

IPC/WHMA-A-620B-S

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Space Applications Electronic Hardware Addendum to IPC/WHMA-A-620B

Supersedes IPC/WHMA-A-620AS with Amendment 1
June 2012

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Association Connecting Electronics Industries



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Developed by the Space Electronic Assemblies IPC/WHMA-A-620
Addendum Task Group (7-31fs) of the Product Assurance Committee
Committee (7-30) of IPC

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Users of this publication are encouraged to participate in the
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Space Applications Electronic Hardware

Addendum to IPC/WHMA-A-620B

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0.1 SCOPE This addendum provides additional requirements over those published in IPC/WHMA-A-620B to ensure the performance of cable and wire harness 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/WHMA-A-620B apply.

0.1.1 Purpose When required by procurement documentation/drawings, this Addendum supplements or replaces specifically identified requirements of IPC/WHMA-A-620B.

0.1.2 Precedence The contract takes precedence over this Addendum, referenced standards and User-approved drawings. 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/WHMA-A-620B, this addendum takes precedence.

0.1.3 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.

0.1.4 Use of this Addendum This addendum **shall not** be used as a stand-alone document.

Where criteria are not supplemented by this addendum, the Class 3 requirements of IPC/WHMA-A-620B **shall** apply. If an IPC/WHMA-A-620B requirement is changed or added by this Addendum, the clause is identified and only the process requirements and defects for that clause are listed in Table 1 of this addendum (i.e., Target and Acceptable conditions are not listed). If a feature is not listed as a defect, it **shall** be considered acceptable. Target and Acceptable conditions (except where changed by this addendum) and Figures are provided in IPC/WHMA-A-620B.

The clauses modified by this Addendum do not include subordinate clauses unless specifically stated (i.e., changes made to 1.4 do not affect 1.4.1 unless 1.4.1 is also addressed in this Addendum). Clauses, Tables, Figures, etc. in IPC/WHMA-A-620B that are not listed in this addendum are to be used as-published.

0.1.5 Lead-Free Tin For the purpose of this document, lead-free tin is defined as tin containing less than 3 percent lead by weight as an alloying constituent. Solder alloy Sn96.3Ag3.7 is exempt from this requirement. See Table 1 of this addendum, clause 4.1.1.1.

0.1.6 Use of Lead-Free Tin The use of components, assemblies, packaging technology, mechanical hardware, and materials identified as having external surfaces (platings, metallization, etc.) of lead-free tin or assembled with lead-free tin solder alloys **shall** be prohibited unless documented and controlled through a User approved Lead Free Control Plan (LFCP). The LFCP **shall** incorporate either a replating or hot solder dip (HSD) process that completely replaces the lead-free tin finish, or a minimum of two mitigation measures.

0.1.6.1 Lead Free Control Plan The Lead Free Control Plan (LFCP) **shall** document controls and processes that assures that assemblies containing lead-free tin solder alloys and/or component finishes will perform as intended within the expected parameters of the mission, e.g., environment, duration, etc. At a minimum, the LFCP **shall**:

- a. Document every incidence of lead-free tin technology and prevent its use without review and approval by the User prior to implementation.
- b. Incorporate a minimum of two mitigation measures when the lead-free tin finish is not completely replaced through a replating or HSD process.
- c. Include any special design requirements, mitigation measures, test and qualification requirements, quality inspection and screening, marking and identification, maintenance, and repair processes.
- d. Require review and approval by the User prior to implementation.

The following documents may be helpful when developing the LFCP:

- GEIA-STD-0005-1, Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder
- GEIA-STD-0005-2, Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems
- GEIA-HB-0005-1, Program Management/Systems Engineering Guidelines For Managing The Transition To Lead-Free Electronics
- GEIA-HB-0005-2, Technical Guidelines for Aerospace and High Performance Electronic Systems Containing Lead-free Solder and Finishes
- GEIA-STD-0006, Requirements for Using Solder Dip to Replace the Finish on Electronic Piece Parts

0.1.6.2 Mitigation Components, sub-assemblies, assemblies, and mechanical hardware identified as having lead-free tin surfaces, platings, metallization, etc., but which by package design or engineering decision are not protected by tin-lead replating or HSD, **shall** be protected by at least two process or design mitigation techniques to reduce or eliminate the risks created by metallic whisker formation in

the expected end-use application/environment. Use of mitigation methods **shall** require technical review and approval by the User prior to implementation. Mitigation measures that may be used are:

- a. **Design** – Components, sub-assemblies, assemblies, and mechanical hardware identified as having external surfaces, platings, metallization, etc., with a lead-free tin finish **shall** be physically positioned or mechanically isolated to ensure the growth of conductive whiskers does not adversely affect performance or reliability. Direct line-of-sight spacing between electrically uncommon conductive surfaces **shall** be sufficient to ensure whisker growth rates (1mm/yr. nominal) over the life of the mission do not violate minimum electrical spacing requirements.
- b. External surfaces, platings, metallization, etc., with a lead-free tin finish **shall** be fully coated with conformal coating with a total cured finish of not less than 100 μm [0.004 in].
- c. **Embedment/Encapsulation** – Embedment or encapsulant material **shall** fully wet and cover all surfaces of parts and areas specified by the approved engineering documentation. Cured material **shall** be void-free, be compatible with the hardware and mission environment, and **shall not** adversely affect hardware performance or reliability.
- d. Other mitigation techniques approved by the User prior to use.

0.1.7 Red Plague (Cuprous Oxide Corrosion) Red Plague (cuprous oxide corrosion) can develop in silver-coated soft or annealed copper wire when a galvanic cell forms between the copper base metal and the silver coating in the presence of moisture (H_2O) and oxygen (O_2). Once initiated, the sacrificial corrosion of the copper base conductor can continue indefinitely in the presence of oxygen. The color of the corrosion by-product (cuprous oxide crystals) may vary depending on the different levels of oxygen available, but is commonly noted as a red/reddish-brown discoloration on the silver coating surface.

Definitions For the purpose of this document:

Desiccant is defined as a chemically-inert media used to absorb moisture from the air within a sealed container or package to induce or sustain a level of dryness (desiccation).

Dew Point is defined as the temperature at which a volume of air at a given atmospheric pressure reaches saturation and the entrained water vapor precipitates and condenses.

Red Plague (Cu_2O) is defined as the sacrificial corrosion of copper in a galvanic interface comprised of silver and copper, resulting in the formation of red cuprous oxide (Cu_2O). Galvanic corrosion is promoted by the presence of

moisture and oxygen at an exposed copper-silver interface (i.e.: conductor end, pin-hole, scratch, nick, etc.).

Unit Pack is defined as the standardized unit of desiccant material, which at thermal equilibrium with air at +77°F [+25°C], will adsorb at least 3 gm [0.1 oz] of water vapor at 20% relative humidity (RH) and at least 6 gm [0.2 oz] of water vapor at 40% RH.

0.1.7.1 Red Plague Control Plan – Minimum Requirements The use of silver-coated copper wire and cable **shall** require the implementation of a User-approved Red Plague Control Plan (RPCP) to reduce and control exposure to environmental conditions and contamination that promote the development of red plague and latent damage. The minimum requirements are as outlined below.

0.1.7.1.1 Shipping and Storage Wire and cable **shall** be shipped and stored in sealed water-vapor-proof packaging (i.e.: Moisture Barrier Bag, dry pack, etc.), with capped ends, activated desiccant, and humidity indicator card. Silver-coated copper wire and cable **shall** be segregated and dispositioned if the humidity indicator card registers 70% or more RH.

- a. Water-vapor-proof protection packaging **shall** meet MIL-STD-2073-1E Method 51. Moisture Barrier Bags (MBB) **shall** meet MIL-PRF-81705, TYPE 1.
- b. **Capping.** Wire and cable ends **shall** be capped with heat shrinkable end-caps conforming to SAE-AMS-DTL-23053/4, or sealed with a material such as an insulating electrical varnish for a length of approximately 25 mm [1 in].
- c. **Desiccant (Activated).** The bagged, activated desiccant **shall** conform to MIL-D-3464 Type 2 or equivalent. The minimum quantity of desiccant to be used (unit packs) **shall** be based on the protective package's interior exposed surface area, in accordance with MIL-STD-2073-1E, Method 50, Formula 1, or equivalent.
- d. **Humidity Indicator Card.** The humidity indicator card **shall** be either an Irreversible Indication (50-60-70-80-90% RH) card or a combination Irreversible/Reversible Humidity Indicator (50-60-70-80-90% RH) card conforming to MIL-I-8835 or equivalent.

0.1.7.1.2 Assembly All assembly processes, including receiving inspection and kitting, **shall** be conducted in an environmentally-controlled and monitored area where dew point is not attained and the relative humidity is less than 70% RH.

- a. Wire and cable **shall not** be removed from its protective packaging until it has reached thermal equilibrium with the assembly environment to prevent condensation.
- b. Aqueous solvents **shall not** be used for cleaning and flux removal.

0.1.7.1.3 Limited Life Article

- a. Silver-coated copper wire and cable that has exceeded a shelf life of 10 years from manufacturing date **shall not** be used on assemblies fabricated to this standard.
- b. Completed cable/harness assemblies incorporating silver-coated copper wire and cable with a storage or use life exceeding 10 years from date of assembly **shall** be identified, inspected and tested, and tracked as a limited-life article.

0.1.8 White Plague (Fluorine Attack) To reduce the risk of fluorine attack (White Plague), when fluoropolymer-insulated silver-coated copper wiring is either stored in sealed packaging (e.g.: vapor-proof bagging, MBB) or used in enclosed environments / compartments, the fluorine evolution rate **shall not** exceed 20 PPM when tested in accordance with SAE AS4373E Method 608, Fluoride Offgassing. Bulk wiring and harness assemblies exhibiting fluorine attack **shall** be rejected.

