MIL-STD-1475
14 FEBRUARY 1974

MILITARY STANDARD

CONTAMINATION CONTROL TECHNOLOGY

PACKAGING PROTECTION OF PRECISION CLEANED MATERIEL

FSC 3694

DEPARTMENT OF DEFENSE
Washington, D.C. 20301

Contamination Control Technology

MIL-STD-1475

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Recommended corrections, additions, or deletions should be addressed to Commanding General, U.S. Army Missile Command, Standardization Division, AMSMI-RCS, Redstone Arsenal, Alabama 35809.

FOREWORD

The purpose of this document is to establish general data for operational and performance characteristics in standard form in accordance with DOD documentation criteria for use in contamination control technology relative to the logistic protection for precision cleaned materiel.

The information in this standard is an accumulation of existing documents, Governmental, Technical Society, and DOD contractor data which, after evaluation, is pertinent to the state-of-the-art.

Materials and procedures included are those used by military services and industry in the packaging of precision cleaned products and logistics procedures for packaging precision cleaned materials and items. These materials and procedures were considered in conjunction with their effectiveness in maintaining the required cleanliness level of a product from a controlled environment to its final destination.

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SECTION 1

SCOPE

1.1 Scope. This Standard establishes the minimum requirements for methods and procedures to be employed in the protection of precision cleaned materiel.

1.2 Selection of packaging procedure. Unless otherwise specified, the responsibility for selection of packaging procedure shall rest with the activity responsible for the end item.

1.3 Conflicts. In the event of conflict between the requirements of this standard and those of specifications or drawings, the conflict shall be resolved by the procuring agency or activity in accordance with established DOD procedures.

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SECTION 2

REFERENCED DOCUMENTS

2.1 Government.

2.1.1 Federal.

1. FED-STD-75, Glossary of Packaging Terms.
2. FED-STD-101, Preservation, Packaging, and Packing Materials, Test Procedures.
3. FED-STD-102, Preservation, Packaging, and Packing Levels.

2.1.2 Military.

2.1.2.1 Standards.

1. MIL-STD-648, General Design Criteria for Systems Shipping Containers.
2. MIL-STD-726, Packaging Requirements.
3. MIL-STD-794, Parts and Equipment, Procedure for Packaging and Packing of.
4. MIL-STD-1165, Glossary of Environment Terms (Terrestrial).
5. MIL-STD-1186, Cushioning, Anchoring, Bracing, Blocking, and Waterproofing, with Appropriate Test Methods.
6. MIL-STD-1246, Degree of Cleanliness and Clean-Room Requirements.

2.1.2.2 Specifications.

1. MIL-P-116, Methods of Preservation.
2. MIL-B-121, Barrier Material, Greaseproofed, Waterproofed, Flexible.
3. MIL-B-131, Barrier Material, Water Vapor Proof Flexible, Heat Sealable.
4. MIL-D-3464, Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification.

5. MIL-D-3716, Desiccants, Activated for Dynamic Dehumidification.

6. MIL-L-10547, Liners, Case, and Sheet, Overwrap; Water-Vaporproof or Waterproof, Flexible.

7. MIL-M-14077, Molding Plastic, Polytetrafluorethylene (TFE-Fluorocarbon Resin).

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9. MIL-G-81559, Preservation and Packing Procedures for Gryoscope Assemblies, Altitude and Directional Reference Instructions for Aircraft.

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2.1.3.1 Kennedy Space Center. Code: IS-SAT-1, John F. Kennedy Space Flight Center, NASA Kennedy Space Center, Florida 32899.

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2.1.3.2 Lyndon B. Johnson Space Center. Code: JSC/JM22, Houston, Texas 77058.

1. Contamination Control Program Requirements, Vol. 1, MSCM 5322, September 1970.

2. Definitions for Contamination Programs, MSC-STD-C-1.

3. Packaging of Precision Cleaned Parts/Components, MSC-PROC-C-100.

4. Precision Clean Packaging, MSC-SPEC-C-12.

5. Precision Packaging Materials Cleanliness, MSC-SPEC-C-25.

2.1.3.3 Marshall Space Flight Center. Code: S & E-S/P-S, Marshall Space Flight Center, NASA, Huntsville, Alabama 35812.

1. Contamination Control and Environmental Protection of Space Launch Vehicles and Associated Equipment, MSFC-PROC-151.

2. Electronic Parts and Components, Protection, Handling, and Packaging Of, MSFC-STD-343/3.

3. Film, Transparent, Plastic, LOX Compatible, Gas and Contamination Barriers, MSFC-SPEC-456A.

4. Laboratory Analysis of Intimate Wraps, Memorandum R-ME-MMC-96-64, George C. Marshall Space Flight Center, Huntsville, Alabama, 16 July 1964.

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7. Polytetrafluorethylene (Teflon) Molded and Extruded Parts, Sheets, Rods, and Tubing, MSFC-SPEC-236.

