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Cleaning and Cleanliness Control For ACIS, Electronic Assemblies

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Cleaning and Cleanliness Control for ACIS, Electronic Assemblies

1.0 Scope

This specification establishes the general requirements for cleaning and cleanliness control, and the related quality assurance provisions, for the DEA and DPA Electronic Assemblies and interconnecting cables to the ACIS Instrument. This specification applies to the first cleaning of components and subassemblies, through final testing and preparation for integration of the science instrument.

1.1 Introduction

The Electronic Boxes and cables go through extensive assembly and test processes prior to final closure. It is inherent that contamination will arise from these various processes. In order to maintain the acceptable levels of contamination the Electronic Boxes need to be cleaned in different stages of manufacturing per this procedure. Following this procedure will ensure Flight Electronic Boxes meet the contamination requirements of the ACIS Instrument.

1.2 Engineering Information

This specification is for the purpose providing information for gross and precleaning, precision cleaning, and final cleaning after completion (removing contamination such as loose wires, solder balls, solder splashes, flux, brush hairs, insulation particles, clipped part leads or any other loose particles in preparation for hardware closure.)

1.2.1. The engineering drawing shall specify any additional cleanliness or handling requirements.

1.2.2 The assembly drawing shall identify the components that need to be cleaned/conditioned prior to assembly.

2.0 Applicable Documents

MIT Specification and Standards

99-01003 Handling for Static Sensitive Electronic Parts
36-01316 Clean Tent Dressing, Behavior, Material Handling, and Bagging Procedure

Marshall Space Flight Center

MSFC-SPEC-1238	Thermal Vacuum Bakeout Specification for Contamination Sensitive Hardware
MSFC-SPEC-1443	Outgassing Test For Non-Metallic Materials Associated With Sensitive Optical Surfaces In A Space Environment

3.0 Requirements

3.1 Materials

3.1.1 Lint Free Wipes
Spec: Alpha 10 - Texwipe
3.1.2 1,1,1 Trichloroethane, Technical. (See Safety 3.3)
3.1.3 Ethanol (200 Proof). (See Safety 3.3)
3.1.4 Liberty Latex gloves, Class 100 pkg, model 677HP(Cleaning and handling, non ESD parts and assemblies)
3.1.5 Ansell Edmont Gloves, Nitrilite, (Handling ESD and Non ESD)
3.1.6 Texwipe Q-tips(non-cotton tip, no wooden handles)
3.1.7 Solvent containers shall be made of metal, glass or Teflon.
3.1.8 Dry, filtered nitrogen, grade 5 or better

3.2 Equipment

Equipment shall be as necessary to ensure conformance to the requirements of this specification.

3.2.1 Vacuum Cleaner, with hose and ESD controlled nozzle, minimum capacity of 1/3 cfm at sea level pressure.

3.2.2 Brush, nominal 3/8 to 1/2 inch width, non-scratching ferule, with no-shedding, 7/8 inch long (minimum), solvent resistant bristles. Brushes to be rinsed with ethanol, and loose bristles are to be removed prior to use.

3.2.3 Ionized, filtered dry nitrogen, grade 5 or better, supply with adjustable regulator at 30 psi maximum.

3.3 Safety

3.3.1 Precautions and safety information.
Personnel who work with solvents and other hazardous materials specified herein shall be familiar with the applicable Material Safety Data Sheets(MSDS).

Solvents defat skin and can cause dermatitis. Breathing of solvent vapors can harm body functions. Provide ventilation to the building exterior when necessary to prevent vapor concentrations in excess of federal maximum allowable concentrations, such that the solvent vapors do not cause breathing difficulty, eye irritation, dizziness or nausea.

Flammable liquids and their vapors must be kept away from open flames, sparks, furnaces, and other ignition sources.

Personnel should wear ultraviolet-absorbing eyeglasses when using an ultraviolet lamp.

3.3.2 First Aid
If excessive exposure occurs, the following first aid steps shall be taken until medical attention can be provided:

Eye contact	Immediately flush the eyes and surrounding area with cool water for 3 to 15 minutes.
Skin contact and	Immediately flush solvents from the skin with cool water. Wash with soap water. Apply skin lotion as necessary.
Breathing	Withdraw from the hazardous are.
Clothing	Remove if contaminated.