Table 1 IPC/WHMA-A-620B Space Applications Requirements

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
1.1	<p>Scope This standard prescribes practices and requirements for the manufacture of Cable, Wire and Harness Assemblies.</p> <p>Note: This clause is unchanged from IPC/WHMA-A-620B. It is included here to clarify that the Scope of the space addendum does not replace nor alter Scope of the base document.</p>
1.2	<p>Purpose This Standard describes materials, methods, tests and acceptability criteria for producing crimped, mechanically secured, or soldered interconnections and the related assembly activities associated with cable and harness assemblies.</p> <p>Any method that produces an assembly conforming to the acceptability requirements described in this standard may be used.</p> <p>Note: This clause is unchanged from IPC/WHMA-A-620B. It is included here to clarify that the Purpose of the space addendum does not replace nor alter Purpose of the base document.</p>
1.8	<p>Classes of Product If an IPC/WHMA-A-620B clause is not addressed by this addendum, the Class 3 requirement in IPC/WHMA-A-620B shall apply.</p>
1.11	<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 shall be in accordance with the IPC/WHMA A-620-Space Addendum Training and Certification Program or a supplier developed program that shall be made available for review and approval upon request by the User. All training shall be traceable to a Master IPC Trainer (MIT).</p>
1.11.1 [new]	<p>Vision Requirements All instructors, operators and inspection personnel shall meet the following vision requirements as a condition of proficiency. The vision requirements may be met with corrected vision. The vision tests shall be administered by a qualified examiner, accepted by the User, using standard instruments and techniques. Results of the visual examinations shall be maintained and available for review.</p> <p>The following are minimum vision requirements; alternate vision industry recognized tests may be used. Binocular vision is not required.</p> <p>a. Near Vision. Jaeger 1 at 355.6 mm [14 in] or reduced Snellen 20/20, or equivalent.</p> <p>b. Color Vision. Ability to distinguish red, green, blue, and yellow colors.</p> <p>Note: A practical test using color coded wires and/or color coded electrical parts, as applicable, is acceptable for color vision testing.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
1.13.3	<p>Materials and Processes The materials and processes used to assemble, manufacture, handle and store cable and wire harness assemblies shall be selected such that their combinations produce products acceptable to this standard.</p> <p>Connector mating surfaces and harness assemblies shall be protected.</p> <p>When major elements of the proven processes are changed, e.g., flux, solder alloy or soldering system, crimping technology, cleaning media or system, etc., validation of the acceptability of the change(s) shall be performed and documented. The method of validation shall be agreed upon between the Manufacturer and User. Changes shall be approved by the User prior to use.</p> <p>Limited shelf life items shall be stored and controlled in accordance with material manufacturer’s recommendations, or in accordance with the Supplier’s documented procedures for controlling shelf life and shelf life extensions.</p> <p>For adhesives, potting material and other polymers:</p> <ul style="list-style-type: none"> • The material specification or other documented procedure shall be followed for mixing and curing. • Material shall be used within the pot life (working time) specified by the material supplier or used within the time period indicated by a documented system. • When curing conditions (temperature, time, infrared (IR) intensity, etc.) vary from the material manufacturer’s recommended instructions, they shall be documented and available for review. • Equipment used for measuring viscosity, mixing, applying and curing silicone material shall not be used for processing other material. • A mix record shall be created for each mixed batch of multi-part polymers used. 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. • For one-part polymers, the Manufacturer’s part number and lot/date code, and shelf life expiration date shall be documented. • Materials shall be cured in accordance with a documented cure schedule and within the thermal limitations of the hardware. Objective evidence of full cure for each batch of material shall be documented. A witness sample may be used for this verification. • If used, non-liquid fillers, e.g., thickening agents, thermal property enhancers, etc., shall be treated to remove detrimental moisture and other volatiles. • Non-porous containers and mixing tools shall be used. Containers and mixing tools shall be selected such that their use in combination cannot introduce contamination into the mix, e.g., a metal stirrer can scrape shavings from a plastic container. <p>Note: Specific criteria regarding application and/or acceptance requirements are included where applicable throughout this document.</p>
1.15.5	<p>Disposition Disposition is the determination of how defects should be treated. Dispositions include, but are not limited to, rework, use as is, scrap or repair. Each disposition of “use as is” or “repair” shall be approved by the User. Repairs shall be conducted in accordance with documented procedures approved by the User. Each repair shall be approved by the User prior to implementation.</p>
1.15.7	<p>Conditions Not Specified The development of unique criteria for conditions not specified shall include User involvement and consent. The criteria developed shall include an agreed upon definition for acceptance of each characteristic between the Manufacturer and the User.</p>
1.17.1	<p>Sampling (Verification of Acceptability) Sampling for verification shall be agreed upon between the User and Manufacturer prior to use.</p> <p>Verification of acceptability to this standard shall be based on 100% inspection of the assemblies, including crimps, solder connections, and each successive level of assembly, e.g., securing, shielding, connectorization, etc. Visual inspection may be supplemented by the measurement of characteristics appropriate to the product being assembled, e.g., go/no-go gauges, pull force measurements, torque measurement.</p> <p>Partially visible or hidden features shall be acceptable provided that all of the following conditions are met:</p> <ol style="list-style-type: none"> a. The visible portion, if any, of the feature is acceptable. b. Process controls are maintained in a manner assuring repeatability of assembly techniques. <p>For requirements that do not meet any of the above conditions, non-destructive evaluation (NDE) shall be used. The NDE method shall be approved by the User prior to use.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
1.17.1.1	<p>Lighting Illumination at the surface of workstations should be at least 1000 lm/m² (approximately 93 foot candles). Supplemental lighting may be necessary to assist in visual inspection.</p> <p>The light source shall provide shadowless illumination of the area being viewed unless directional or oblique lighting is specifically required.</p> <p>Note: In selecting a light source, the color temperature of the light is an important consideration. Light ranges from 3000-5000° K enable users to distinguish various metal and plating features and contaminants with increased clarity.</p>
1.17.1.2	<p>Magnification Aids When required, magnification power for assembly inspection shall be at least the minimum inspection power specified in IPC/WHMA-A-620B Table 1-2. Other magnification powers within the inspection range may be used. The magnification power requirement is based on the gauge of the wire being inspected. For assemblies with mixed wire sizes, the greater magnification may be used for the entire assembly. 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> <p>Magnification aids shall be capable of rendering true colors, proportional dimensions, and adequate resolution at the chosen magnification to perform the specified inspection.</p> <p>The tolerance for magnification aids is $\pm 15\%$ of the selected magnification power. Magnification aids should be maintained and calibrated as appropriate (see IPC-OI-645).</p>
3.1	<p>Stripping Wire insulation may be removed using chemical, thermal or mechanical strippers.</p> <p>Chemical solutions, pastes, and creams used to strip solid wires shall not cause degradation to the wire. Chemical strippers shall not be used with stranded wires. Chemical stripping materials shall be completely neutralized and be cleaned such that there are no residues from the stripping, neutralizing, or cleaning steps.</p>
3.2	<p>Strand Damage and End Cuts IPC/WHMA-A-620B Table 3-1 does not apply; there shall be no nicked, scraped or broken wire strands (see IPC/WHMA-A-620B Figure 3-3). For plated wires, a visual anomaly that does not expose basis metal is not considered to be strand damage.</p> <p>Smooth indentations, e.g., tooling marks, up to 10% of the conductor diameter that do not expose basis metal are not considered to be strand damage.</p> <p>Defect</p> <ul style="list-style-type: none"> • Variation in strand length within a strand group that prevents installation to the full depth of the crimp contact area or solder cup. • Severed (broken) wire strands (see IPC/WHMA-A-620B Figure 3-2). • Deformation exceeding 10% of the diameter of the conductor. • Base metal is exposed. • Evidence of red plague (cuprous oxide). See 0.1.7.
4.1.1.1	<p>Material, Components and Equipment – Materials – Solder Solder alloys shall be Sn60Pb40, Sn62Pb36Ag2, Sn63Pb37, or Sn96.3Ag3.7 in accordance with J-STD-006 or equivalent. 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. High temperature solder alloys, e.g., Sn96Ag3.7, shall only be used where specifically indicated by approved drawings. Flux that is part of flux-cored solder wire shall meet the requirements of 4.1.1.2. Flux percentage is optional.</p>
4.1.1.2	<p>Material, Components and Equipment – Materials – Flux Flux shall be in accordance with J-STD-004 or equivalent. Flux shall conform to flux activity levels L0 or L1 of flux materials rosin (RO) or resin (RE). Use of any other flux shall be approved by the User prior to use.</p> <p>When other activity levels or flux materials are used, data demonstrating material and process compatibility through testing agreed upon between the Manufacturer and User shall be provided.</p> <p>Note: Flux or soldering process combinations previously tested or qualified in accordance with other specifications do not require additional testing.</p> <p>Type H or M fluxes shall not be used for tinning of insulated wires except for solid wires with insulation bonded to the wire, e.g., magnet wire. 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.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
4.1.2	<p>Material, Components and Equipment – Gold Removal Gold shall be removed from at least 95% of the surface to-be-soldered.</p> <p>A double tinning process or dynamic solder wave may be used for gold removal prior to mounting the component on the assembly.</p> <p>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.</p>
4.2.1	<p>Cleanliness – Presoldering The assembly shall be clean of any matter that will inhibit compliance to the requirements of this standard.</p>
4.2.2	<p>Cleanliness – Postsoldering Solder connections produced using processes and materials that are required to be cleaned, e.g., rosin/resin fluxes, shall be cleaned in a manner that assures removal of residual flux and activators. Flux residue can degrade product performance over time based upon environmental conditions. Methods and materials that are used to clean soldered assemblies shall be compatible with the product and assembly materials so that the cleaning process does not adversely affect performance characteristics.</p> <p>Surfaces cleaned shall be inspected between 4X and 10X magnification and shall be free of visual evidence of residue or contaminants per 4.2.2.1 and 4.2.2.2.</p>
4.3.1	<p>Solder Connection – General Requirements</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder has not wetted to the termination where solder is required (nonwetting, dewetting). • Solder forms a contact angle > 90°, except when the quantity of solder results in a contour which is limited by the edge of the attached surfaces. • Solder coverage does not meet requirements for the termination type. • Not soldered. • Disturbed solder. • Cold solder. • Overheated solder. • Fractured. • Insufficient. • Inclusions (foreign material). • Solder that violates minimum electrical clearance (e.g., bridges, solder splashes, solder balls, solder peaks). • Lead or wire extensions that violate minimum electrical clearance. • Contaminated solder connections, e.g., flux residues after cleaning. • Solder wicking inhibits required flexibility. • Blowholes, pinholes, and voids (where the bottom and all sides are not visible).
4.3.2.2	<p>Solder Connection – Soldering Anomalies – 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"> a. The design does not restrict solder flow to any connection element. b. The visible portion, if any, of the connection is acceptable. c. Process controls are maintained in a manner assuring repeatability of assembly techniques. <p>For solder connections that do not meet all of the above conditions, non-destructive evaluation (NDE) shall be used. The NDE method shall be approved by the User prior to use.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
4.4	<p>Wire/Lead Preparation, Tinning In this document, the term pretinning and tinning have the same meaning, as defined in IPC-T-50: The application of molten solder to a basis metal in order to increase its solderability.</p> <p>When wires are tinned using alloys other than those listed in section 4.1.1.1, the solder used for tinning shall be the same alloy used in the subsequent soldering process.</p> <p>Stranded wires shall be tinned when:</p> <ul style="list-style-type: none"> • Wires will be formed for attachment to solder terminals. • Wires will be formed into soldered splices (except for mesh splices). <p>Stranded wires shall not be tinned when:</p> <ul style="list-style-type: none"> • Wires will be used in crimp terminations. • Wires will be used in forming mesh splices. <p>When using heat shrinkable soldering devices, tinning is optional (following device manufacturer's recommendations).</p> <p>The following criteria are applicable if tinning is required:</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder does not wet 100% of the portion of the wire in the required fillet area (see IPC/WHMA-A-620B Figure 4-4). • Stranded wire is not tinned prior to attachment to terminals, forming soldered splices (other than mesh splices), or when engineering documentation requires it for heat shrinkable solder devices. • Wires strands not discernable after tinning. • Solder wicking extends to a portion of the wire which is required to remain flexible. • Length of untinned strands from end of wire insulation is greater than 1 wire diameter (D).

A-620B Reference	Space Applications Requirement (as changed by this Addendum)										
4.8	<p>Terminals The terminal wire wrap summarized in Table 4-1 apply equally to wires and component leads. The criteria associated with each terminal type or connection in clauses 4.8.1 through 4.8.8 apply only to that connection.</p> <p>Wire Overwrap When a wire/lead that is wrapped more than 360° and remains in contact with the terminal post (see IPC/WHMA-A-620B Figure 4-18-A).</p> <p>Wire Overlap When a wire/lead that is wrapped more than 360° and crosses over itself, i.e., does not remain in contact with the terminal post (see IPC/WHMA-A-620B Figure 4-18-B).</p> <p style="text-align: center;">Table 4-1 Terminal Lead/Wire Placement</p> <table border="1" data-bbox="334 489 1500 669"> <thead> <tr> <th>Terminal Type</th> <th></th> </tr> </thead> <tbody> <tr> <td>Turret & Straight Pin</td> <td>Defect <180°</td> </tr> <tr> <td>Bifurcated</td> <td>Defect <90°</td> </tr> <tr> <td>Hook</td> <td>Defect <180°</td> </tr> <tr> <td>Pierced/Perforated</td> <td>Defect <90°</td> </tr> </tbody> </table> <p>The preferred wrap conditions achieve a mechanical connection between the lead/wire and the terminal sufficient to assure that the lead/wire does not move during the soldering operation. Typically the mechanical connection includes a 180° mechanical wrap to effect mechanical connection.</p> <p>Attachments should be positioned on the base of the solder termination area or previous attachment consistent with the thickness of the wire insulation. When practical, wires should be placed in ascending order with the largest on the bottom. Connection wraps shall be in contact with the post termination area for the full curvature of the wrap.</p> <p>As an exception to the wrap conditions described above, under certain circumstances, leads/wires attached to some terminal types may be routed straight through. See the specific terminal type for requirements.</p> <p>Wires connected to terminals shall have stress relief. For additional stress relief criteria see 4.8.7, 6.2.6, 6.2.8, 15.3.3, 17.3.1 and 17.3.2.</p> <p>Terminals shall not be modified to accept oversize conductors. Wires shall not be modified to fit terminals.</p> <p>Attachments to terminals that require a wrap may be wrapped clockwise or counterclockwise (consistent with the direction of potential stress application). The lead or wire shall continue the curvature of the dress of the lead/wire (see IPC/WHMA-A-620B Figure 17-18) and shall not interfere with the wrapping of other leads or wires on the terminal or overlap itself or each other.</p> <p>The criteria in this section are grouped together in subsections. Not all combinations of wire/lead types and terminal types can possibly be covered explicitly, so criteria is typically stated in general terms to apply to all similar combinations. For example, a solid wire and a stranded wire connected to turret terminals have the same wrap and placement requirements, but only the stranded wire could be subject to birdcaging.</p> <p>Unless otherwise stated for a specific terminal type, the following are general requirements for all terminals:</p> <p>Defect</p> <ul style="list-style-type: none"> • Wire/lead not discernible in solder connection. • Height (climb on wire) of solder is less than 50% of wire diameter (D) (see IPC/WHMA-A-620B Figure 4-20). • Depression of solder between the post and the wrap of the wire is deeper than 25% of wire radius (r) (see IPC/WHMA-A-620B Figure 4-20). • Solder fillet is less than 100% of the wire/lead and terminal interface. 	Terminal Type		Turret & Straight Pin	Defect <180°	Bifurcated	Defect <90°	Hook	Defect <180°	Pierced/Perforated	Defect <90°
Terminal Type											
Turret & Straight Pin	Defect <180°										
Bifurcated	Defect <90°										
Hook	Defect <180°										
Pierced/Perforated	Defect <90°										
4.8.1.2	<p>Terminals – Turrets and Straight Pins – Solder</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder is wetted to less than 100% of the contact area between the wire/lead and terminal interface (see IPC/WHMA-A-620B Figure 4-26). • Depression of solder between the post and wrap of the wire is deeper than 50% of the wire radius (see IPC/WHMA-A-620B Figure 4-20). 										

