.</p>
10.1.1.1	<p>Adjustable Components The adjustable portion of adjustable components, as well as electrical and mechanical mating surfaces such as probe points, screw threads, bearing surfaces (e.g., card guides) shall be left uncoated unless otherwise specified on the assembly drawing(s)/documentation.</p>	<p>As a check against the assembly drawings/ documentation, the "as" in the last sentence was changed to "unless otherwise" to ensure adjustable portions of components are not coated unless specified.</p>
10.1.1.2	<p>Conformal Coating on Connectors Mating connector surfaces of printed wiring assemblies shall be free of conformal coating. The conformal coating specified on the assembly drawing(s)/ documentation should, however, provide a seal around the perimeter of all connector/board interface areas.</p>	<p>The first sentence was changed from "...shall not be coated with conformal coating." to "...shall be free of conformal coating." This change addresses both unintended application of coating on the mating surface, as well as the presence of coating for any other reason.</p>
10.1.3	<p>Rework of Conformal Coating Procedures which describe the removal and replacement of conformal coating shall be documented and available for review. Chemical stripping processes shall be approved by the User prior to use.</p>	<p>A new last sentence was added requiring prior approval before chemical stripping processes are used to remove coatings.</p>
10.2.2	<p>Performance Requirements The applied encapsulant shall be completely cured, homogeneous, and cover only those areas specified on the assembly drawing(s)/documentation. The encapsulant shall be free of bubbles, blisters, or breaks that affect the printed wiring assembly operation or sealing properties of the encapsulant material. There shall be no visible cracks, crazing, mealing, peeling, and/or wrinkles in the encapsulant material. Minor surface swirls, striations, or flow marks are not considered defects.</p>	<p>To prevent unnecessary rework, a new last sentence was added allowing minor surface anomalies.</p>

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
10.3	<p>10.3 Staking (Adhesive)</p> <p>a. Components to be staked shall be identified on the assembly drawing(s)/ documentation. Some component packages should always be staked (e.g., solid-slug tantalum capacitors).</p> <p>b. Staking materials shall not contact component lead seals or solder terminations unless the material has been selected so as not to damage the components/assembly in its service environment.</p> <p>c. Unsleeved axial leaded components Staking material shall be applied to both sides of the component. The length of the fillets of the staking material shall be minimum 50% to a maximum 100% of the length of the component. The minimum fillet height shall be 25% of the height of the component. The maximum fillet height shall be that the top of the component is visible for the entire length of the component. See Figure 10-1.</p> <p>d. Sleeved axial leaded components Staking material shall be in contact with both endfaces of the component and the surface it is being staked to. The minimum fillet height shall be at least 25% of the height of the component. The maximum fillet height shall be no greater than 50% of the height of the component, and shall not violate 10.3.b. See Figure 10-2. Glass bodied components that are sleeved as part of the assembly process (in order to protect them from damage from adhesives) shall be staked in accordance with 10.3.c for unsleeved axial leaded components.</p> <p>e. Radial leaded components:</p> <ul style="list-style-type: none"> • Radial leaded components whose longest dimension is their height (e.g., CKR capacitors, Single In-Line (SIP) resistor networks) Individual components shall be staked in accordance with Figure 10-3. The staking material shall be applied to a minimum height of 50% to a maximum of 100% of the component body height. Closely spaced arrays consisting of up to four components shall be staked in accordance with Figure 10-4. Fillet height requirements for the two outer endfaces shall be the same as for an individual component. In addition, the top inner surfaces shall be bonded to each other for 100% of the components' width. Closely spaced arrays consisting of more than four components shall be staked in accordance with Figure 10-5. Staking shall be applied in the same manner as arrays up to four components, with the additional requirement that every other internal component shall have their sides staked to the board surface. • Radial leaded components whose longest dimension is their diameter or length (e.g., TO5 semiconductors, etc.). Cylindrical components shall be staked in accordance with Figure 10-6. At least three beads of staking material shall be placed approximately evenly around the periphery of the component. For each bead, the staking material shall contact a minimum-25% to maximum-100% of the height of the component body. Slight flow of staking material under the component body is acceptable provided it does not violate 10.3b. Rectangular components shall be staked in accordance with Figure 10-7. A bead of staking material shall be placed at each corner of the component. For each bead, the staking material shall contact a minimum-25% to maximum-100% of the height of the component body. Slight flow of staking material under the component body is acceptable provided it does not violate 10.3b. • Fasteners Fasteners identified on the drawing to be staked shall be staked either: <ul style="list-style-type: none"> – At two places spaced approximately opposite of each other. Each bead of staking material shall cover at least 25% of the perimeter of the fastener in accordance with Figure 10-8. – One bead of staking material that covers at least 50% of the perimeter of the fastener in accordance with Figure 10-9. 	New section for staking (adhesive) requirements.