3.4 Sequence of Operations

The first level of solvent cleaning is "precleaning". The final level of solvent cleaning is "precision cleaning". Vacuum preconditioning applies to non-metallics as specified per MSFC-SPEC-1443. For cleaning and cleanliness control of components of the ACIS, the normal sequence of operation is:

Preclean as necessary prior to fit check, inspections, and other dirty operations.
Precision solvent clean and vacuum condition components prior to beginning final assembly.
Inspect cleanliness on hardware and reclean if necessary.
Vacuum bake specified components and assemblies.
Measure cleanliness of vacuum baked items.
Apply cleanroom procedures and handling controls as specified during assembly and test.
Periodically measure cleanliness of hardware and witness plates.
Prior to integration of the Electronic Boxes to XRCF, verify cleanliness to MSFC-SPEC-1238.

Exceptions to this normal sequence is made for cables and printed wiring assemblies (PWAs).

3.5 Work areas.

All cleaning operations, both cleaning and precision cleaning, shall be in areas rated as good housekeeping areas, or better. After precision cleaning all operations are to be in controlled work areas.

3.6 Bagging and Identification

Individual items shall bagged and marked per 36-01316, after precision cleaning of components and assemblies and when components and assemblies are moved outside controlled work areas. In addition, precision cleaned flight hardware will have adequate marking stating that it is clean flight hardware with the part number, date, and other information as required.

3.7 Cleaning

3.7.1 Machined Parts And Assemblies

3.7.1.1 Inserts

All locking helicoils that are used are to be precision cleaned and vacuum conditioned per APS 202, 203, or equivalent prior to installation. There should be no evidence remaining of the red coating from the helicoils.

Locking(excluding helicoils) and non-locking inserts, that will be installed into parts, including those that will be painted, shall be precleaned per APS 202, 203, or equivalent prior to the installation of inserts and application of paint.

(Equivalent method of cleaning (excluding locking helicoils) is flushing or ultrasonic cleaning thoroughly with ethyl alcohol and gently wiping with Q-Tips until no further residue appears on the Q-tip. Follow this with flushing with ethyl alcohol and blow drying with Nitrogen. (An initial vapor degreasing process prior to cleaning would be preferred along with a post thermal vacuum bake at 125C for 12 hours.))

There should be no visual evidence of grease, oils or fingerprints remaining when looked at under normal and UV light.

3.7.1.2 Panels, Complex Geometry's, Hardware

Threaded holes for inserts shall be precleaned per APS 202, 203 or equivalent prior to installation of inserts. Special attention should be addressed on blind tapped holes.

(Equivalent method of cleaning is soaking in 1,1,1 TCA, flushing with ethyl alcohol then ultrasonic cleaning thoroughly with ethyl alcohol and gently wiping tapped holes with Q-Tips until no further residue appears on the Q-tip. Follow this with another flushing with ethyl alcohol and blow drying with Nitrogen, and drying in a HEPA filtered Oven at 100 C in for one hour. (An initial vapor degreasing process prior to cleaning would be preferred along with a thermal vacuum bake at 125C for 12 hours.))

All hardware(screws, brackets, and other metallic parts) are to be precision cleaned per APS 202 or 203 and vacuum conditioned for 24 hours at 125 C prior to being used in the assembly.

There should be no visual evidence of grease, oils or fingerprints remaining when looked at under normal and UV light. There should be no residue visible on a Q-Tip when installed into threaded holes.(Carefully install Q-tip in a turning in the direction of the threads. Be careful not to break the Q-tip in the hole.

3.7.1.3 Installation of Inserts

Ethyl alcohol may be used during installation of inserts. Use of oils during installation of inserts is prohibited. Clean latex gloves shall be worn when handling precleaned inserts. Inserts are to be installed prior to application of paint. Contact surfaces of tools used to install inserts should be free of oil and grease. (Wipe with 1,1,1, TCA until no residue is evident on the wipe.)

After inserts are installed and prior to paint where applicable, materials are to be precision cleaned per APS 202 or 203. Metal parts with complex geometry's and blind tapped holes and inserts must be vacuum conditioned at 125 C for 24 hours, min.

3.7.1.4 Painted Surfaces

After cleaning as above, the panels are to be handled with clean latex gloves. Do not allow the panels to come in contact with oil or greasy surfaces.

After application of paint, surfaces can only be cleaned using Micro-Clean solution, or equivalent, in an ultrasonic bath for one minute, rinse with tap water for 2 minutes, then final rinse with deionized water for 2 minutes. Blow dry with Nitrogen at 20 psi. Dry in HEPA filter oven at 125 C for 1-2 hours then place in thermal vacuum chamber at 125 C max. for 72 hours min. Handle with clean latex gloves during all subsequent assembly operations.

3.7.2 Cables and Harnesses

All tools (crimping tools, tweezers, screwdrivers, etc..) to be used on previously precision cleaned hardware shall be periodically cleaned per 36-01316.