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
4.8.2.2	<p>Terminals – Bifurcated – Lead/Wire Placement – Bottom and Top Route Top route connections shall only be used when required by approved drawings.</p> <p>Defect</p> <ul style="list-style-type: none"> • Wire insulation enters base or posts of terminal (see IPC/WHMA-A-620B Figure 4-33). • Top route wire is not supported with filler (see IPC/WHMA-A-620B Figure 4-33). • Bottom route wire not wrapped to terminal base or post with a minimum 90° bend (see IPC/WHMA-A-620B Figure 4-33).
4.8.2.4	<p>Terminals – Bifurcated – Solder</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder is wetted to less than 100% of the contact area between the wire/lead and terminal interface for side or bottom entry (see IPC/WHMA-A-620B Figure 4-38). • Solder is wetted to less than 100% of the height of the terminal post for top route connections (see IPC/WHMA-A-620B Figure 4-41).
4.8.4.2	<p>Terminals – Pierced/Perforated/Punched – Solder</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder is not wetted to 100% of the contact area between the wire/lead and terminal interface. • Depression of solder between the terminal and the wrap of the wire is deeper than 25% of wire radius (see IPC/WHMA-A-620B Figure 4-20).
4.8.5.2	<p>Terminals – Hook – Solder</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder is not wetted to 100% of the contact area between the wire/lead and terminal interface. • Depression of solder between the post and the wrap of the wire is deeper than 25% of wire radius (see IPC/WHMA-A-620B Figure 4-20).
4.8.6.2	<p>Terminals – Cup – Solder</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder buildup on the outside of the cup affects form, fit, or function (see IPC/WHMA-A-620B Figure 4-67). • Solder fill less than 100% (when measured at the back wall of the cup) (see IPC/WHMA-A-620B Figure 4-63). • Wire not in contact with the back wall of the cup when it affects form, fit, or function (see IPC/WHMA-A-620B Figure 4-62). • Solder not visible in the inspection hole (if one is provided). • Depression of solder between the cup and the wire is deeper than 25% of wire radius.
4.8.7	<p>Terminals – Series Connected When a common bus wire connects 3 or more terminals, the end terminals shall meet the required wrap for individual terminals. Solder criteria are based on the individual terminal attachment.</p> <p>Defect</p> <ul style="list-style-type: none"> • No stress relief between any 2 terminals (see IPC/WHMA-A-620B Figure 4-70). • Turret Terminals – An intermediate wrap is less than 360° and is not in full contact with the base, a turret or a previously installed wire • Hook Terminals – Wire wraps less than 360° around intermediate terminal. • Bifurcated Terminals – Wire does not pass between the posts or is not in contact with the terminal base or a previously installed wire. • Pierced/Perforated Terminals – Wire does not contact 2 nonadjacent sides of each intermediate terminal.

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
5	<p>Crimp Terminations (Contacts and Lugs) For the purposes of this section, the term “terminal” includes both lugs and contacts.</p> <p>In addition to the basic requirements outlined in this section, there shall be no damage to plating or finish. Contacts shall be deformed only by crimp tools.</p> <p>Conductor strands shall not be cut or modified in any manner to reduce circular mil area (CMA) to fit a termination. Contacts shall not be altered to accept oversized wire or an excessive number of conductors. Conductors shall not be tinned prior to termination, unless otherwise specified. Solid wire shall not be crimped except as allowed in 13.2.1.</p> <p>Terminals shall not be re-crimped or double-crimped unless required as part of a documented process for the specific terminal.</p> <p>Shrinkable sleeving shall not be applied as insulation support filler unless required by the drawing.</p> <p>Any material used for CMA buildup shall be specified on the drawing.</p> <p>The tooling identified on a terminal manufacturer’s documentation shall be used unless there is objective evidence available to show validity of the alternate process. As an exception, if a terminal is manufactured in accordance with an industry specification, e.g., military, medical, automotive, the tool called out in that specification shall be used to crimp the terminal.</p> <p>Crimp tools may be either manually (hand) or automatically operated. All hand tools shall employ some form of an integral mechanism to control the crimping operation to the extent that, once the crimping operation has been started, the crimp tool cannot be opened until the crimping cycle has been completed (full-cycle/ratcheting tools). All adjustable crimp tools shall be set, sealed or locked, and verified prior to use.</p>
5.1	<p>Stamped and Formed – Open Barrel Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.1	<p>Stamped and Formed – Open Barrel – Insulation Support Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.1.1	<p>Stamped and Formed – Open Barrel – Insulation Support – Inspection Window Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.1.2	<p>Stamped and Formed – Open Barrel – Insulation Support – Crimp Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.2	<p>Stamped and Formed – Open Barrel – Insulation Clearance if No Support Crimp Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.3	<p>Stamped and Formed – Open Barrel – Conductor Crimp Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.4	<p>Stamped and Formed – Open Barrel – Crimp Bellmouth Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.5	<p>Stamped and Formed – Open Barrel – Conductor Brush Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.1.6	<p>Stamped and Formed – Open Barrel – Carrier Cutoff Tab Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
5.2.1	<p>Stamped and Formed – Closed Barrel – Insulation Clearance Defect</p> <ul style="list-style-type: none"> • Insulation is greater than 1 wire diameter from the end of the entry bellmouth. • Insulation enters barrel of terminal (see IPC/WHMA-A-620B Figure 5-35).
5.2.2	<p>Stamped and Formed – Closed Barrel – Insulation Support Crimp Defect</p> <ul style="list-style-type: none"> • The wire insulation is not within the insulation crimp area (see IPC/WHMA-A-620B Figure 5-38-A). • Wire insulation damage exceeds the criteria of 3.5. • Outer insulation of terminal is not secure on the terminal (see IPC/WHMA-A-620B Figure 5-38-C). • Filler wire extends beyond the terminal insulation (see IPC/WHMA-A-620B Figure 5-38-D). • Insulation support crimp does not support the wire (see IPC/WHMA-A-620B Figure 5-38-E). • Wire strands folded back or visible in the insulation crimp (see IPC/WHMA-A-620B Figure 5-38-F).

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
5.2.3	<p>Stamped and Formed – Closed Barrel – Conductor Crimp and Bellmouth</p> <p>Defect</p> <ul style="list-style-type: none"> • Wire end is less than flush to the end of the bellmouth (see IPC/WHMA-A-620B Figure 5-42, top image). • Bellmouth not evident at each end of the conductor crimp area when tooling is intended to form a bellmouth. • Terminal insulation, if present, has damage exposing metal (see IPC/WHMA-A-620B Figure 5-42-A). • Conductor extends into the mating area of the terminal (see IPC/WHMA-A-620B Figure 5-42-B). • Crimp indentations not uniform. • Any conductor strands that do not enter the conductor crimp area.
5.3	<p>Machined Contacts When attaching multiple wires to a single contact, each wire shall meet the same acceptability criteria as a single wire contact.</p> <p>When attaching single or multiple wires to a contact the combined circular mil area of the wires shall comply with the circular mil area range for the contact.</p> <p>Each crimp tool shall have a minimum of four indenter blades (preferably double-indenter blades).</p>
5.3.1	<p>Machined Contacts – Insulation Clearance</p> <p>Defect</p> <ul style="list-style-type: none"> • Insulation is greater than 1 wire diameter from the end of the contact barrel (see IPC/WHMA-A-620B Figure 5-46). • Exposed conductor violates minimum electrical clearance. • Insulation enters barrel of terminal (see IPC/WHMA-A-620B Figure 5-48).
6	<p>Insulation Displacement Connection (IDC) Insulation displacement connection (IDC), sometimes referred to as insulation displacement termination (IDT), is a method for terminating an insulated wire to a connector or terminal without pre-stripping the insulation from the conductor. However, this method may be used for an uninsulated wire as well. It is recognized that this technology is utilized by a significant number of different connector types. This section attempts to define common acceptance criteria regardless of the connector type.</p> <p>The wire, the connector, tooling and assembly process shall be compatible. Tooling used to accomplish connector installation shall apply consistent and controlled force. Variations in wire gauge, wire-to-wire spacing (for multiple conductor flat or ribbon cable), insulation thickness, insulation type, application tooling, or alignment of the cable to the connector may result in an unreliable connection or in an electrical open or short circuit.</p> <p>It is also recognized that in some insulation displacement products, visual inspection of the wire/termination connection is not possible without destructive analysis.</p>
7 (All)	<p>Ultrasonic Welding Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
8.1	<p>Soldered Splices Stranded wires shall be tinned when wires will be formed into splices (other than mesh) and optional (following device manufacturer’s recommendations) when heat shrinkable solder devices are used.</p> <p>Prior to sleeving, there shall not be any sharp points that could pierce the sleeving.</p> <p>Sleeving shall conform to the splice contour and have a snug fit over the wire splice area and wire insulation. Sleeving shall cover wire insulation on both ends of the spliced area by a minimum of 2 diameters of the wire group.</p> <p>When wires are tinned using alloys other than those listed in section 4.1.1.1, the solder used for tinning shall be the same alloy used in the subsequent soldering process (see 4.4).</p> <p>Requirements in Clauses 3, 4.1 through 4.4, 4.5.2 and 16.2 are applicable to soldered wire splices.</p>
8.1.1	<p>Soldered Splices – Mesh Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
8.1.2	<p>Soldered Splices – Wrap</p> <p>Defect</p> <ul style="list-style-type: none"> • Less than 3 wraps of each conductor. • Insufficient solder fillet. • Wire splice area is exposed (see IPC/WHMA-A-620B Figure 8-10). • Sleeving is loose. • Conductor strands or sharp points pierce the sleeving (see IPC/WHMA-A-620B Figure 8-11). • Sleeving does not overlap wire insulation (on both ends) a minimum of 2 wire diameters. • Sleeve or wire insulation is burned/charred. • Sleeving is split or damaged. • Wraps overlap each other or the insulation of the other wire.
8.1.3	<p>Soldered Splices – Hook Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
8.1.4.1	<p>Soldered Splices – Lap – Two or More Conductors</p> <p>Defect</p> <ul style="list-style-type: none"> • End splice insulating shrink sleeving overlaps the wire less than 2 diameters of the wire group. • End splice insulating shrink sleeving is not sealed when it is less than 2 wire group diameters beyond the cut end. • Conductors are not in full contact or are not parallel (see IPC/WHMA-A-620B Figure 8-25). • Solder fillet less than 100% of the length of the overlap interface (see IPC/WHMA-A-620B Figure 8-26). • Insufficient solder fillet (see IPC/WHMA-A-620B Figure 8-26). • Wire splice area is exposed (see IPC/WHMA-A-620B Figure 8-28). • Sleeving is loose. • Conductor strands or sharp points pierce the sleeving (see IPC/WHMA-A-620B Figure 8-27). • Sleeving does not overlap the insulation on both ends of the spliced area by a minimum of 2 wire group (largest group) diameter. • Sleeve or wire insulation is burned/charred. • Sleeving is split or damaged (see IPC/WHMA-A-620B Figure 8-27). • Conductor overlaps insulation of the other wire (see IPC/WHMA-A-620B Figure 8-26). • Wires do not overlap a minimum of 3 wire diameters of the largest wire (see IPC/WHMA-A-620B Figure 8-26).
8.1.4.2	<p>Soldered Splices – Lap – Insulation Opening (Window)</p> <p>Defect</p> <ul style="list-style-type: none"> • The wire opening (window) is shorter in length than the stripped portion of the pickoff wire. • Conductor overlaps insulation of the other wire. • No visible fillet between the wire and pickoff lead. • Wire strands are exposed. • Sleeve or wire insulation burned or charred. • The sleeve does not overlap insulation at both ends of the spliced area by a minimum of 2 diameters of the largest wire group in the splice. • Conductor is damaged beyond the limits of 3.2. • Insulation is damaged beyond the limits of 3.5.