Reference	Space Applications Requirement (as changed by this Addendum)	Description of Change
10.3.1	<p>Staking shall:</p> <ul style="list-style-type: none"> a. Be completely cured and homogeneous. b. Be free of voids or bubbles that expose component conductors, bridge noncommon conductors and/or violate design electrical clearance. c. Not bridge between the substrate and the bottom of radial leaded components. This does not apply to bonding or underfilling when used as part of a documented process. d. Be free of contamination. e. Not negate stress relief. 	New section for staking (adhesive) requirements.
10.3.2	<p>Rework of Staking Procedures that describe the removal and replacement of staking shall be documented and available for review.</p>	New section for staking (adhesive) requirements.
10.3.3	<p>Staking Inspection Visual inspection of staking may be performed without magnification. Magnification from 1.75X to 4X may be used for referee purposes.</p>	New section for staking (adhesive) requirements.
Table 11-1	<p>Add as a Note Table 11-1: All additional defects identified by this space addendum shall be considered part of Table 11-1.</p>	Table 11-1 cannot realistically be recreated in this addendum. The Note is added to classify any departures from the requirements added by this Addendum as defects.
11.2.2	<p>Visual Inspection After soldering, the assembly shall be evaluated by 100% visual or nondestructive inspection (see 9.1) except for solder connections as specified in 9.2.4.3 and 9.2.6.15. If the presence of a defect cannot be determined at the inspection power, the item is acceptable. The referee magnification power is intended for use only after a defect has been determined but is not completely identifiable at the inspection power.</p>	The first sentence was reworded to require 100 percent visual or nondestructive inspection. The change, in effect, disallows sampling inspection plans because SPC is difficult to apply to low volume production runs.
11.2.3, 11.3.c, 11.3.d	Disregard these paragraphs which provide for sampling inspection.	Adequate sampling plans are difficult to apply to low volume production runs.
13.2.2	<p>High Frequency Applications High frequency applications (i.e., radio wave and microwaves) may require part clearances, mounting systems, and assembly designs which vary from the requirements stated herein. When high frequency design requirements prevent compliance with the design and part mounting requirements contained herein, manufacturers may use alternative designs. Alternative designs, including acceptance criteria shall be approved by the User prior to use.</p>	These are unique topics that require unique processes. It is important to know how the manufacturer intends to manufacture these types of products in order to assure personnel and/or hardware safety, and that alternate designs will survive space environments.
13.2.3	<p>High Voltage Applications High power applications such as high voltage power supplies may require part clearances, mounting systems, and assembly designs which vary from the requirements stated herein. For example, wires used at a potential of 6kV or greater there shall be no broken strands nor any birdcaging beyond the insulation outside diameter. When such design requirements prevent compliance with the design and part mounting requirements contained herein, manufacturers may use alternative designs. Alternative designs, including acceptance criteria shall be approved by the User prior to use.</p>	These are unique topics that require unique processes. It is important to know how the manufacturer intends to manufacture these types of products in order to assure personnel and/or hardware safety, and that alternate designs will survive space environments.