Prior to starting flight fabrication, all non-metallic parts (such as connectors (including connector savers), expando sleeving, tyewraps, Teflon shields, etc..) are to be cleaned and vacuum conditioned, at a minimum, per the time and temperature specified by MSFC-SPEC1443, and the CCE.

All metal parts (backshells, stainless steel braid, etc.) are to be precision cleaned and vacuum conditioned per APS 202,203 or equivalent or as deemed by the CCE.

Shrink tubing and marking shall be precleaned after marking and prior to installation onto the cable.

Prior to cable fabrication, wipe each cable with ethanol and alpha wipe until no signs of residue appears on the wipe. Prior to crimping of pins, ultrasonic clean the pins in ethyl alcohol followed by blowing dry with nitrogen. Also, ensure the crimping tool is clean.

Ultrasonic clean soldered connections in ethyl alcohol for five minutes, followed by nitrogen blow off, and air drying in HEPA filtered Oven for 1 hr min.

Prior to installation of shields and braids, the fabricated harness shall be precision cleaned and vacuum conditioned at Lincoln Laboratory per APS XXX. All shrink tubing shall be left unshrunk until after this vacuum conditioning.

After final harness fabrication, thermal vacuum harnesses for 72 hours at 85-90 C(TBR). After final vacuum bake, bag per 36-01316.

3.7.3 Printed Wiring Assemblies (PWAs)

All connectors used on the PWAs that will not be covered by conformal coat must be vacuum conditioned prior to assembly on to the PWA. All hardware used, that will not be covered with conformal coat, shall be free of grease and oils prior to installation.

After completion of assembly of the PWAs in accordance with the drawing requirements and prior to conformal coat and staking material, PWAs shall be solvent cleaned by vapor degreasing and vacuum baked for 16 hours at 80-85 C(TBR), unless other wise specified by the engineering drawing. Prior to the PWA bakeout the vacuum chamber shall be baked at 120 C, minimum, for 12 hours, minimum. Conformal coating shall be per 36-02024.

3.7.4 Electronic Box/Hardware Cleaning

After PWAs, cables and harnesses, panels, hardware, clamps, etc. have been cleaned and conditioned they will be installed per the assembly drawings. During the electronic box assembly contamination from particulates will occur from various types of processing. In order to maintain cleanliness, continued cleaning, inspection, and monitoring is required.

3.7.4.1 Solder splashes or solder balls adhering to interior surfaces shall be dislodged using a nonmetallic rod and removed in accordance with 3.7.4.2.

3.7.4.2. Loose particles such as loose wire, solder balls, solder splashes, brush hairs, insulation particles, clipped part leads, etc. shall be removed using vacuum equipment or dry nitrogen

3.7.4.3 Boxes shall be inverted, if necessary, to allow fallout of loose particles. Shake the box gently to allow fallout of particles that are lodged in inaccessible areas.

3.7.4.4 Particles lodged in tight clearance spaces which cannot be removed with a vacuum shall be removed using tweezers.

3.7.4.5 To remove flux, fingerprints, oil, grease, and other contamination from parts or assemblies which are neither conformal coated nor painted, use brush , wipe, or Q-tip saturated with trichloroethane . Excessive amounts of solvent shall be avoided to preclude contaminated solvent running into inaccessible areas. Remove all traces of solvent using wipes or swabs. Dry in accordance with 3.7.4.8.

3.7.4.6 For parts or assemblies which are conformal coated or for painted surfaces, clean in accordance with 3.7.4.5 except use ethyl alcohol and dry in accordance with 3.7.4.8. Excessive alcohol contact with painted surfaces shall be avoided.

3.7.4.8 Drying: After cleaning with solvents, but before packaging, items shall be dried 10 to 30 minutes at 150°F + 10°F in HEPA filtered oven. When oven drying is not practical, parts shall be dried with dry filered ionized, nitrogen or heat lamp.

3.7.5 Cleaning Static Sensitive Connectors

3.7.5.1External surface contamination shall be removed from static sensitive connectors or from connector dust covers by use of a vacuum cleaner or by use of a clean brush or wipe dampened with trichloroethane.

3.7.5.2 Static sensitive connectors contaminated with resinous materials (such as locking compounds or torque stripe) or lubricants on the external surface shall be cleaned in accordance with 3.7.5.1 except with a conductive cover or the mating connector installed. Connectors contaminated internally with such materials shall be subject to material review procedures.

3.7.5.3 Internal surface contamination such as dry particulate or water shall be removed from static sensitive connectors by use of a vacuum cleaner. (DO NOT ALLOW THE NOZZLE TO TOUCH THE CONNECTOR CONTACTS) or by purging with dry filered ionized, nitrogen. If these methods are unsuccessful, the contamination may be agitated by using a clean brush. The brush may be dampened with trichloroethane for removal of flux or other difficult-to-remove contaminate. DO NOT ALLOW SOLVENT TO FLOW IN THE CONNECTOR.