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
8.2.1	<p>Crimped Splices – Barrel</p> <p>Defect</p> <ul style="list-style-type: none"> • The sleeve does not overlap insulation at both ends of the spliced area by a minimum of 2 diameters of the largest wire group in the splice. • Any insulation gap in the splice exceeds 1 wire diameter (see IPC/WHMA-A-620B Figure 8-44). • Conductors extend greater than 1 wire diameter beyond crimp barrel (see IPC/WHMA-A-620B Figure 8-44). • Wire insulation extends into barrel splice crimp. • Barrel or seam/weld is split or cracked (see IPC/WHMA-A-620B Figure 8-45 arrow). • Crimp indentation is off the end of the barrel splice, bellmouth is not evident (see IPC/WHMA-A-620B Figure 8-46). • Wires are not contained in the crimp. • Conductors twisted together before insertion into the contact. • All conductor ends are not visible. • End splice insulating shrink sleeving overlaps the wire group less than 2 diameters of the wire group (see IPC/WHMA-A-620B Figure 8-43). • End splice insulating shrink sleeving is not sealed when it is less than 2 wire group diameters beyond the cut end.
8.2.2	<p>Crimped Splices – Double Sided</p> <p>Defect</p> <ul style="list-style-type: none"> • Wire insulation extends into the wire crimp barrel (see IPC/WHMA-A-620B Figure 8-53-A). • Crimp indent is off the end of the splice (see IPC/WHMA-A-620B Figure 8-53-B). • Wire end(s) are not visible through the inspection window(s) (see IPC/WHMA-A-620B Figure 8-53-C). • Wire insulation gap is greater than 1 wire diameter including insulation (see IPC/WHMA-A-620B Figure 8-53-D). • Sleeving, if required, does not overlap wire insulation at least 2 wire diameters on both ends. • Wire strands extend out of inspection window (see IPC/WHMA-A-620B Figure 8-54). • Wire strands have pierced the heat shrinkable sleeve (see IPC/WHMA-A-620B Figure 8-55). • Multiple conductors twisted together before insertion into the crimp barrel. • Barrel or seam/weld is split or cracked. • Barrel with integral strain relief does not meet the insulation support requirements of 5.2.2.
8.3	<p>Ultrasonic Weld Splices Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
9.1.1	<p>Hardware Mounting – Jackpost – Height This section covers the height relationship of the face of the jackpost to the associated connector face. This is critical to obtain maximum connector pin contact.</p> <p>Defect</p> <ul style="list-style-type: none"> • Face of jackpost is greater than ± 0.75 mm [0.030 in] with the connector face (see IPC/WHMA-A-620B Figure 9-3). • Jackpost height has been adjusted by adding or removing washers not specified on the drawing.

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
9.2.1	<p>Strain Relief – Clamp Fit Clamps, as specified on the drawing, shall support cables, harnesses or individual wires to prevent wire movement that may place strain on the wire/connector terminations. Split lock washers incorporated as part of the backshell or strain relief clamp shall be fully compressed.</p> <p>Build-up material shall not be used unless specified on the drawing(s).</p> <p>Build-up material is referred to as “sleeving” in the following criteria. The sleeving criteria apply only when such material is applied to the wire bundle.</p> <p>Cable clamp fasteners shall be staked for at least 50% of the perimeter of the fastener after the cable clamps have been torqued.</p> <p>Thread extension shall not be more than 3 mm [0.12 in] plus one and one-half threads for bolts or screws up to 25 mm [0.984 in] long or more than 6.3 mm [0.248 in] plus one and one-half threads for bolts or screws over 25 mm [0.984 in].</p> <p>Defect</p> <ul style="list-style-type: none"> • Sleeving extension beyond clamp causes stress on the wires (see IPC/WHMA-A-620B Figure 9-13-A). • The split lock washers are not collapsed (see IPC/WHMA-A-620B Figure 9-13-B). • Clamps do not captivate and support the cable. • Clamps do not prevent movement of the cable. • Bundle diameter has 5% indentation or distortion caused by the clamps. • Damage to sleeving that exposes the harness or other protected material. • If spacers are required, they are not present, not mounted on both ears of the backshell, and/or are not on the same side of each ear on both sides of the backshell. • Thread extension interferes with adjacent component.
9.4.2	<p>Connector Damage – Limits – Hard Face – Mating Surface</p> <p>Defect</p> <ul style="list-style-type: none"> • Any chip or crack (see IPC/WHMA-A-620B Figures 9-42, 43).
9.4.3	<p>Connector Damage – Limits – Soft Face – Mating Surface or Rear Seal Area</p> <p>Defect</p> <ul style="list-style-type: none"> • Any cut, fracture or tear (see IPC/WHMA-A-620B Figures 9-45, 46).
9.4.4	<p>Connector Damage – Contacts</p> <p>Defect</p> <ul style="list-style-type: none"> • Damaged contact. • Pin is bent more than 0.5 pin diameter (see IPC/WHMA-A-620B Figure 9-48). • Basis metal exposed.
9.4.4.1 [New]	<p>Connector Damage – Contacts – Exposed Sockets, Protected Pins, e.g., MIL-DTL-83513 Micro D</p> <p>Defect</p> <ul style="list-style-type: none"> • Damaged contact. • Any misalignment of socket. • Basis metal exposed.

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
<p>9.4.5 [New]</p>	<p>Connector Damage – Seals/Gaskets See 17.1 of this addendum.</p> <p>Defect</p> <ul style="list-style-type: none"> • Damage to any feature intended to provide a seal between mating connectors, e.g., o-rings, gaskets, seating/mating surfaces. <div style="display: flex; justify-content: space-around;">    </div> <p style="display: flex; justify-content: space-around;"> 620B Space Figure 9-1 620B Space Figure 9-2 620B Space Figure 9-3 </p>
<p>9.5</p>	<p>Installation of Contacts and Sealing Plugs into Connectors Contacts retention (seating/locking) shall be verified in accordance with 19.7.5.1 or 19.7.5.2 of this addendum. Verification shall be accomplished prior to addition of any restraining devices, including potting or molding.</p> <p>Unused contact locations shall be filled with contacts and/or plugs if specified on the documentation. The contacts are not crimped unless required for insertion.</p> <p>Non-metal contact insertion tools should be used to prevent connector/contact damage.</p> <p>Damaged contact insertion/extraction tools shall be discarded and replaced with a new tool. Should part of the tip of a tool break off, all pieces of the tip shall be accounted for.</p> <p>Exceptions to retention verification include:</p> <ul style="list-style-type: none"> • Prewired molded connectors. • Potted or molded connectors after molding/potting. • Connectors with soldered terminals.
<p>10</p>	<p>Over-Molding/Potting The requirements in this section are imposed primarily to give confidence in the reliability of the wire or cable. Any allowable cosmetic anomalies should be agreed upon between the Manufacturer and the User prior to the molding or potting operation.</p> <p>Opaque materials preclude visual inspection for internal anomalies. Use of any other inspection technologies, including acceptance criteria, shall be documented and agreed upon between the Manufacturer and the User.</p> <p>Areas to be potted or molded shall be cleaned prior to material application.</p> <p>The requirements in this section are based on the use of materials that are within shelf life, and have been processed in accordance with 1.13.3.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
12	<p>Marking/Labeling</p> <p>Note: For the purposes of this section, marking and labeling are referred to as marking as applied by the Manufacturer.</p> <p>All interconnecting cables, harness assemblies and connectors shall be identified and permanently marked.</p> <p>Regardless of the marking method used, markings shall contain the required information, be legible, be permanent in the intended application, and shall not damage the product nor impair its function.</p> <p>Marking inspection is to be performed without magnification.</p> <p>Additional (non-required) information may be marked onto the product for internal purposes. This marking is not subject to the provisions of this section, provided that:</p> <ul style="list-style-type: none"> • The marking does not conflict with, and is separated from, required information. • Prior to delivery nonpermanent internal markings shall be removed. • After removal of nonpermanent markings, there shall be no tape residues or other contamination present. <p>Criteria with obvious understanding may not have illustrations.</p>
12.4	<p>Location and Orientation Connectors shall be identified to facilitate mating. The identification may be placed directly on the connector, or on the cable/harness within 15 cm [5.9 in] of the connector unless specified otherwise on the drawing.</p> <p>For cables longer than 2.5 m [8.2 ft] and marking locations are not specified, markings shall be repeated at intervals no greater than 1.25 m [4.1 ft] along the length of the cable.</p> <p>Defect</p> <ul style="list-style-type: none"> • Marking not in specified location(s). • If the location is not specified, the marking is more than 15 cm [5.9 in] from the breakout, end of wire (where the end product is unterminated wire or wires), or the rearmost connector accessory; e.g., backshell, boot, ferrule, etc.). • Color coded marking (bands) does not read away from the connector (see IPC/WHMA-A-620B Figure 12-6). • Marker orientation does not meet specified requirements. • For cables longer than 2.5 m [8.2 ft.] and the location is not specified, the marking is repeated at intervals of more than 1.25 m [4.1 ft.].
12.6.1	<p>Marker Sleeve – Wrap Around</p> <p>Defect</p> <ul style="list-style-type: none"> • Any wrinkles or misalignment that affects legibility or further assembly steps (see IPC/WHMA-A-620B Figure 12-12). • The marker sleeve overlap is not secure (see IPC/WHMA-A-620B Figure 12-13). • The marker sleeve does not wrap around the cable a minimum of 1.25 times (see IPC/WHMA-A-620B Figure 12-14). • The overlap obscures required marking.
12.6.2	<p>Marker Sleeve – Tubular</p> <p>Defect</p> <ul style="list-style-type: none"> • Any splits or holes (see IPC/WHMA-A-620B Figure 12-17). • The marker sleeve is not sufficiently shrunk to remain secure.
12.7.1	<p>Flag Markers – Adhesive There shall not be any exposed adhesive after flag marker attachment.</p> <p>Defect</p> <ul style="list-style-type: none"> • The flag marker side or end misregistration exceeds 10% of the width of the marker (see IPC/WHMA-A-620B Figure 12-19).
12.8	<p>Tie Wrap Markers For this addendum, these criteria are applicable to all types of tie wrap attached markers.</p> <p>Tie wrap attached markers shall be installed in accordance with the tie wrap installation requirements of 14.1, 14.1.1 and 14.1.2.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
13	<p>Coaxial and Biaxial Cable Assemblies For coaxial and biaxial assemblies to function properly, it is critical to follow all assembly instructions provided by the connector manufacturer. In general, the pieces of the connectors must remain as concentric as possible. The relationship of the outside diameter (OD) of the cable center conductor/connector contact, the thickness of the dielectric, and the inside diameter (ID) of the connector body and cable shielding are critical to electrical and mechanical function of the assembly. Insulation integrity is important to preclude shorting of shields to each other or shorting of shields to the center conductor.</p> <p>Criteria for sleeving damage are provided in 16 (Cable/Wire Harness Protective Coverings).</p> <p>It is common for coaxial cable dielectric materials to shrink as a result of contact with processing materials and temperatures. This is likely to continue after the cable has been placed in use. This needs to be considered in the design, engineering and manufacturing processes. A preconditioning process shall be employed using an appropriate method such as thermal cycling.</p> <p>Center conductors shall not be used as connector mating contacts unless it is necessary for the specific technology, e.g., semi-rigid coaxial assemblies.</p> <p>Center contacts with gold plating thickness of less than 1.25 μm [50 μin] in the solder area do not need gold to be removed. Gold on mating surfaces shall not be removed.</p> <p>All adjustable crimp tools shall be set, sealed or locked, and verified prior to use.</p>
13.1	<p>Stripping IPC/WHMA-A-620B Table 13-1 does not apply.</p> <p>For center conductors, there shall be no nicked or broken wire strands. For plated wires, a visual anomaly that does not expose basis metal is not considered to be strand damage.</p> <p>Nicked shield strands shall not exceed 10 percent of the total number of strands. There shall be no severed strands.</p> <p>Defect</p> <ul style="list-style-type: none"> • Braid twisted/birdcaged (see IPC/WHMA-A-620B Figure 13-5-1). • Damage exceeds 10% of shield strands (see IPC/WHMA-A-620B Figure 13-5-2). • Any severed shield strands. • Any cuts or breaks in outer jacket. • Outer jacket thickness is reduced greater than 20% (see IPC/WHMA-A-620B Figure 13-5-3). • Uneven or ragged pieces (frays, tails, tags) of outer jacket are greater than 50% of the outer jacket thickness or 1 mm whichever is more (see IPC/WHMA-A-620B Figure 13-5-3). • Internal dielectric damaged (see IPC/WHMA-A-620B Figure 13-5-5). • Uneven cut on braid; any long strands (see IPC/WHMA-A-620B Figure 13-5-6). • Discernible nicks or cuts in center conductor. • Burns or melted areas on dielectric. • Damage to center dielectric reducing insulation diameter by more than 10%.
13.6	<p>Coaxial Connector – Center Conductor Solder</p> <p>Defect</p> <ul style="list-style-type: none"> • Solder splash or spillage on sides of contact, inside walls of cavity or the terminal cover area (see IPC/WHMA-A-620B Figure 13-31). • Any solder balls inside cavity (see IPC/WHMA-A-620B Figure 13-32). • Excess solder on top of contact (see IPC/WHMA-A-620B Figures 13-32, 33) or solder peaks/icicles (see IPC/WHMA-A-620B Figure 13-31). • Any pinholes/blowholes where all inner surfaces are not visible (see IPC/WHMA-A-620B Figure 13-30).
13.7.2	<p>Coaxial Connector – Terminal Cover – Press Fit Press fit covers shall be secured by using adhesive or other means.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
13.10	<p>Semirigid Coax The acceptability of semirigid cable assemblies is greatly affected by three factors.</p> <ul style="list-style-type: none"> • Application – Bend radii and deformation of a cable assembly have a greater or lesser effect depending upon the frequency the cable will carry. • Cleanliness – Mating surfaces, including test equipment shall be free of all foreign material (i.e., flux residue, metallic or other particles). • Tooling – Proper tooling will prevent cable deformation and surface damage. <p>The criterion that follows will establish acceptance conditions for the most common applications.</p> <p>Visual inspection of the cable cannot in all cases determine its fitness for use. With the exception of obvious damage or improper solder connections, the correct function of the cable assembly will be the determining factor of acceptance.</p> <p>There shall be no nicks, scrapes or other deformation greater than 10% of the diameter of center conductor.</p>
13.10.6	<p>Semirigid Coax – Solder</p> <p>Defect</p> <ul style="list-style-type: none"> • Insufficient solder (see IPC/WHMA-A-620B Figure 13-79). • Solder fillet has voids. • Solder does not wet to connector body and cable for entire circumference (see IPC/WHMA-A-620B Figure 13-80). • Excess solder onto cable or connector impedes subsequent assembly operations (see IPC/WHMA-A-620B Figure 13-81). • Contamination, e.g., flux residue. • Solder is nonwetted or dewetted. • Shield strand is not contained in connector barrel.
14.1	<p>Tie Wrap/Lacing Application IPC/WHMA-A-620B Figures 14-1, 14-2 and 14-3 are provided as guidance for applying lacing. IPC/WHMA-A-620B Figure 14-1 shows running lock stitches, IPC/WHMA-A-620B Figure 14-2 shows a clove hitch secured by a square knot, and IPC/WHMA-A-620B Figure 14-3 is an example of a surgeon's knot.</p> <p>A clove hitch knot shall secure the bundle and the clove hitch shall be secured with a locking knot, e.g., square knot, surgeon's knot.</p> <p>Wax impregnated lacing tape shall not be used.</p> <p>Processing cut ends to prevent fraying of lacing is optional; frayed cut ends are not cause for rejection.</p> <p>Continuous lacing shall not be used unless specified on the engineering drawing.</p> <p>Defect</p> <ul style="list-style-type: none"> • Cut end protrusion (1) greater than tie wrap thickness (see IPC/WHMA-A-620B Figure 14-5). • Continuous lacing does not use lock stitches (see IPC/WHMA-A-620B Figure 14-10). • Wires not constrained securely and uniformly or are birdcaged (see IPC/WHMA-A-620B Figure 14-10). • Cable tied with a bowknot or other nonlocking knot (see IPC/WHMA-A-620B Figure 14-11). • Tie wraps/straps are inverted or not locked. • Knots are secured by heat searing. • Double lock stitch not used where required. • Branch lacing not started on trunk (see IPC/WHMA-A-620B Figure 14-9-1). • Excess lacing trimmed either too close to knot (less than 6 mm [0.25 in]) (see IPC/WHMA-A-620B Figure 14-9-2), or too far from knot (greater than 13 mm [0.5 in]) (see IPC/WHMA-A-620B Figure 14-9-3). • The first and last stitch of continuous lacing is not tied with a clove hitch or equivalent and secured with a square knot, surgeon's knot, or other lock knot (see IPC/WHMA-A-620B Figure 14-10).
14.2.1	<p>Breakouts – Individual Wires</p> <p>Defect</p> <ul style="list-style-type: none"> • A restraining device is not used prior to each breakout (see IPC/WHMA-A-620B Figure 14-18). • If continuous lacing is used, there is no double lock stitch before the first wire breakout or before and after any breakout of 4 or more wires.