8. Tape, Pressure-Sensitive Adhesive for Preservation and Sealing, MSFC-SPEC-124.

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SECTION 3

GLOSSARY

3.1 Definitions

A.

Abrasion. The damage caused by the scuffing or friction of a part against its package, or of a package against an external object.

Abrasion-resistance. Ability to withstand the effects of repeated rubbing, scuffing and scratching.

Absorption. Penetration of a substance into the body of another; to take in and incorporate; assimilate.

Acceptable quality level. A nominal value expressed in terms of percent defective or defects per hundred units, whichever is applicable, specified for a given group of defects of a product.

Acid. A substance whose molecules ionize in water solutions to give off hydrogen ions; a substance which registers less than 7 on the pH scale.

Adherence. The state of adhering, or sticking together. The strength of an adhesive assembly or test specimen measured in such a manner that a large part of the loading stress is concentrated at or near the bone to produce apparent fracture in the band.

Adhesive. A material that initially is a fluid or is capable of being rendered fluid, to be spread on one or both surfaces to be bonded together for the purpose of forming a fluid or semi-solid interface across which affinities are established that hold the nearly contiguous surfaces together with a strength adequate for the end use.

Adhesive, Pressure sensitive. An adhesive which requires only briefly applied pressure at room temperature for adherence to a surface.

Agglomeration. The combining, joining, clumping, or clustering of two or more particles or droplets by any means.

Air-cleanliness class. Each class of air cleanliness is determined by the particle count per unit volume, based on tabulation of particles 0.5 micron and larger or 5.0 microns and larger.

Air shower. A chamber with interlocked doors and equipped with an exhaust system, having numerous air nozzles arranged in a predetermined pattern, for the purpose of forcibly blowing loose particles, fibers, dust, and other particulate matter from the person and garments.

Alkali. Any base or hydroxide that is soluble in water and can neutralize acids; a substance that registers more than 7 on the pH scale.

Ambient condition. Environmental conditions such as pressure, temperature, humidity, etc., which are normal for one specific location.

B.

Bag. A preformed container made of flexible material, generally enclosed on all sides except one which forms an opening that may be sealed after filling. May be made of any flexible material or multiple plies of flexible materials, or a combination of two or more materials.

Barrier Material. A material designed to withstand, to a specified degree, the penetration of water, oils, water vapor or certain gases, as desired. May serve to exclude or retain such elements without or within a package.

Blanket. Low pressure gas introduced into a container (or system) to provide an inert atmosphere.

Blocking. The physical phenomenon of a material sticking or adhering to itself due to temperature or pressure; an undesirable characteristic for packaging films at temperatures under 200° F.

Breaking strength. The ability of a material to resist rupture by tension. A measure of the strength of paper, fabrics, films and other materials.

C.

Carton. A form of package used in interior packaging made from bending grade of paperboard.

Case. A non-specific term for a container.

Case mark. Identification and shipping information on a shipping container.

Cavitation. The formation of cavities, such as the microscopic vacuum pockets created in a solution by ultrasonic energy (or any mechanical energy).

Certificate. A statement or certification, either affixed to or marked on a container, showing information concerning the container and its contents, usually in accordance with, and to show compliance with, the specification, rules and regulations of a shipping or regulatory agency.

Chemical cleaning. The term shall indicate pickling, passivating, descaling, deoxidizing and other cleaning processes where surface conversion or preparation is the prime objective.

Clean. That contaminant level just below that which adversely affects the operation or reliability of the part, component, system, or environment.

Cleanable. Capable of being cleaned to specified levels without detrimental effect.

Clean item. A part, component, or system which is wholly cleaned or has significant surfaces which have been cleaned and verified to a specified level of cleanliness.

Cleanliness level. An established maximum allowable distribution of contamination of a given size and quantity in a stipulated area or volume.

Clean packaging. The application of packaging measures and material to maintain the cleanliness of a clean item during handling, storage, or shipment. Clean packaging activities are performed in the clean room.

Clean room. A clean room is an enclosed area employing control as required. To meet the requirements of a "clean room", the area must meet the particulate count as specified in FED. STD. 209A, Paragraph 5.1.3.

Clean work station. A work bench or similar working enclosure characterized by having its own filtered air supply. The filters must be capable of providing the required air-cleanliness level.

Closure. A sealing or covering device affixed to or on a container for the purpose of retaining the contents and preventing contamination thereof.

Cohesion. The tendency of a mass to hold together.

Combustible contaminants. Flammable solvents, cleaning solutions, oils, paints, preservatives, wood, or other materials that are present in a component or system.

Complete blocking. Blocking or plugging which occurs when individual contamination particles are large enough to plug a clearance or orifice.

Component. A series of two or more parts, sub-assemblies, assemblies, or any combination thereof, which in turn becomes a piece of functional equipment or assembly.

Contaminant. Any material or substance which is unwanted or adversely effects the contaminee.