3.7.5.4 Cleaned connectors shall be dried using dry filered ionized,nitrogen. Complete drying may be expedited by 10 to 30 minutes at 150°F+ 10°F in a HEPA filtered oven.

3.8 Cleaning Materials and Solutions

3.8.1 Cleaning materials and solutions used for cleaning shall not cause etching or removal of material in excess of dimensional tolerances specified on the engineering drawing, or shall they effect the functional requirements of equipment.

3.8.2 Lint free wipes and Q-tips shall be used for final cleaning of hardware prior to closure to preclude further contamination of the hardware by the cleaning process.

CAUTION: TRICHLOROETHANE SHALL NOT BE USED TO CLEAN CONFORMAL COATED PARTS OR PAINTED HOUSINGS.

3.9 Non-Flight Parts

3.9.1 Connectors savers that are used must be cleaned and vacuum conditioned per APS 202 or 203. This is in the event that they are used inside the thermal vacuum testing prior to MSFC-SPEC-1238 certification.

3.9.2 All connectors, hardware, cables, etc. that are GSE that will be used inside the thermal vacuum testing must be conditioned and cleaned per APS 202 or 203.

3.10 Acceptance Criteria

3.10.1 Hardware cleaned in accordance with this specification shall have no visible evidence of moisture, physical damage, or (except as specified in the following paragraphs) particles, debris, and contamination. Any hardware with corrosion products shall be subject to material review procedures.

3.10.2 Hardware other than connectors shall be free of all visible contamination such as metal chips or metallic particles, scale, oil, grease, preservatives, adhesives, flux residues and any other foreign matter, in all areas that can be accessed. Non-metallic particulate contamination shall be acceptable when:

a. The particles are too small to be observed at 3X magnification.

-OR-

b. The particulate is embedded in the conformal coating material.

3.10.3 There shall be no unspecified, loose or extraneous parts, fabrication materials, tools or debris on or in the hardware to be closed.

3.10.4 Hardware which is not conformal coated shall be free from fingerprints. Fingerprints which are permanently imprinted on conformal coating are acceptable provided the finger oils and salts are removed from the hardware.

3.10.5 There shall be no damage to connectors that would interfere with proper mating/demating operations. There shall be no visible water, solder flux or other contamination in the mating face or end of any connectors. Particle contamination on the internal surfaces of a connector shall be acceptable when:

a. The particles are too small to be identified at 3X magnification.

OR

b. The metallic (plating flakes) or solid nonmetallic (dielectric flash, dust, lint, etc.) particles do not exceed one-third (1/3) the distance between conductive surfaces (pin to pin, or pin to shell) in their longest dimension.

c. Not more than one particle exists between two conductive surfaces, and particles exist in no more than five (5) scattered areas.

3.11 Box/Hardware Closure

When hardware has reached a point where closure is imminent, the final cleaning, inspection, and closure shall take place in an acceptable closing area.

3.11.1 The closing area shall be in a location that will see minimum transient personnel and equipment. It shall be isolated or shielded from other work stations to preclude any outside contaminants or debris from inadvertently entering the cleaned and open hardware to be cleaned.

3.11.2 The workstation where cleaning, inspection and closure are performed shall be clean and free of debris and loose particles (wire, clipped leads, etc.).

3.11.3 When the authorizing document specifies STATIC SENSITIVE or Special ESD controlled workstation, the closing area shall meet the applicable requirements.

3.11.4 Cleanliness of the hardware shall be verified by visual inspection prior to closure.

3.12 Maintenance of Cleanliness

After drying and verification of cleanliness, the hardware shall bagged be per 36-01316 in such a manner as to ensure that the specified cleanliness level is maintained until assembly into the specified end item is complete. Personnel shall wear gloves or finger cots when handling cleaned hardware. Cleaned hardware shall be protected using applicable ESD approved materials.

3.13 Rework After Closure has Occurred

If a box is reopened for rework or repair, the box shall be recleaned, reinspected and closed in accordance with the requirements of this process.

3.14 Maintenance cleaning procedures

3.14.1 Precleaned Items

Immediately following precleaning, observable surfaces of the cleaned items shall be inspected for visual cleanliness. These items shall meet the visible requirements of 3.17.1.

During all operations following precleaning, if visual inspections of the hardware show that surfaces do not meet the requirements of 3.17.1 maintenance cleaning shall be performed.

The cleaning procedures in table I are to be used.