A-620B Reference	Space Applications Requirement (as changed by this Addendum)																
<p>14.3.2</p>	<p>Routing – Bend Radius Bend radius is measured along the inside curve of the wire or wire bundles.</p> <p>The minimum bend radius of a harness assembly shall not be less than whichever wire/cable in the assembly has the largest bend radius defined in IPC/WHMA-A-620B-S, Table 14-1.</p> <p style="text-align: center;">Table 14-1 Minimum Bend Radius Requirements</p> <table border="1" data-bbox="272 363 1435 730"> <thead> <tr> <th data-bbox="272 363 781 394">Cable Type</th> <th data-bbox="786 363 1435 394">Space Addendum</th> </tr> </thead> <tbody> <tr> <td data-bbox="272 401 781 432">Coaxial Fixed Cable, Note 2</td> <td data-bbox="786 401 1435 432">6X OD¹</td> </tr> <tr> <td data-bbox="272 438 781 470">Coaxial Flexible Cable, Note 3</td> <td data-bbox="786 438 1435 470">10X OD¹</td> </tr> <tr> <td data-bbox="272 476 781 533">Shielded and Unshielded Wires and Cables, Note 4</td> <td data-bbox="786 476 1435 533">3X OD¹ for ≤AWG 10 (AWG 10, 12, 14, 18, 22, 24, etc.) 5X OD¹ for >AWG 10 (AWG 8, 6, 4, 2, 1, 0, etc.)</td> </tr> <tr> <td data-bbox="272 539 781 571">Polyimide Insulated Wire</td> <td data-bbox="786 539 1435 571">10X OD¹</td> </tr> <tr> <td data-bbox="272 577 781 609">Composite, (AS 2759/80-/92)</td> <td data-bbox="786 577 1435 609">6X OD¹</td> </tr> <tr> <td data-bbox="272 615 781 672">Semi-Rigid Coax</td> <td data-bbox="786 615 1435 672">Not less than Manufacturer’s stated minimum bend radius, see 13.10.1</td> </tr> <tr> <td data-bbox="272 678 781 730">Harness Assembly, Note 5</td> <td data-bbox="786 678 1435 730">Shall not be less than whichever wire/cable in the assembly has the largest bend radius defined in this table.</td> </tr> </tbody> </table> <p>Note 1: OD is the outer diameter of the wire or cable, including insulation.</p> <p>Note 2: Coaxial Fixed Cable Coaxial cable that is secured to prevent movement; not expected to have the cable repeatedly flexed during operation of the equipment.</p> <p>Note 3: Coaxial Flexible Cable Coaxial cable that is or may be flexed during operation of the equipment.</p> <p>Note 4: Shielded and Unshielded Wires and Cables Includes the following wire/cable categories from IPC/WHMA-A-620B, Table 14-1: Ethernet cable, shielded wires and cables, unshielded wires, insulated wire and flat ribbon cable, and bare bus or enamel insulated wire.</p> <p>Note 5: Harness Assembly (Protected/Unprotected):</p> <ul style="list-style-type: none"> ▪ Protected: A harness with a protective outer covering consisting of an overbraid, tape wrap, sleeving, conduit, etc. ▪ Unprotected: A laced or tie-wrapped harness with no protective outer covering, jacket, or shielding. ▪ Includes all wire/cable categories listed in Table 14-1 above and the following wire/cable categories from IPC/WHMA-A-620B, Table 14-1: Cable bundles with coaxial cables, cable bundles with no coaxial cables, Ethernet cables, and those listed in Note 4. <p>Defect</p> <ul style="list-style-type: none"> • Bend radius does not meet the requirements of Table 14-1 of this addendum. 	Cable Type	Space Addendum	Coaxial Fixed Cable, Note 2	6X OD ¹	Coaxial Flexible Cable, Note 3	10X OD ¹	Shielded and Unshielded Wires and Cables, Note 4	3X OD ¹ for ≤AWG 10 (AWG 10, 12, 14, 18, 22, 24, etc.) 5X OD ¹ for >AWG 10 (AWG 8, 6, 4, 2, 1, 0, etc.)	Polyimide Insulated Wire	10X OD ¹	Composite, (AS 2759/80-/92)	6X OD ¹	Semi-Rigid Coax	Not less than Manufacturer’s stated minimum bend radius, see 13.10.1	Harness Assembly, Note 5	Shall not be less than whichever wire/cable in the assembly has the largest bend radius defined in this table.
Cable Type	Space Addendum																
Coaxial Fixed Cable, Note 2	6X OD ¹																
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Harness Assembly, Note 5	Shall not be less than whichever wire/cable in the assembly has the largest bend radius defined in this table.																
<p>15.1</p>	<p>Braided Metal braid shielding can either be woven directly over a core or obtained in prefabricated form and installed by sliding it over the wire bundle. All breakouts shall be properly secured prior to applying the braid. IPC/WHMA-A-620B Figure 15-1 shows using tape to provide the breakouts. Lacing or cable ties may also be used (see Section 14 (Securing)).</p> <p>To prevent potential damage, e.g., cold flow or shorting of the underlying wire, a separator such as the tape shown in IPC/WHMA-A-620B Figure 15-2 shall be applied over the wire bundle.</p> <p>Directly applied braid shall be back braided to lock the weave. Prewoven braids shall be secured at the ends. When using cable straps or spot ties, fold the braid over itself, secure, and cover the end with heat shrink tubing or tape. Prewoven metallic braid shall be cleaned to remove contamination prior to installation over the harness.</p> <p>Temporary holding devices, e.g., spot ties, plastics straps and lacing shall be removed from wire bundles prior to braid application. Approved flat tapes may be left under braid if the tape has a low profile.</p>																
<p>15.1.1</p>	<p>Braided – Direct Applied</p> <p>Defect</p> <ul style="list-style-type: none"> • Braid strands bunched (excess overlap) (see IPC/WHMA-A-620B Figure 15-3). • Braid coverage does not meet drawing requirements. • Wire or shield braid visible through top braid. • Braiding overlap less than 13 mm [0.5 in] at breakouts and branches. • Braid has loops (see IPC/WHMA-A-620B Figure 15-4). • Ends not secured, frayed or unraveling (see IPC/WHMA-A-620B Figure 15-5). • Tears and/or cuts of braiding. • End strands not trimmed. • Damage exceeds the shield braid damage limits of 13.1 of this addendum. 																