Contaminant level. A quantitative expression for the size, distribution, shape, quantity and physical properties of one type of particulate matter in a fluid.

Contaminant-sensitive part. A part whose function may deteriorate with the presence of materials other than those for which it was designed. The foreign material may be liquid, gaseous, or solid in nature, with size, number, or character harmful to the operation of the device.

Contaminate. The act of introducing any contaminant; to make impure or unclean; to pollute, defile, sully, taint, or soil.

Contamination control. The planning, organization, and implementation of all activities needed to determine, achieve, and maintain a required cleanliness level in, on, or around the contaminee.

Contamination tolerance level. The contamination level which cannot be exceeded and still allow components to have a specified performance, reliability, and life expectancy. Contaminant tolerance level would refer only to the influence of one type of contaminant.

Contaminee. That which is or can be contaminated. Contaminees may be products, materials, devices, people, gases, or surfaces.

Controlled area. Any enclosure which has a degree of control of contaminants in air, gases, and fluids (may include temperature, humidity, and pressure) and which will not qualify as a clean room.

Controlled environment facility. A specified working area that has the primary objective of controlling one or more physical, chemical, or biological variables.

Critical moisture content. The moisture content of a substance at which physical or chemical deterioration occurs to a degree sufficient to render the substance unusable.

Cushioning. (1) The protection from physical damage afforded to an item by placing about its outer surfaces materials that have been designed to absorb the shock or reactions caused by external forces. (2) Resilient materials used for cushioning.

D.

Decontamination. The process of removing unwanted matter; the reduction of contamination to an acceptable level.

Degreasing. Solvent cleaning, usually with hot vapor, for removal of grease.

Dehydrating agent. A material that has a high affinity for moisture and absorbs it from the surrounding air or fluid; a desiccant.

Desiccant. A dehydrating agent. A material which will absorb moisture by physical or chemical means.

Desiccant, activated. A desiccant which has been physically treated, by means such as heating, to produce the maximum capacity for absorption or adsorption of moisture.

Direct test. Any surface cleanliness test in which the parameter measured is the amount of soil remaining on a surface.

Dust preventive clothing. This clothing is specially designed for wear by all personnel who enter a clean room. Special particle/lint free clothing such as overalls, caps, gloves, finger cots, boots and shoes are primarily manufactured from synthetic fabrics and materials. Their purpose is to minimize contamination of clean rooms by particulate matter from an individual's skin, hair, clothing, and shoes such as dust, lint, dandruff, skin flakes, etc.

E.

Electronic sealing. Heat sealing of adjoining surfaces of thermoplastic films by high frequency electrical current.

Electrostatic. Pertaining to the phenomena due to attractions and repulsions of electrical charges.

Emission factor. A statistical average of the rate at which contaminants are emitted from any given source.

Entrapment. The act of securing and holding, as dirt is entrapped in a filter.

Environment. The total of all factors which might influence or cause contamination of a contaminee. The primary factors of environment are the forms air, gas, liquid, solid, or surfaces.

Environmental control. Environmental control is the positive control of atmospheric conditions within a specific area. It is a collective

term to identify the control of all factors of the environment of the clean room or clean work area. These factors include air temperature, humidity, air-borne particle control, pressurization, illumination, and injurious vapor control.

Environmentally adjacent. A condition in which packaging materials are not in direct contact with clean or significant surfaces but are exposed to these surfaces.

Environmental package. A clean material closure, wrap or container over the intimate package that is sealed to provide an additional contamination barrier to protect the intimate package and its contents from environmental elements.

F.

Filtration. The process of removing contaminants from a gas or liquid by passing them through a porous media.

First work location. The work location that is first in the path of the clean airstream.

Flush. Rinsing a component or system using a liquid or gas as the rinsing medium.

Foil. Unsupported thin metal membrane less than 0.006 inch thickness.

G.

Gas transmission. The movement of gas through film materials. The gas transmission property (Permeability) of a film is measured in terms of: volume of gas (at standard temperature and pressure) transmitted through a given area of film of a given thickness within a given time at specified temperature and relative humidity.

Gassing. (1) Removing air from a filled package, usually a metal can, and replacing it with another gas, such as carbon dioxide or nitrogen. (2) The action of a packaged product when producing gas.

Generated contamination. That contamination which is generated within the system components as a result of such actions as wear, cavitation, and erosion.

H.

Hermetic seal. A seal or closure that is airtight and impervious to external influences.

High efficiency particulate air filter(HEPA). MIL-T-51068A specified filters with minimum efficiency of 99.97 percent determine by the homogeneous DOP method at airflows of 20 and 100 percent of the rated flow capacity of the filter. It is referred to as the HEPA filter.

Horizontal laminar airflow clean room. A room equipped with one entire vertical wall of HEPA filters through which the air passes at a predetermined speed to an exhaust wall directly opposite the HEPA filter wall. The entire body of air moves hoizontally across the room along essentially parallel flow lines at uniform velocity.