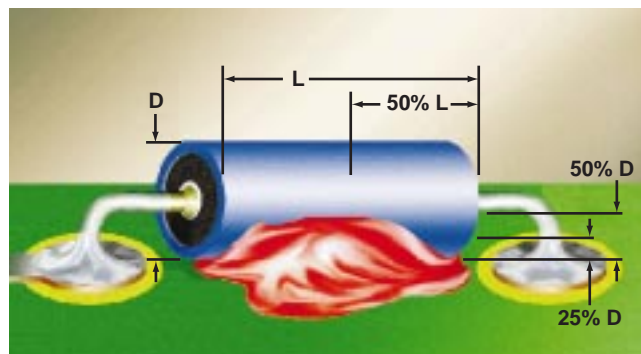


Figure 10-1

FIGURE 10-1

- Fillet Length: >50% L, to 100% L.
- Fillet Height: >25% D to 100% D. Top of component is visible for its entire length.

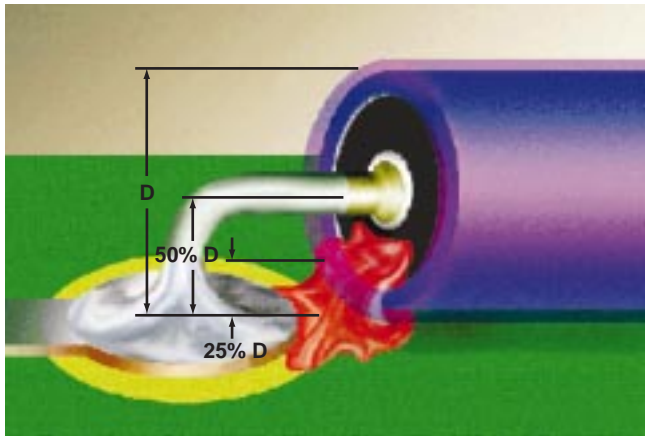


Figure 10-2

FIGURE 10-2

- Staking is in contact with both endfaces of component.
- Fillet Height: $>25\% D$ to $50\% D$ and does not contact lead seals or solder termination (see 10.3.b).

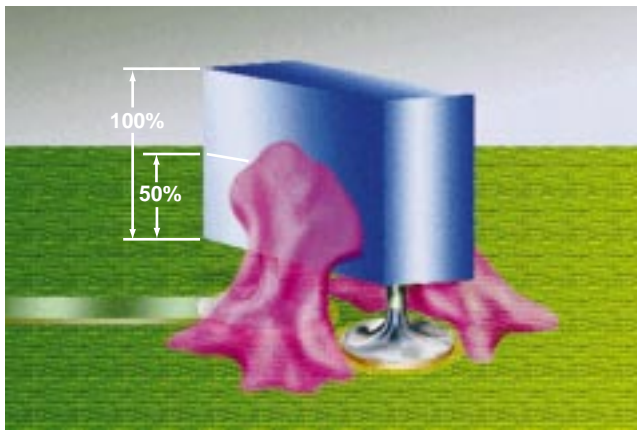


Figure 10-3

FIGURE 10-3

- Fillet Height: $>50\% H$ to $100\% H$.

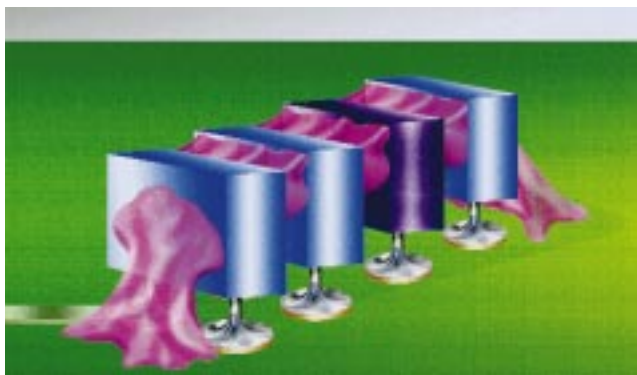


Figure 10-4

FIGURE 10-4

- Two outside ends – fillet height: $>50\% H$ to $100\% H$.
- Inner surfaces – fillet is in contact with both surfaces for 100% of component width.