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
15.1.2	<p>Braided – Prewoven</p> <p>Defect</p> <ul style="list-style-type: none"> • Braid coverage does not meet drawing requirements. • Ends not secured. • Tears and/or cuts of braiding. • Overlap is less than 1 bundle diameter where multiple braids meet. • Ends frayed or unraveling. • Loose ends protruding from potting or shrink sleeving. • Braid ballooned or bunched. • Damage exceeds the shield braid damage limits of 13.1 of this addendum. • Severed (broken) shield strands.
15.2	<p>Shield Termination Insulation of the inner wire(s) shall be protected from damage that can be caused by the soldered ends of the shield braid.</p> <p>Shield terminations shall be staggered within specified design limits to minimize wire bundle diameter buildup in the shield termination area.</p>
15.2.1.1	<p>Shield Termination – Shield Jumper Wire – Attached Lead Shield should terminate as close as possible to inner conductor termination point. For critical applications, engineering documentation should provide maximum limits on the gap between the conductor termination point and the shield termination point. Terminations made with self-sealing heat shrinkable devices are exempt from the cleaning requirements. Heat shrinkable solder devices, including those supplied with an integral shield wire, may be changed 1 size up or down to achieve correct fit when size is not called out on the engineering drawing.</p> <p>When removing the outer jacket, damage to the shield braid shall not exceed the damage limits of 13.1 of this addendum.</p>
15.2.1.1.1	<p>Shield Termination – Shield Jumper Wire – Attached Lead – Solder These criteria apply to connections made by hand soldering or using heat shrinkable solder devices. The criteria of 8.1.5 apply when using heat shrinkable solder devices.</p> <p>Note: To enable viewing of strands and solder fillets, some of the illustrations in this section were made with the sleeving removed.</p> <p>Defect</p> <ul style="list-style-type: none"> • Shield wire is not aligned with the stripped portion of the shield (see IPC/WHMA-A-620B Figure 15-13). • Solder fillet is less than 75% of the stripped length of the shield jumper wire (see IPC/WHMA-A-620B Figure 15-14). • Meltable sealing ring precludes formation of acceptable solder connection. • Shield wire extends beyond stripped surface of shield preventing wire from contacting shield (see IPC/WHMA-A-620B Figure 15-15-A). • Shield wire has pierced the insulation sleeving (see IPC/WHMA-A-620B Figure 15-15-B). • Solder joint is insufficient (see IPC/WHMA-A-620B Figure 15-14). • Shield strand is protruding from end of insulation sleeving (see IPC/WHMA-A-620B Figure 15-16-A). • Shield strand has pierced the insulation sleeving (see IPC/WHMA-A-620B Figure 15-16-B). • Insufficient solder flow, contour of solder preform is discernible (see IPC/WHMA-A-620B Figure 15-17, 18). • Plastic sleeve burned/charred (see IPC/WHMA-A-620B Figure 15-19). • Discoloration of sleeving obscures the solder connection. • Heat shrinkable solder device/protective sleeving is not properly positioned on the shield and bare shield is exposed (see IPC/WHMA-A-620B Figure 15-20). • Sleeve is not formed tightly onto the lead and the cable. • Length of contact between the shield and the drain wire being attached is less than 3 wire diameters of the drain wire.
15.2.1.2	<p>Shield Termination – Shield Jumper Wire – Shield Braid Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
15.2.1.3	<p>Shield Termination – Shield Jumper Wire – Daisy Chain Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
15.2.1.4	Shield Termination – Shield Jumper Wire – Common Ground Point Requirements for shield jumper wires spliced to a common point ground shall be the same as the splice requirements documented in 8.1 or 8.2 for the type of splice called out, e.g., lap.
15.3.1	Shield Termination – Connector – Shrink Defect <ul style="list-style-type: none"> • Gaps are present in weave pattern. • Damage exceeds the shield braid damage limits of 13.1 of this addendum. • Shield extends beyond backshell crimp area (see IPC/WHMA-A-620B Figure 15-40-A). • Shield is not visible between shrinkable ring and backshell (see IPC/WHMA-A-620B Figure 15-41-B). • Shrinkable ring is not shrunk, movement of the ring and shield is evident. (Ring has retained its original color.) (see IPC/WHMA-A-620B Figure 15-36).
15.3.2	Shield Termination – Connector – Crimp Defect <ul style="list-style-type: none"> • Gaps are present in weave pattern. • Damage exceeds the shield braid damage limits of 13.1 of this addendum. • Shield extends beyond backshell crimp area (see IPC/WHMA-A-620B Figure 15-40-A). • Shield strands not contained within crimp ring have not been trimmed (see IPC/WHMA-A-620B Figure 15-40-C). • Crimp ring extends greater than 10% of the crimp ring length beyond backshell (see IPC/WHMA-A-620B Figure 15-39-A). • Crimp ring is under-crimped resulting in movement of the ring or shield. • Sharp edges are present in the cut off area (see IPC/WHMA-A-620B Figure 15-40-B). • Banding clamp is not wrapped around backshell 2 times.
15.3.3	Shield Termination – Connector – Shield Jumper Wire Attachment Defect <ul style="list-style-type: none"> • Shield jumper wire is not within the envelope dimension of the connector (where possible) (see IPC/WHMA-A-620B Figure 15-45). • Terminal lug is not properly torqued to the grounding point. • Shield jumper wire is taut causing stress on the solder or crimp connections (see IPC/WHMA-A-620B Figure 15-44).
15.4.1	Shield Termination – Splicing Prewoven – Soldered Defect <ul style="list-style-type: none"> • Tack solder has not flowed to inner shields (see IPC/WHMA-A-620B Figure 15-50, arrows). • Shield overlap is less than 1 times the diameter of the large (combined) wire bundle. • Solder flow in the shield overlap area is excessive with no flexibility (see IPC/WHMA-A-620B Figure 15-51). • Shield weave pattern is disturbed beyond the allowable limits defined in clause 15.1.1 or 15.1.2. • Shield overlap is greater than 3 wire bundle diameters.
15.7	Shrink Tubing – Conductive Lined Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.
16.1.2	Braid – Prewoven Defect <ul style="list-style-type: none"> • Ends frayed or unraveling (see IPC/WHMA-A-620B Figure 16-6). • Pulled loops (see IPC/WHMA-A-620B Figure 16-7). • Braid ballooned or bunched (see IPC/WHMA-A-620B Figure 16-8). • Ends not secured. • Damage to braiding, i.e., tears, cuts, melting (see IPC/WHMA-A-620B Figure 16-9). • Overlap is less than 1 bundle diameter where multiple braids meet.
16.3	Spiral Plastic Wrap (Spiral Wrap Sleeving) Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
17	<p>Finished Assembly Installation A finished assembly is a harness, cable or wire(s) that may be covered or uncovered.</p> <p>See 19.4.1 for post-installation testing requirements.</p>
17.1	<p>General This section provides acceptance criteria for installation of a harness.</p> <p>Mechanical assembly refers to mounting of assemblies requiring the use of any of the following: screws, bolts, nuts, washers, fasteners, clips, component studs, adhesives, tie downs, rivets, connector pins, etc.</p> <p>This section covers visual criteria. Compliance to torque requirements is to be verified as specified by engineering documentation. The verification procedure ensures that no damage to components or assembly occurs. Where torque requirements are not specified, follow standard industry practices.</p> <p>Process documentation (drawings, prints, parts list, build process) will specify what to use; deviations shall have prior user approval.</p> <p>Where the criteria are self-explanatory, no illustrations are provided.</p> <p>When no specific requirements have been established by other documentation, the following criteria apply:</p> <ul style="list-style-type: none"> • Wires and cables are positioned or protected to avoid contact with rough or irregular surfaces and sharp edges and to avoid damage to conductors or adjacent parts. • There are no rough, irregular surfaces or sharp edges on connector mating surfaces that can damage O-rings, gaskets or other sealing features. • There is no damage to o-rings, gaskets, or other sealing features. • Minimum electrical clearance is maintained. • Installation hardware including accessories is tight, including applicable torque if required. • Wiring connections to ground are free of any protective finishes (e.g., paint, anodized coating, etc.) that can preclude an adequate ground connection. • Wire routing meets requirements for drip loops, no mechanical interference, etc. • Soldered connections meet the requirements of Section 4 (Soldered Terminations). • Crimping meets the requirements of Section 5 (Crimp Terminations). • Splice connections meet the requirements of Section 8 (Splices). • Wiring is terminated at the destination specified by the wire marker/documentation. • Wire is not routed through “keep out” zones, e.g., hot surfaces or mechanical interference areas. • Adhesives are applied at the required location and properly cured. • Cable wire/harness bend radius maintained as specified. If not otherwise specified, the minimum bend radius is in accordance with IPC/WHMA-A-620B Table 14-1. • The harness is supported with mounting hardware to preclude stress. • Cable restraints do not compress or damage wire insulation. • If required, a service loop is provided to allow at least 1 field repair. • The harness is installed to meet required form, fit and function. <p>Defect</p> <ul style="list-style-type: none"> • Product that does not conform to requirements or the above criteria.

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
17.2	<p>Hardware Installation This section illustrates several types of mounting hardware.</p> <p>All hardware shall be assembled in accordance with the supplier's (1.7.5) specifications.</p> <p>Process documentation will specify configuration of the hardware (drawings, prints, parts list, build procedures). Deviations shall require User approval prior to use.</p> <p>There shall be a documented process for torquing of threaded fasteners, including, but not limited to, standard torque values (when not specified in engineering documentation), requirements, procedures, quality assurance provisions, and tool control.</p> <p>Visual inspection is performed in order to verify the following conditions:</p> <ol style="list-style-type: none"> Correct parts and hardware. Correct sequence of assembly. Correct security and tightness of parts and hardware. No discernible damage. Correct orientation of parts and hardware. Existence and correct application of materials to the fastener system In-process torque verification (i.e., witness) <p>The amount of torque applied establishes the preload in the fastener and the joint clamping force. Incorrect preload may result in static or fatigue failure of the fastener, joint slip, or separation. Threaded fasteners shall be torqued to the value specified on the drawing. If the torque value is not specified on the drawing, threaded fasteners shall be torqued to a defined standard torque value. The application of this torque value shall not cause the violation of the requirements in this specification.</p> <p>The torque applied at final assembly shall include: the torque required to overcome the kinetic friction between the mating bearing faces and between the mating threads and the torque required to overcome the self-locking feature (i.e., prevailing torque), if any, plus the torque required to apply the required axial load to the fastener system (i.e., specified torque).</p> <p>Each threaded fastener used in a design shall have a torque value and should have a torque tolerance specified on the engineering drawing, e.g., 8 in-lbs \pm 6%. The torque tool accuracy shall be equal to or less than the tolerance, if defined. (Note that the tolerance is only used in the context of limiting the tool use to those tools that can meet the specified torque.) When a locking mechanism is used with a threaded fastener, the engineering drawing shall state that the prevailing torque shall be added to the specified torque value.</p> <p>Threaded fasteners which have been over-torqued shall be removed and discarded.</p> <p>Tooling and Equipment</p> <p>Tool standards equivalent to those below may be used.</p> <p>Torque tools (mechanical hand) shall conform to ASME B107.14, ASME B107.28 or ISO6789, as applicable.</p> <p>Torque tools (rotary) shall be tested and have their accuracies stated in accordance with ISO5393.</p> <p>Torque tools and measuring equipment shall be calibrated at regular intervals based on the type of tool and records of the tool's calibration. Calibration shall be in accordance with section 1.13.2.</p> <p>Periodic torque tool verification (if required) shall be performed to documented procedures. Process control for torquing of threaded fasteners shall be established, documented, and followed.</p> <p>Torque tools shall be selected and used in accordance with the Manufacturer's recommendations (i.e., tolerance, accuracy, and range of the tool).</p> <p>Torque tool settings/values shall be adjusted to compensate for additions to the torque tool, e.g., extensions, adapters, etc.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)
<p>17.2 (cont.)</p>	<p>Materials Applied to the Fastener System</p> <p>Compounds applied to fasteners (thread-locker, torque identification/witness/anti-tampering stripes, corrosion protection, sealants, adhesives, staking, lubricant, etc.) shall be identified on the drawing and shall be applied and cured in accordance with documented procedures, and the requirements of Section 1.13.3 of this addendum.</p> <p>Threaded fasteners that have been retained by the use of thread locking compounds shall be cleaned and inspected before reuse.</p> <p>Fasteners requiring torque stripe (witness/anti-tampering stripe) shall have the stripe in accordance with the following requirements. The stripe shall :</p> <ul style="list-style-type: none"> • Be continuous. • Extend from the top of the fastener onto the adjacent substrate (at minimum). • Be aligned with the center line of the fastener. <p>Fasteners requiring staking shall be retained by the appropriate approved adhesive, with a minimum of 50% circular coverage (either one continuous bead for 50% of the circumference, or two beads with at least 25% each of the circumference).</p> <p>Visual Inspection The following shall be the visual criteria for threaded fastener hardware installation, in addition to the other visual criteria in Section 17:</p> <p>Defect</p> <ul style="list-style-type: none"> • Hardware is not seated. Gaps exist between hardware and mating surfaces. • Proper hardware installation sequence (i.e., torque pattern) not applied. • Fasteners are damaged (worn, burrs, frayed edges, cross-threading, mutilation). • Flathead screws protrude above the mounting surface.
<p>17.2.3</p>	<p>Hardware Installation – Threaded Fasteners – Wires Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
<p>17.2.4</p>	<p>Hardware Installation – Threaded Fasteners – High Voltage Applications Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>
<p>17.3.3</p>	<p>Wire/Harness Installation – Service Loops A service loop sufficient to allow 1 field repair shall be incorporated only when indicated on approved engineering documentation.</p> <p>Defect</p> <ul style="list-style-type: none"> • Insufficient wire length if required by drawing (see IPC/WHMA-A-620B Figure 17-22).
<p>17.4 [New]</p>	<p>Lock Wires When lock wires are required, they shall be installed in accordance with the engineering documentation (work instructions). In the absence of criteria in the engineering documentation, the following requirements are applicable:</p> <ul style="list-style-type: none"> • The double twist method of lock-wiring shall be used. • Devices shall not be loosened to align lock-wire holes. • Lock wire shall not be reused. • Lock wire shall not be stretched, nicked, or kinked. • The lock wire shall not have a slack loop that enables the wire to move up over the device being secured. • The lock wire shall be installed such that the wire is put in tension if the device tends to loosen. • The twisted portion of the pigtail shall begin within three wire diameters of the hole being lock-wired. • The wire pigtail shall be long enough to be bent into a loop but shall not be longer than 25 mm [0.98 in]. • The wire pigtail shall be bent into a loop or otherwise positioned to prevent sharp ends.
<p>18 (All)</p>	<p>Solderless Wrap Process and acceptance criteria shall be agreed upon between the User and Manufacturer prior to use.</p>