Humidifier. A device which causes water vapor to be diffused into the atmosphere of an enclosure, as in a freight car, storage compartment.

Hygroscopic. Having the ability to readily absorb and retain moisture.

I.

Impact strength. Resistance of a material or product to shocks such as from dropping and hard blows.

Implosion. A bursting inward; the opposite of an explosion. When the cavitations in an energized solution collapse, implosion occurs.

Indirect test. Any surface cleanliness test in which the parameter measured is the amount of soil removed from a surface.

Inhibitor. A substance or agent which slows or prevents chemical reactions, such as those of corrosion, oxidation, adhesive deterioration, mold, etc., even though present only in small quantities.

Insulation. (1) Separation of bodies by means of non-conductors to prevent transfer of electricity, heat, sound, etc. (2) The material used for insulating.

Internal surfaces. Internal surfaces are defined as those surfaces of assemblies, subsystems, and ground support equipment that contact service medium (gases or liquids) during use.

Intimate cushioning. A clean material used to protect additional packaging materials from puncture or damage caused by the clean item.

Intimate package. A clean material closure, wrap or container that will have intimate contact with, or is environmentally adjacent to, the clean item or surface, and is sealed to provide a barrier to external contaminants ane environments.

K.

Kraft. A chemical wood pulp made by the sulphate process, or paper or paperboard made from such pulp. It is brown in color and is the strongest pulp product made from wood.

L.

Lading. The load or material packed in a shipping container or vehicle.

Laminant. An adhesive designed for the purpose of combining and bonding a combination of films, foils, plastics, papers or other material in sheet or web form.

Laminar airflow. Airflow in which the entire body of air within a confined area moves with uniform velocity along parallel flow lines.

Laminar airflow room. A room in which the laminar airflow characteristic predominate throughout the entire air space.

Laminated film. An adhered combination of two or more films or sheets made to improve overall characteristics.

Limited linting. The term limited linting applies to towels, garments, and other fabric materials which have been tested and proven to exhibit limited shedding or linting characteristics.

Localized clean operations. Operations conducted under locally maintained environment provided by tenting and conditioned air source.

Logistics. The procurement, maintenance, and transportation of materiel.

M.

Materials cleaning room. A materials cleaning room is a room immediately adjacent to the clean room, equipped with vacuum lines, ultrasonic cleaners, and other mechanical devices for cleaning parts, tools, and materials immediately prior to their entry into the clean room.

Membrane filter. Cellulose plastic porous membrane material with controlled pore sizes ranging from 5 microns downward to approximately 8 millimicrons, composed of 15 to 20 percent solid material and 80 to 85 percent void.

Microbe. An organism of microscopic or submicroscopic size, generally including viruses, rickettsiae, bacteria, algae, yeasts, and molds.

Micron. A unit of measurement equal to one-millionth of a meter or approximately 0.00003937 inch (e.g., 25 microns are approximately 0.001 inch).

Migration. Act of changing locations; moving from place to place, as fine dust is moved by air currents or agitation.

Mil. A unit of linear measurement, equivalent to 0.001 inch.

Moisture-vapor-proof. (1) Not affected by moisture or vapor. (2) A barrier to moisture as a liquid or vapor.

Mositure-resistant material. A material which will not readily absorb moisture when subjected to conditions of high humidity for extended periods of time.

N.

Noncritical surface. A surface of a fluid system which does not directly contact the service media.

Nonlaminar flow clean room. A room characterized by nonuniform airflow patterns and velocities.

Nonlaminar flow clean work station. A work station characterized by non-uniform air patterns and velocities.

Nonvolatile residue(NVR). Soluble (or suspended) material and insoluble particulate matter remaining after controlled evaporation of a filtered volatile liquid, usually measured in grams. Filtration is normally through a 0.45 micron or 0.8 micron membrane filter.

O.

Opacity. Resistance of a material or body to transmission of light. The degree of opacity of paper is measured by an opacimeter.

Operational periods. That period of time when an environmental test chamber is classified as a controlled work area. Such periods will normally commence with cleaning and inspection or inspection to the requirements operational readiness and continue to completion of test.

Organic. Designating any chemical compound containing carbon.

Overseal. A secondary closure to prevent undetected tampering with the primary closure. An example is a tear-off aluminum seal placed over the replaceable closure of a large metal container.

Overwrap. (1) A wrapper applied over a product, package, carton, box, etc. (2) (verb) To apply an overwrap.

P.

Packaging. The application or use of appropriate closures, wrappings, cushioning, containers, and complete identification to a single unit.

Packaging film. Any film or sheet material used as a packaging wrap or container, usually limited to thicknesses less than 10 mils.

Packaging, flexible. Packaging involving the use of such flexible materials as foils, films, paper, flexible sheeting, etc., to form the container.

Packaging material. Any substance used in or with a package, wrapping, container, closure, liner or coating, or a composition of matter derived therefrom.