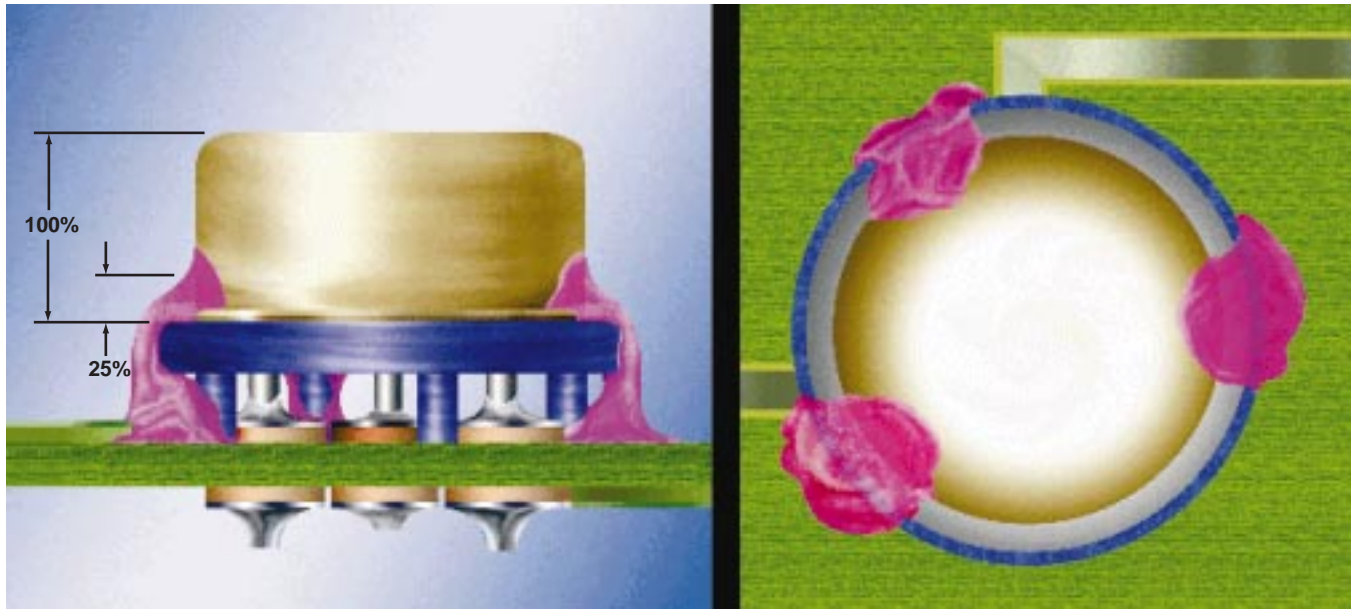
Figure 10-5

FIGURE 10-5

- Two outside ends – fillet height: $>50\% H$ to $100\% H$.
- Inner surfaces – fillet is in contact with both surfaces for 100% of component width.
- Side of every other internal component is staked to board surface.

FIGURE 10-6

- At least three beads spaced approximately evenly around periphery of component.
- Each bead fillet height: $>25\%$ H to 100% H.
- Slight flow underneath component, but bead(s) do not contact lead seals or solder termination (see 10.3.b).

**Figure 10-6****FIGURE 10-7**

- At least three beads spaced approximately evenly around periphery of component.
- Each bead fillet height: $>25\%$ H to 100% H.
- Slight flow underneath component, but bead(s) do not contact lead seals or solder termination (see 10.3.b).