Table I. Cleaning Procedures

procedure	item	cleaning	drying
A	all surfaces	gently blow off with ionized Nitrogen	Not applicable
B	all surfaces	vacuum clean, brush with clean brush	Not applicable
C	all except titanium	spot wipe with ethanol only	Blow-dry with ionized nitrogen
D	titanium only	spot wipe with acetone only	Blow-dry with ionized nitrogen

3.14.2 Precision Cleaned Items

Immediately after precision cleaning, inspectable surfaces of the cleaned items shall be inspected for visual cleanliness per 3.17.2. The precision cleaning process shall be proved to meet the particulate and NVR requirements per Table II.

Following precision cleaning and vacuum baking , maintenance cleaning shall be performed if visual or quantitative inspections of the hardware show that surfaces do not meet the requirements of 13.7.2. The cleaning procedures of table I shall be used. Care should be taken not to blow off particles onto adjacent surfaces.

3.15 Dirty operations

During operations such as drilling, insert replacement, fastener removal etc., the adjacent precision cleaned surface shall be covered with clean nylon 6 or static shielding NMD type bagging material. The bagging material should be tapped to itself with Kapton 3M 1205 tape. Particles released from the operation shall be collected by vacuum cleaner.

3.16 Cleanliness Monitoring

3.16.1 Monitoring During Assembly and Test.

At least weekly after precision cleaning, all surfaces of items which have been left unbagged or uncovered shall be visibly inspected and meet the requirements of 3.17.1
At time intervals not exceeding 3 months at least one NVR specimen and one particle count specimen shall be taken from randomly selected , accessible surfaces of the cabling and structures. These surfaces shall meet the NVR and particulate requirements of 3.17.2 and 3.17.3.

- A minimum of two contamination witness plates shall be maintained within three feet of the DEA and DPA during integration and test operations. At time intervals not exceeding 3 months at least one NVR specimen and one particle count specimen shall be taken from these witness plates. These surfaces shall meet the NVR and particulate requirements of 3.17.5.

3.16.2 Vacuum Bake and Cleanliness

Prior to environmental testing the DEA, DPA, Support Structure, and interconnect cabling shall be vacuum conditioned for 168 hours minimum at 80-85 C.(TBR)

Immediately following the assembly level vacuum bake, the ACIS will be integrated for thermal testing. In conjunction with thermal testing certification to MSFC-SPEC 1238 shall be performed per 36-XXXXX(TBD) Thermal vac bakeout, MSFC-SPEC-1238 Procedure.

3.17 End Process Requirements

3.17.1 Precleaned Items

There shall be no visually detectable foreign matter on the surfaces when inspected in accordance with 4.5.1.

3.17.2 Precision Cleaned Items

Visually clean. There shall be no visually detectable foreign matter on the surfaces when inspected in accordance with 4.5.1.

3.17.3 Quantitative Surface Cleanliness

Precision clean process items shall have NVR and particulate cleanliness meeting the requirements of Table II, when inspected accordance with 4.4 and 4.5.

4.0 Quality Assurance

The work areas, precleaning precision cleaning, baking and cleanliness operations shall be shown to meet the requirements of section 3.

4.1 Responsibility for inspection

The cleaning facility personnel shall be responsible for visual inspections. The assembly and test personnel will be responsible for visual inspections during assembly and test operations. Particulate and NVR measuring will be performed by the Contamination Control Engineer.

4.2 Visible Inspection

Surfaces which can be observed without the item disassembly shall be inspected visually without magnification using incandescent white light >or = 100 foot-candles illumination when viewed at a distance of 12-18 inches.

4.3 Ultraviolet Inspection

Surfaces which can be observed without item disassembly shall be inspected visually without magnification using an ultraviolet inspection lamp, 360 nm wavelength, illumination when viewed at a distance of 12-18 inches. This can also be used to aid in locating particles the removal of particles.

4.4 Particle counts

Particle counts shall be made in accordance with MIT procedure 36-xxxxxxTBD. The results shall be reported as the average number of particles having maximum dimensions greater than 25 microns per square centimeter and the average number of particles having maximum dimensions greater than 100 microns per 100 square centimeter

4.5 Non-Volatile Residue

NVR shall me made in accordance with36-xxxxTBD. The results shall be reported as the average weight per unit area in nanograms per square centimeter.

Table II. Particle And NVR Distribution.(TBR)

Item or Surface	NVR, ng/cm sq	average particle distribution	
		size> 25 microns	size>100 microns
internal surfaces	< 600	< 8 / cm sq	< 10/ 100 cm sq
external surfaces	< 800	< 12 / cm sq	< 15 / 100 cm sq