Packing. The application or use of exterior shipping containers with the packages therein, together with necessary blocking, bracing, cushioning, weather-proofing, and exterior strapping or the shipping container to protect and preserve the integrity of the packaged item during shipment or extended storage.

Part. A part is defined as one piece of two or more pieces joined together which are not normally subject to disassembly without destruction of designed use.

Particle. A piece of matter with observable length, width, and thickness; usually measured in microns.

Particle counters. Automatic electronic devices designed to electronically separate, size, and count individual particles.

Particle size. Particle size is expressed as the apparent maximum linear dimension or diameter of the particle. The linear dimension is implied unless otherwise specified.

Particulate matter. The general term applied to matter of miniature size, with observable length, width, and thickness, and contrasted to non-particulate matter without definite dimension.

Permeability. Ability to be penetrated by gases or liquids.

Personnel cleaning chamber. A chamber equipped with shoe cleaning devices, vacuum lines, and other devices to remove dirt, dust, and lint from clothing prior to entrance into clean rooms.

Plasticizers. Chemicals added to rubbers and resins to impart flexibility, workability, and stretchability.

Plenum. An enclosed space in which the air pressure is greater than that of the adjoining outside area.

Potential of Hydrogen (pH). A symbol for the logarithm of the reciprocal of the hydrogen ion concentrations, expressed in gram atoms per liter of a solution; used to indicate acidity or alkalinity.

Precision cleaning. Final or fine cleaning accomplished in a controlled environment to remove minute quantities of contaminants to better than visual standards.

Precleaning. That cleaning which is accomplished outside of a clean area, for the purpose of removing contaminants such as rust, oxidation, grease, oil, heavy scale or soil deposits to control the amount of contaminants brought into the cleaning room.

Purge. To flow an inert gas or system media through a system (or line, tank, etc.) for the purpose of ridding the system of a residual fluid or for providing a positive flow of gas from some opening in the system.

Q.

Quality control (QC). A process or test oriented operation for obtaining or manufacturing a uniform product within specified limits.

R.

Radiation. The process of emitting radiant energy in the form of waves or particles.

Random flow clean room. Air enters the room through diffusers located on or near the ceiling and is exhausted through openings near the floor; air within this type room follows a random pattern.

Range. The difference between the maximum and the minimum of a set of variate values.

Reagent. A substance used to produce a characteristic reaction in chemical analysis.

Reliability. The probability that a system, subsystem, component, or part will perform its required functions under defined conditions at a designated time and for a specified operating period.

Residual flux. Waste products remaining as a result of welding or soldering.

Rinse test. A test to determine cleanliness by entrainment or by solution of soluble materials with a suitable rinsing liquid; the liquid is sloshed or agitated over the critical surfaces of the component to ensure entrainment of particles.

S.

Seal, pressure. (1) A seal that will retain pressure in the package. (2) A bone effected by pressure-sensitive adhesives.

Seal, pressure-sensitive. A package closure made by pressing together, manually or by pressure rollers or jaws, two areas which are coated with a special pressure-sensitive adhesive.

Shedding. (See Slough)

Shroud. (1) A protective cover of barrier material fashioned with a top, four sides and bottom.

Slough. To release particles of the base material as a result of flexure, erosion, or abrasion.

Smut. The accumulation of noticeable amounts of nonadherent reaction products on ehcmically treated metal surfaces, usually resulting from cleaning or etching.

Solvent. That solution or constituent of a solution which exhibits the capability to dissolve other substances through chemical action.

Static electricity. Stationery charges of electricity which sometimes develop on surfaces during handling or in maching operation. May cause undesired attraction, sparking, etc.

Storage life. The period of time during which a packaged product can be stored under specific conditions and remain suitable for use. Sometimes called SHELF LIFE.

Strength. The mechanical properties of a material which permit it to withstand parting or distortion under the application of force.

Surface tension. A phenomenon of molecular attraction between the

molecules of a liquid which tends to contract the exposed surface to the smallest possible area; expressed as dynes per centimeter.

T.

Tape, pressure sensitive. A type of tape that is coated with an adhesive which adheres under pressure and does not require moistening, heat, or solvent for activation.

Tensile strength. The resistance of a material to longitudinal tension stress.

Thermoplastic. Capable of being repeatedly softened by heat and hardened by cooling.

Translucent. Permitting passage of light but diffusing it so that objects cannot be seen clearly.

Transparent. Transmitting rays of light so that objects can be seen through the material.

Tuck. The folds which comprise the side walls of square and automatic-type bags, which are folded (tucked) in to permit the bag to be packed flat.

U.

Ultrasonics. The physical science of those acoustic waves that oscillate in the approximate range of 18 to 80 kHz.

V.

Vacuum seal. All air has been removed when seal is applied and this air free state can be maintained indefinitely.

Vapor. The gaseous form of any subtance.

Vertical laminar airflow room. A room equipped with ceiling HEPA filters, with a grated or perforated floor for the exhausting or air issuing from the ceiling filters; the airflow is vertical, and moves within the walled area along essentially parallel lines at uniform velocity.