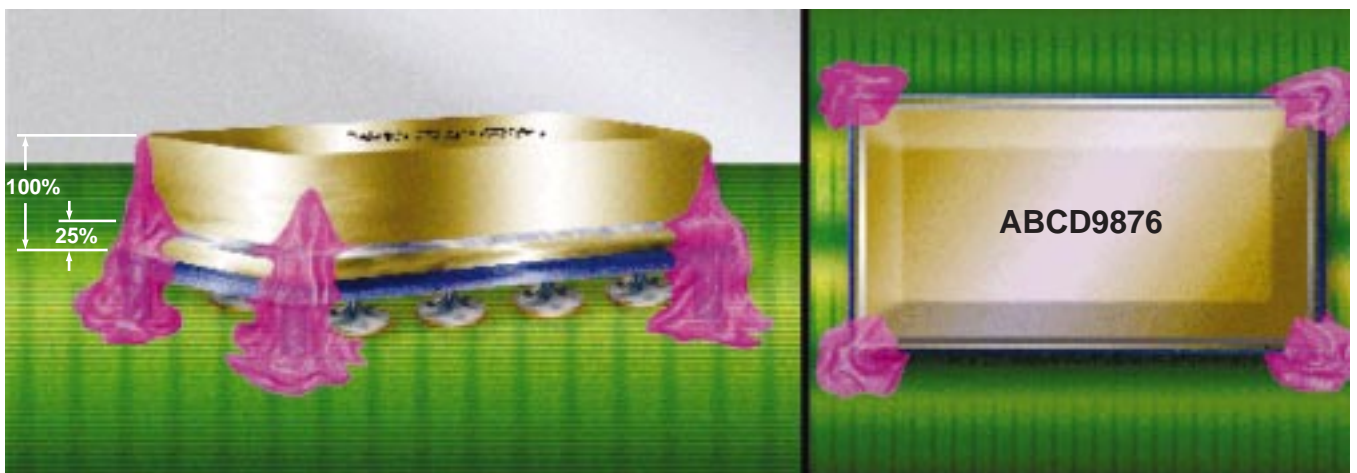
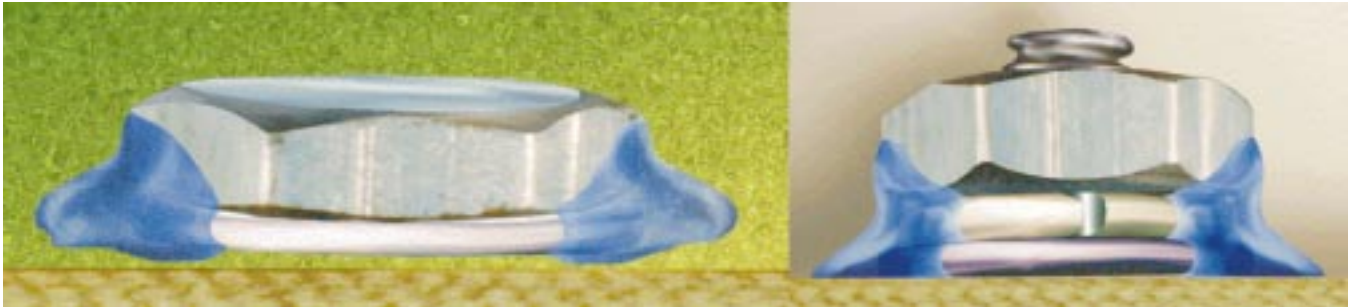
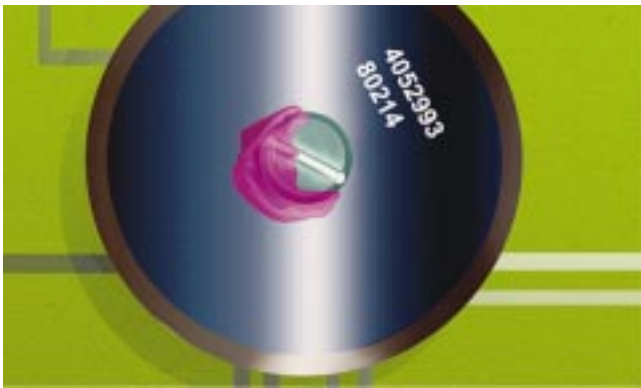
**Figure 10-7**

FIGURE 10-8

- Two beads of staking material placed approximately opposite of each other.
- Each bead of staking material is at least 25% of the perimeter of the fastener.

**Figure 10-8****FIGURE 10-9**

- One bead of staking material that covers at least 50% of the perimeter of the fastener.

**Figure 10-9**