A-620B Reference	Space Applications Requirement (as changed by this Addendum)																											
<p>19.4.1</p>	<p>Electrical Test – Selection Table 19-1 of this addendum gives an overview of the electrical tests that are required by default when agreement has not otherwise been made between the Manufacturer and the User. The “Requirements” column identifies whether a test is required for all assemblies (Required) or when the test must be specified by the User (As Specified).</p> <p>Post installation testing shall be performed to assure that individual wire conditions have not been degraded by installation operations. The post installation test requirements shall be those identified in this clause. The tests shall be performed after installing the cables or harness in place, but before mating connectors.</p> <p>The required tests shall be conducted in this order:</p> <ol style="list-style-type: none"> 1. Low Voltage Tests (Continuity/Shorts¹) 2. High Voltage Tests (DWW/IR²) <p>¹The shorts test is not valid for an assembly that has continuity defects. ²If DWW and IR tests are performed independently, the IR test shall be conducted after the DWW.</p> <p>Records of all acceptance testing shall be complete and shall be traceable to the cable or harness assembly being tested.</p> <p>Adapter cables, breakout boxes, and/or connector savers shall be used to conduct any and all electrical tests on interconnecting cable and harness assemblies.</p> <p>Hand probes shall not be used directly in the cable or harness connectors.</p> <p>At a minimum, the electrical acceptance tests on potted-type connectors shall be performed immediately before the potting operation and after final assembly.</p> <p style="text-align: center;">Table 19-1 Electrical Test Requirements</p> <table border="1" data-bbox="269 867 1435 1199"> <thead> <tr> <th>Paragraph</th> <th>Test</th> <th>Requirements</th> </tr> </thead> <tbody> <tr> <td>19.5.1</td> <td>Continuity Test Parameters</td> <td>Required</td> </tr> <tr> <td>19.5.2</td> <td>Shorts</td> <td>Required</td> </tr> <tr> <td>19.5.3</td> <td>Dielectric Withstanding Voltage (DWW) Test Parameters</td> <td>Required</td> </tr> <tr> <td>19.5.4</td> <td>Insulation Resistance (IR) Test Parameters</td> <td>Required</td> </tr> <tr> <td>19.5.5</td> <td>Voltage Standing Wave Ratio (VSWR) Test Parameters</td> <td>As Specified</td> </tr> <tr> <td>19.5.6</td> <td>Insertion Loss Test Parameters</td> <td>As Specified</td> </tr> <tr> <td>19.5.7</td> <td>Reflection Coefficient Test</td> <td>As Specified</td> </tr> <tr> <td>19.5.8</td> <td>Other Electrical Tests - User Defined</td> <td>As Specified</td> </tr> </tbody> </table>	Paragraph	Test	Requirements	19.5.1	Continuity Test Parameters	Required	19.5.2	Shorts	Required	19.5.3	Dielectric Withstanding Voltage (DWW) Test Parameters	Required	19.5.4	Insulation Resistance (IR) Test Parameters	Required	19.5.5	Voltage Standing Wave Ratio (VSWR) Test Parameters	As Specified	19.5.6	Insertion Loss Test Parameters	As Specified	19.5.7	Reflection Coefficient Test	As Specified	19.5.8	Other Electrical Tests - User Defined	As Specified
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<p>19.5.2</p>	<p>Electrical Test Methods – Shorts Testing for shorts is a low voltage test used to detect unintended connections.</p> <p>When a limit is specified and included in the “Other Defined Value” column of Table 19-3 of this addendum, the shorts test shall verify that the measurement is not below that limit. In the absence of specific agreed on test requirements between Manufacturer and User or an agreement by the User to accept the Manufacturer’s documented test requirements, the requirements of Table 19-3 of this addendum shall apply.</p> <p style="text-align: center;">Table 19-3 Shorts Test (low voltage isolation) Minimum Requirements</p> <table border="1" data-bbox="269 1455 1435 1598"> <thead> <tr> <th>Parameter</th> <th>Requirement</th> <th>Other Defined Value</th> </tr> </thead> <tbody> <tr> <td>Min Resistance</td> <td rowspan="3" style="text-align: center;">Tester Default</td> <td style="text-align: center;">___Ohms</td> </tr> <tr> <td>Max Current</td> <td style="text-align: center;">___mA</td> </tr> <tr> <td>Max Voltage¹</td> <td style="text-align: center;">Volts</td> </tr> </tbody> </table> <p>Note 1: A maximum voltage and or current should be specified when components within an assembly may be damaged by these tests.</p>	Parameter	Requirement	Other Defined Value	Min Resistance	Tester Default	___Ohms	Max Current	___mA	Max Voltage ¹	Volts																	
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A-620B Reference	Space Applications Requirement (as changed by this Addendum)								
19.5.3	<p>Electrical Test Methods – Dielectric Withstanding Voltage Test (DWV) The dielectric withstanding voltage test is a high voltage test, either AC or DC, used to validate that the components can operate safely at their rated voltage and withstand momentary spikes in voltage due to switching, surges or other causes. It assures that insulating materials and spacing in the component part are adequate. When a component part is faulty in these respects, application of the test voltage will result in either disruptive discharge (arc-over) or deterioration (dielectric breakdown).</p> <p>The test potential shall be applied between the following:</p> <ol style="list-style-type: none"> 1. each conductor and all other conductors in the cable or harness assembly 2. each conductor and connector shell 3. each conductor and shield 4. shields that are not electrically common 5. shields and connector shell/ground, except when shields are connected to ground <p>The assembly fails when the measured current exceeds the specified value or the test equipment detects an electrical discharge.</p> <p>AC tests are usually chosen over DC tests when an assembly is used in applications operating at voltages over 90VAC or where performance under AC stresses is a concern. AC test frequency is 60 Hz unless otherwise specified. When a total leakage current above 2 mA is expected, the test limits should be defined in terms of real current.</p> <p>Cable or harness assemblies with a large capacitance, e.g., long runs generally over six feet, a long cable, or a harness incorporating shielding, should be tested using the DC potential option to avoid erroneous indications of failure.</p> <p>When limits other than those defined in Table 19-4 of this addendum are specified by the User, the DWV test shall be performed using those limits. In the absence of specifically agreed upon test requirements between Manufacturer and User, or an agreement by the User to accept the Manufacturer’s documented test requirements, Table 19-4 of this addendum shall apply.</p> <p style="text-align: center;">Table 19-4 Dielectric Withstanding Voltage Test (DWV) Requirements</p> <table border="1" data-bbox="334 1026 1498 1171"> <thead> <tr> <th>Parameter</th> <th>Requirement</th> </tr> </thead> <tbody> <tr> <td>Voltage Level¹</td> <td>1500 VDC ± 75 VDC or equivalent peak AC voltage</td> </tr> <tr> <td>Maximum Leakage Current</td> <td>1 mA</td> </tr> <tr> <td>Dwell time¹</td> <td>>0² to 60 seconds</td> </tr> </tbody> </table> <p>Note 1: See 19.1 Note 2: Steady state condition is achieved</p>	Parameter	Requirement	Voltage Level ¹	1500 VDC ± 75 VDC or equivalent peak AC voltage	Maximum Leakage Current	1 mA	Dwell time ¹	>0 ² to 60 seconds
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<p>A-620B Reference</p>	<p align="center">Space Applications Requirement (as changed by this Addendum)</p>									
<p>19.5.4</p>	<p>Electrical Test Methods – Insulation Resistance (IR) The insulation resistance test is a high voltage test used to verify the resistance offered by the insulating materials. Failure occurs when the measured resistance value is lower than the specified value or the test equipment detects an electrical discharge.</p> <p>For the IR test, the duration of the test may be reduced to the time required for steady state current to be established. If a DC test potential is used for the dielectric withstanding voltage test, the insulation resistance may be measured simultaneously.</p> <p>If both DWV and IR tests are performed independently, the IR test shall be conducted after the DWV.</p> <p>The test potential shall be applied between the following:</p> <ol style="list-style-type: none"> 1. each conductor and all other conductors in the cable or harness assembly 2. each conductor and connector shell 3. each conductor and shield 4. shields that are not electrically common 5. shields and connector shell/ground, except when shields are connected to ground <p>When limits other than those defined in Table 19-5 of this addendum are specified by the User, the IR test shall be performed using those limits. In the absence of specifically agreed upon test requirements between Manufacturer and User, or an agreement by the User to accept the Manufacturer’s documented test requirements, Table 19-5 of this addendum shall apply.</p> <p align="center">Table 19-5 Insulation Resistance (IR) Test Minimum Requirements</p> <table border="1" data-bbox="269 806 1435 1014"> <thead> <tr> <th align="center">Parameter</th> <th align="center">Requirement</th> </tr> </thead> <tbody> <tr> <td align="center">Voltage Level¹</td> <td align="center">500 VDC ± 50 VDC or tester default</td> </tr> <tr> <td align="center" rowspan="2">Minimum Insulation Resistance²</td> <td align="center">Any cable other than coaxial ≥100M ohms</td> </tr> <tr> <td align="center">Coaxial, biaxial and similar multi-conductor shielded wires of any length ≥500 Meg ohms</td> </tr> <tr> <td align="center">Max Dwell Time</td> <td align="center">10 Seconds</td> </tr> </tbody> </table> <p>Note 1: See 19.1 Note 2: IR levels specified are applicable at less than 80% relative humidity. When relative humidity exceeds 80%, derating should be addressed between User and Manufacturer.</p>	Parameter	Requirement	Voltage Level ¹	500 VDC ± 50 VDC or tester default	Minimum Insulation Resistance ²	Any cable other than coaxial ≥100M ohms	Coaxial, biaxial and similar multi-conductor shielded wires of any length ≥500 Meg ohms	Max Dwell Time	10 Seconds
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<p>A-620B Reference</p>	<p align="center">Space Applications Requirement (as changed by this Addendum)</p>																								
<p>19.6.1</p>	<p>Mechanical Test – Selection In the absence of specific agreed on test requirements between Manufacturer and User, or an agreement by the User to accept the Manufacturer’s documented test requirements, the requirements of Table 19-9 of this addendum shall apply to 100% of assemblies.</p> <p>If the Manufacturer has a documented process control program in place (see 1.3 and 1.8), supported by objective evidence, for maintaining crimp tooling and validating crimped connections, that program may be used in lieu of 19.7.2 when approved by the User prior to use. However, crimp tools shall not be used for longer than 30 days between verification testing.</p> <p>Contacts used for tensile testing shall be from the same lot number as those that will be used in the assembly.</p> <p>As an exception, contacts used for tensile testing contacts in coaxial connectors need not be from the same lot but shall be of the same size and construction (e.g., geometry, base metal, heat treating, and plating).</p> <p align="center">Table 19-9 Mechanical Test Requirements</p> <table border="1"> <thead> <tr> <th>Paragraph</th> <th>Test</th> <th>Requirement</th> </tr> </thead> <tbody> <tr> <td>19.7.1</td> <td>Crimp Height Testing</td> <td>Optional</td> </tr> <tr> <td>19.7.2</td> <td>Pull Force/Tensile Testing</td> <td>Required</td> </tr> <tr> <td>19.7.3</td> <td>Crimp Force Monitoring</td> <td>As Specified</td> </tr> <tr> <td>19.7.5</td> <td>Contact Retention Verification</td> <td>Required Either 19.7.5.1 or 19.7.5.2</td> </tr> <tr> <td>19.7.6</td> <td>RF Connector Shield Pull Test</td> <td>As specified</td> </tr> <tr> <td>19.7.7</td> <td>RF Connector Shield Torsion Test</td> <td>As specified</td> </tr> <tr> <td>19.7.8</td> <td>Other Mechanical Tests - User Defined</td> <td>As specified</td> </tr> </tbody> </table>	Paragraph	Test	Requirement	19.7.1	Crimp Height Testing	Optional	19.7.2	Pull Force/Tensile Testing	Required	19.7.3	Crimp Force Monitoring	As Specified	19.7.5	Contact Retention Verification	Required Either 19.7.5.1 or 19.7.5.2	19.7.6	RF Connector Shield Pull Test	As specified	19.7.7	RF Connector Shield Torsion Test	As specified	19.7.8	Other Mechanical Tests - User Defined	As specified
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19.7.7	RF Connector Shield Torsion Test	As specified																							
19.7.8	Other Mechanical Tests - User Defined	As specified																							
<p>19.7.1</p>	<p>Mechanical Test Methods – Crimp Height (Dimensional Analysis) Crimp height testing verifies that the terminal crimp height is within the terminal manufacturer’s specifications. Each crimp terminal and conductor combination will have unique crimp height criteria. If the Manufacturer and User agree to use this optional test, in the absence of specifically agreed upon test requirements between Manufacturer and User or an agreement by the User to accept the Manufacturer’s documented test requirements, crimp height testing shall be performed to the parameters specified in Table 19-10 of this addendum.</p> <p align="center">Table 19-10 Crimp Height Testing</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Requirement</th> </tr> </thead> <tbody> <tr> <td>Max Flash Height</td> <td>0.5x material stock thickness</td> </tr> <tr> <td>True Crimp Height</td> <td>Use terminal supplier’s specification¹</td> </tr> <tr> <td>Width (non-circular crimp, i.e., Lugs)</td> <td>Use terminal supplier’s specification¹</td> </tr> </tbody> </table> <p>Note 1: If the User or Manufacturer has objective evidence indicating that the terminal supplier’s specification is not sufficient, other values may be agreed upon between User and Manufacturer.</p> <p>It is critical that crimp height measurements are taken correctly. Crimp height measurement tools have a flat blade on one side and a pointed contact on the other. The purpose of the pointed contact is to avoid the flash that may form on some terminals during the crimping process. Excessive flash may be a sign that the crimp anvils are worn (see IPC/WHMA-A-620B Figure 19-1).</p>	Parameter	Requirement	Max Flash Height	0.5x material stock thickness	True Crimp Height	Use terminal supplier’s specification ¹	Width (non-circular crimp, i.e., Lugs)	Use terminal supplier’s specification ¹																
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A-620B Reference	Space Applications Requirement (as changed by this Addendum)
19.7.2	<p>Mechanical Test Methods – Pull Force (Tensile) These criteria apply to crimp terminations (contacts and lugs), splices, and crimp rings.</p> <p>Longitudinal force is applied to evaluate the mechanical integrity of the crimped connection. If the contact has a wire insulation support it shall be rendered mechanically ineffective by either manually opening the insulation crimp or by making an extra-long strip so that the uninsulated wire extends beyond the insulation crimp.</p> <p>Pull Force testing shall be performed and the results shall be recorded including:</p> <ol style="list-style-type: none"> 1. Unique identification of the crimp tool, e.g., serial number, asset number, etc. 2. Unique identification of the pull tester (or force gauge if used as a separate part of a tensile testing system). 3. Calibration date of the pull tester or force gauge. 4. Date of pull test. 5. Force at failure (break). 6. Unique identification of contact/lug. 7. Gauge of wire. 8. Crimper position/setting (when applicable). <p>Samples used for pull testing shall not be used for deliverable product.</p> <p>When a testing interval is not defined in the contract, tensile testing shall be performed at the beginning and end of each shift or crimping operation for each contact/conductor combination. Three test samples shall be prepared for each contact/conductor combination test. A crimp-contact-conductor combination is defined as a specific contact used with a specific wire construction, e.g., if a drawing calls out a combination of single wires and twisted pairs of the same construction, e.g., gauge, strand count, alloy (base metal), and plating, the test samples of the single wire qualifies the tool to be used on the twisted pairs.</p> <p>The pull rate shall be ≤ 25 mm [1 in]/minute and shall be held constant throughout the pull.</p> <p>Where specific values for pull force have not been agreed upon between the User and the Manufacturer, the minimum tensile values shall meet or exceed the values in IPC/WHMA-A-620B Table 19-12.</p> <p>For crimped multiple wire applications of varying sizes, pull tests shall be performed on the smallest wire in the crimp.</p> <p>Pull and break testing shall be used unless other pull force test methods are agreed upon between Manufacturer and User. Examples of destructive pull force test methods are:</p> <ul style="list-style-type: none"> • Pull and break – Increasing longitudinal force is applied to the connection until either the terminal and wire separate or the wire breaks. • Pull and return – the terminal is pulled to a specified force. Once the specified force is achieved the force is removed. • Pull and hold – the terminal is pulled to a specified force and held for a specified period of time then the force is decreased to zero. • Pull, hold and break – the terminal is pulled to a specified force and held for a specified period of time then the terminal is pulled until either the terminal is separated from the wire or the wire breaks. <p>IPC/WHMA-A-620B Table 19-12 provides pull-force acceptance values for crimps on stranded copper wire. Where crimp force values are not established, the tensile strength of the crimp connection shall be no less than 60 percent of the tensile strength of the wire.</p>
19.7.2.1	<p>Mechanical Test Methods – Pull Force (Tensile) – Without Documented Process Control Not applicable. Use 19.7.2.</p>