Viable. Capable of living; growing, or developing; metabolizing.

Visibly clean. Freedom from surface particulate matter approximately 50 microns or larger and from all films other than known innocuous films.

Visual cleanliness. The degree of freedom from contaminants that may be detected by the unaided eye; special lighting effects, ultraviolet light, wipe test, water break test, and similar means may be used as techniques to determine visual cleanliness.

Volatile. Easily passing from a liquid into a gaseous state. Subject to rapid evaporation. Having a high vapor-pressure at room temperature.

Volatile corrosion inhibitor. A chemical which slowly gives off vapor that reduces or is inhibitive to corrosion; usually applied to paper used in packaging ferrous metal products.

W.

Water-tight. That quality of a container or package by which it prevents the passage of liquid water into or out of the package.

Work station. A work bench or similar working enclosure.

SECTION 4

ABBREVIATIONS

4.1 Abbreviations defined.

1. A.C.S. American Chemical Society.
2. ADCAD. Auto radiographic detection of contamination by absorption/desorption.
3. AMC. Army Missile Command and Army Materiel Command.
4. A/ft^2. Amperes per square feet.
5. ARP. Aerospace Recommended Practice.
6. ASTM. American Society for Testing and Materials.
7. ^oC. Degrees Celsius.
8. CEF. Controlled Environmental Facility.
9. $ft.^3/min$. Cubic feet per minute.
10. C.F.C. Consolidated Freight Classification.
11. cm. Centimeter.
12. CP. Chemically pure.
13. D.O.T. Department of Transportation.
14. emf. Electromotive force.
15. ^oF. Degrees Fahrenheit.
16. F.C.C. Federal Communication Commission.
17. ft./min. Feet per minute.
18. g. Gram.
19. GOX. Gaseous oxygen.
20. HEPA. High efficiency particulate air filter.

21. I.C.C. Interstate Commerce Commission.
22. I.S.O. International Standards Organization.
23. kc. Kilocycle.
24. KHz. Kilohertz.
25. KSC. Kennedy Space Center.
26. LOX. Liquid oxygen.
27. MAC. Maximum allowable concentration. Now referred to as TLV.
28. mg. Milligram.
29. mg/l. Milligram per liter.
30. mm. Millimeter.
31. JSC. Johnson Spacecraft Center.
32. MSFC. Marshall Space Flight Center.
33. MVTR. Moisture-vapor-transmission rate. (See WVTR).
34. NASA. National Aeronautics and Space Administration.
36. NPC. NASA Process Control.
37. NVR. Nonvolatile residue.
38. pH. Potential of Hydrogen.
39. P.I. Packaging Institute.
40. ppm. Parts per million.
41. lb/in^2. Pounds per square inch.
42. QA. Quality assurance.
43. QC. Quality control.

44. RH. Relative humidity.

45. SAC. Strategic Air Command.

46. TLV. Threshold limit value.

47. T.O. Technical Order.

48. _. Micron.

49. V. Volts.

50. W.G. Water gage.

51. wt. Weight.

52. WVTR. Water-vapor-transmission rate. (See MVTR).

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SECTION 5

GENERAL REQUIREMENTS

5.1 Introduction. The objective of precision clean packaging is to maintain the specified cleanliness level of the enclosed item. This is accomplished by the utilization of proper techniques and materials for maintaining the integrity of the precision cleaned item throughout handling, storage, and transportation until final assembly or use.

5.1.1 To maintain the required cleanliness level, inspection or testing techniques must be applied to both the materials used and packaging operations to verify that this cleanliness level is maintained. Personnel involved in packaging procedures must be provided information to aid in proper operation and control of equipment, work areas, and processes to assure optimum quality, maximum output and safe operating conditions.

5.1.2 The following requirements establish a quality clean packaging program to fulfill a particular need.

5.2 Applicability. Compliance with the quality requirements of the procuring activity is of the utmost importance. To insure conformance to these requirements, it is imperative that a quality assurance program is established and maintained.

5.2.1 It shall be the responsibility of the quality assurance department to assure that each requirement of contractual documents related to services be fulfilled through implementation of the written instruction within the procedures of the program. Quality assurance management shall assume the responsibility and shall initiate necessary action to assure that satisfactory instructions are written to comply with new requirements.

5.3 Requirements. The general control of facility cleanliness and systems shall be in accordance with the requirements established in this quality assurance program and according to specifications.

5.4 Packaging facilities. In order to accomplish its objectives, all clean packaging operations shall be carried out in a clean room or work area which will meet or exceed the cleanliness level required to prevent degradation of the cleaned item. The controls shall be capable of maintaining, as applicable, specified limits of particulate matter in the atmosphere, unwanted gases, relative humidity, and temperature. Any adverse changes in environmental conditions should be reported to the supervisor in charge of the area and utilization of the area will be discontinued until abnormality is corrected.