<p>A-620B Reference</p>	<p align="center">Space Applications Requirement (as changed by this Addendum)</p>										
<p>19.7.5</p>	<p>Mechanical Test Methods – Contact Retention Verification Contact retention (seating/locking) shall be verified with a non-destructive process appropriate to the connector in use. Each contact in all connectors using retention clips or tines shall be push or pull tested 100 percent for seating. Each contact shall be limited to one push (or pull) test per contact insertion. Verification shall be accomplished prior to addition of any restraining devices.</p>										
<p>19.7.5.1 [New]</p>	<p>Mechanical Test Methods – Contact Retention Verification – Push Testing In applications in which the engaging (mating) ends of the pin or socket contacts are accessible, contact retention testing to the requirements of Table 19-1 of this addendum shall be performed by push testing. Push testing shall utilize a tool that minimizes the possibility of accidental contact bending and applies a controlled pressure to the contact before releasing the force within the specified value. A typical tool design is shown in Figure 19-1 of this addendum. Socket testing probes shall be undersized compared to mating-pin diameters and shall not cause a mating cycle to take place.</p> <p>In the event of a failure of the contact retention test, perform a visual inspection of the contact and connector. Clean the contact and connector if there is evidence of debris. Reseat the contact. If the test fails a second time, document and disposition as a defect.</p> <p align="center">IPC/WHMA-A-620B-S Table 19-1 Push Test Contact Retention Test Force¹</p> <table border="1" data-bbox="334 695 1498 877"> <thead> <tr> <th align="center">Contact Size</th> <th align="center">Newtons [Pounds]</th> </tr> </thead> <tbody> <tr> <td align="center">22</td> <td align="center">18 to 27 [4 to 6]</td> </tr> <tr> <td align="center">20</td> <td align="center">22 to 31 [5 to 7]</td> </tr> <tr> <td align="center">16</td> <td align="center">36 to 45 [8 to 10]</td> </tr> <tr> <td align="center">12</td> <td align="center">45 to 53 [10 to 12]</td> </tr> </tbody> </table> <p>Note 1: These values are established for connectors constructed with metal contact retaining tines/clips. Retention value criteria for connectors constructed using composite or other non-metal contact retaining tines/clips shall be agreed upon between the Manufacturer and the User prior to use.</p> <p>Note 2: For contact sizes not shown in Table 19-13, contacts shall be tested at 50 ± 5% of the retention force shown on the connector data sheet.</p> <p>Exceptions to retention verification are:</p> <ul style="list-style-type: none"> • Pre-wired molded connectors. • Molded or potted connectors after the molding/potting has been applied (but must be performed prior to applying molding/potting). • Solder cup connectors. • Connector contacts are soldered into position. <div data-bbox="607 1251 1227 1486" style="text-align: center;"> </div> <p align="center">IPC/WHMA-A-620B-S Figure 19-1 Typical Contact Retention Push Test Tool</p>	Contact Size	Newtons [Pounds]	22	18 to 27 [4 to 6]	20	22 to 31 [5 to 7]	16	36 to 45 [8 to 10]	12	45 to 53 [10 to 12]
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<p>A-620B Reference</p>	<p align="center">Space Applications Requirement (as changed by this Addendum)</p>										
<p>19.7.5.2 [New]</p>	<p>Mechanical Test Methods – Contact Retention Verification – Pull Testing Pull force contact retention testing to the requirements of Table 19-2 of this addendum shall be performed only on devices in which the contact engaging (mating) ends are not accessible. Pull force testing shall be performed by pulling on the wire terminated in the contact as illustrated in Figure 19-2 of this addendum. When the wire breakout to the terminal junction is less than 13 cm [5.118 in] in length, ties and clamps may be removed but only to the point where the wires leave the main bundle. Pull the wire perpendicular to the wire exit face of the connector device. Wires shall not be pulled to a force in excess of 80 percent of the minimum pull force (tensile test) value specified in IPC/WHMA-A-620B Table 19-12 to preclude damage to the wire/contact crimp joint.</p> <p align="center">IPC/WHMA-A-620B-S Table 19-2 Pull Test Contact Retention Test Force¹</p> <table border="1" data-bbox="271 495 1432 678"> <thead> <tr> <th>Contact Size</th> <th>Newtons [Pounds]²</th> </tr> </thead> <tbody> <tr> <td align="center">22</td> <td align="center">13 to 22 [3 to 5]</td> </tr> <tr> <td align="center">20</td> <td align="center">13 to 22 [3 to 5]</td> </tr> <tr> <td align="center">16</td> <td align="center">18 to 31 [4 to 7]</td> </tr> <tr> <td align="center">12</td> <td align="center">18 to 31 [4 to 7]</td> </tr> </tbody> </table> <p>Note 1: These values are established for connectors constructed with metal contact retaining tines/clips. Retention value criteria for connectors constructed using composite or other non-metal contact retaining tines/clips shall be agreed upon between the Manufacturer and the User prior to use.</p> <p>Note 2: For wires smaller or larger than those shown in IPC/WHMA-A-620B-S Table 19-14, an alternate verification method shall be agreed upon between User and the Manufacturer prior to use.</p> <p>In the event of a failure of the contact retention test, perform a visual inspection of the contact and connector. Clean the contact and connector if there is evidence of debris. Reseat the contact. If the test fails a second time, document and disposition as a defect.</p> <p>Exceptions to retention verification are:</p> <ul style="list-style-type: none"> • Pre-wired molded connectors. • Molded or potted connectors after the molding/potting has been applied (but must be performed prior to applying molding/potting). • Solder cup connectors. • Connector contacts are soldered into position. <div data-bbox="621 1144 1122 1417" style="text-align: center;"> </div> <p align="center">Figure 19-2 Typical Contact Retention Pull Test Tool</p>	Contact Size	Newtons [Pounds] ²	22	13 to 22 [3 to 5]	20	13 to 22 [3 to 5]	16	18 to 31 [4 to 7]	12	18 to 31 [4 to 7]
Contact Size	Newtons [Pounds] ²										
22	13 to 22 [3 to 5]										
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<p>19.7.6</p>	<p>Mechanical Test Methods – RF Connector Shield Pull Force (Tensile) Axial force is applied to evaluate the mechanical integrity of the shield connection. This test is not required unless specifically agreed upon between the User and Manufacturer.</p> <p>Pull and break testing shall be used unless other pull force test methods are agreed upon between Manufacturer and User.</p> <p>If RF Connector Shield Pull Force Testing is specified, the tests shall be performed to parameter values of IPC/WHMA-A-620B Table 19-14, as agreed between User and Manufacturer.</p>										



Standard Improvement Form

IPC/WHMA-A-620B-S

The purpose of this form is to provide the Technical Committee of IPC with input from the industry regarding usage of the subject standard.

Individuals or companies are invited to submit comments to IPC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:

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Fax: 847 615.7105
E-mail: answers@ipc.org
www.ipc.org/standards-comment

1. I recommend changes to the following:

- Requirement, paragraph number _____
- Test Method number _____, paragraph number _____

The referenced paragraph number has proven to be:

- Unclear
- Too Rigid
- In Error
- Other _____

2. Recommendations for correction:

3. Other suggestions for document improvement:

Submitted by:

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Company

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