5.5 Clean room regulations.

5.5.1 Clean room garmets. Designated protective clothing shall be worn at all times by individuals entering the clean room. These garmets shall not be worn outside of the clean room or in the contaminated section of the change room.

5.5.1.1 Sampling. Two percent of each shipment of garments shall be tested to assure that the garments meet the particulate level for the clean room in which they will be worn. Particulate determination shall be conducted in an environment equal to or better than the environment where the garment was cleaned. Points of garments to be checked shall be in accordance with, or a method similar to that established by ASTM F51-65T or T.O. 00-25-203. Clean room clothing shall be worn by all personnel in the inspection area, and gloves shall be worn while handling the garment.

5.5.1.1.1 Visual inspection. Garments and accessories shall be inspected for needed repairs, missing snaps, and broken zippers. Any evidence of the breakdown of fabric in the garment shall be cause for rejection of the garment. Sample garments shall have no visible hydrocarbons such as oil stains or grease.

5.5.1.1.2 Particulate count. Methods of particulate sampling and microscopic counting methods shall be performed with or a method similar to that established by ASTM F51-65T or T.O. 00-25-203. The manual method for sizing and counting particulate contaminants is used for determining the detachable particulate contaminant five microns or larger, in and on the fabric or clean room garments.

5.5.1.2 Intimate packaging. All garments shall be packaged individually in a polyethylene bag hermetically sealed in the clean room prior to exposure to an uncontrolled environment. Packages are to be opened cautiously so as not to shred or slough bag.

5.5.2 Visitors. Clean rooms are restricted areas and access to them shall be limited to authorized individuals. Visitors to the clean room shall observe all the rules to which the clean room employees are required to adhere.

5.5.3 Materials and operations. The following general rules shall be enforced to assist in the successful operation of the clean room.

5.5.3.1 Paper materials. Paper materials of any type shall not be allowed within the clean room until an analysis has been made by the Quality Assurance labs to determine its particulate count. No ordinary paper pads, notebooks, manuals, or writing paper of any description will

be permitted in Class 100,000 or better clean rooms. No ordinary writing pencils, pens, erasers, crayons, or chalk will be permitted. Notes and records shall be kept on lint-free watchmaker paper, plastic sheet, or equal, using ball point pens or other suitable non-dust generating materials. Blueprints, work specifications and other instructions shall be printed on plastic or covered with plastic film or other lint-free, non-dust generating materials. At no time shall paper in any form be torn or multilated within a clean room. Paper towels and cloth towels are prohibited in the clean room, personnel and material cleanup rooms, and locker rooms.

5.5.3.2 Tools and fixtures. Small hand tools used in the clean room shall meet clean room requirements. The tools shall be cleaned prior to entry into the clean room and at scheduled intervals. The exact schedule shall be determined on an individual basis. All cutting devices shall be maintained in sharp condition to minimize particle generation and ragged material edges. All tools shall be constructed of corrosion-resistant metals such as stainless steel or minimum particle-generating materials. Tools containing rubber or wood shall not be used. Tools with plating on striking cutting or other working surfaces which are subject to flaking or chipping are prohibited except when specifically authorized. All serrated or knurled-jaw holding tools, such as pliers, pipe wrenches, vise grips, and vises shall have their jaws padded with soft metal or other suitable protection. The use of adjustable tools is prohibited where fixed tools are available such as the use of adjustable wrenches in lieu of fixed open-end or box wrenches. All tools will be cleaned periodically to the clean room standards and all tools with working wear surfaces such as scissors, pliers (working joints), etc., shall be cleaned more frequently such that these tools are maintained as clean as tools without working wear surfaces (soldering aids, tweezers, hammers, etc.) and all tools are maintained to clean room standards. Precision instruments such as microscopes having working wear surfaces which are little used and/or under very little stress shall be considered as tools without working wear surfaces for purpose of frequency of cleaning. Only approved lubricants shall be used.

5.5.3.2.1 Tools shall be kept in drawers, wire baskets, or on tool racks. Tools shall not be kept in toolboxes, felt-lined cases, or leatherette cases. Tools shall always be supported when not in use in such a manner that they cannot pick up nor transfer contaminants. This shall be accomplished by hanging or supporting tools or wire mesh racks or on holding fixtures. Work-holding fixtures shall be readily cleanable, and shall support the work piece firmly in such a manner that it does not touch the work surface. Parts baskets, and tool racks used within clean facilities shall be of round wire or rod, open construction, and with hard, smooth surface finishes. Racks of this type facilitate laminar airflow and minimize the collection of airborne contaminants.

5.5.3.3 Containers. The selection and cleaning of material handling equipment is of the utmost importance. Cleaned smooth sided tote boxes containing a wire mesh base or holding fixture in the bottom, a see-through cover, shall be used for normal handling. Care shall be taken to prevent the transporting of contamination from surface to surface in the clean room by containers.

5.5.3.3.1 In instances where the size or weight of an object necessitates its being taken into a clean room by mechanized conveyances such as dollies, lift trucks, or cranes, such vehicles used for this purpose shall be hydraulic and hand-operated, or propelled by battery-powered motors to reduce the airborne and surface contamination caused by such devices. This equipment shall be maintained at an appropriate cleaned condition and all such equipment shall be retained in a semi-clean room adjacent to the clean room. This semi-clean room shall be used to unpackage cleaned items or clean uncleaned items prior to introduction into the clean room. It shall also serve as a transfer point for handling with cleaned heavy equipment.

5.5.3.4 Exhaust facilities. Cleanup of parts, test equipment, and test hardware shall be accomplished in the airlock or other outside facility prior to being moved into a packaging area. The clean room must be free from all oil and grease not specifically authorized. Exhaust facilities shall be used when working with gage fluids, epoxies or other toxic chemicals. Operations such as lapping, filing, and deburring shall be prohibited in the clean room areas unless all contamination is isolated and exhausted from the areas by use of individual enclosed exhaust hoods designed for use in clean room and clean work areas.

5.5.3.5 Operations. All work shall be done on a clean surface and never on any substance which could transfer contaminants to the work piece. Only approved, clean, low-lint wiping cloths or clean polyurethane wipers shall be used for any cleaning operations. Compressed gas shall be supplied from a source which is equipped with properly maintained dehydrators and filters for removing contamination.

5.5.3.5.1 In-process storage. Items which are not packaged or closed immediately after cleaning shall remain in the clean room and be further protected where practical by containers and covers to exclude possible contamination and unnecessary handling. Items being worked on in a more or less continuous manner while in the clean room shall be covered or closed during periods of inactivity. Protective covers on clean materials shall be resealed if the contents will not be withdrawn for a significant period or if they are transported from one clean area to another. Storage of any excess items shall not be permitted in the clean room.

5.6 Personnel. Employees' attitudes are of prime importance. They shall be instructed to consider everything including their immediate work area as being contaminated, and shall be capable of recognizing the common types of contamination. They shall be advised to report any of this type contamination to their supervisor, and they shall also consider any work or tools dropped on the floor as being contaminated. Any work or tools which they consider to be contaminated shall be reported to their supervisor. Personnel shall restrict their movement as much as possible to prevent stir-up of settled particulate matter on the clean room floor, especially near another's work area.

5.6.1 Selection. Personnel selected for training to work in clean room facilities where high order of cleanliness is required shall meet the following requirements:

(a) Non-allergic to conditions, materials, or solutions used in the controlled environment.

(b) Psychologically suited for the environment; that is, no evidence of claustrophobia or nervous conditions such as itching or scratching.

(c) Willingness to follow rigid rules for dress, behavior, and personal hygiene required by the degree of contamination control.

(d) No physical disorders that tend to raise the contamination level above established normal levels such as excess skin flaking, dandruff, nasal discharge, respiratory diseases, or high amounts of acid in moisture of hands.

(e) Ability and willingness to follow specifications and procedures without deviation or substitution in performing a required operation, process, or sequence.

5.6.1.1 Personnel failing to meet the requirements above shall be ruled ineligible to work with contamination sensitive articles within a controlled environment facility. All personnel selected to work in an activity that will bring them in contact with contamination sensitive articles shall successfully complete a qualifying training program.

5.6.2 Regulations. The following regulations in regard to clean room personnel shall be considered:

(a) Personnel having mustaches or beards shall be required to wear a cover of some type; either face mask or hood with just eye openings.

(b) Hair shall not be combed in the clean room and shall be confined under caps or hoods.

(c) Fingernail polish and cosmetics shall never be worn or applied in the clean room.

(d) Jewelry in the form of large rings, necklaces, earrings, lockets, watches, bracelets, shall not be worn.

(e) Valuable items such as wallets may be carried into the clean room in street clothes pockets, provided that they are not removed inside the clean room. Personal items, such as, keys, coins, cigarettes, matches, handkerchiefs, watches, tissues, and combs shall not be allowed to enter the clean room.

(f) Eating food, chewing gum or tobacco, or smoking in the clean room shall not be allowed.

(g) Nervous relief type mannerisms, such as, scratching head, rubbing hands or parts of the body, or similar type actions shall be avoided.

(h) The specified protective clothing shall be worn in the prescribed manner.

(i) Finger cots or gloves shall be worn if required, or if an employee's hands are severely chapped.

(j) Glasses, if worn, shall be washed and dried with a lint-free towel.

5.6.3 Personal hygiene requirements. All personnel shall receive periodic indoctrination on the importance of personal hygiene in clean room operations. All clean room personnel shall practice clean room habits and observe clean room regulations to maintain a healthy environment. Personnel with colds, temporary coughing, sneezing, or severe subburn shall be assigned to temporary jobs outside the clean room until they are recovered. Clean room personnel shall take all necessary precautions against receiving severe cases of sunburn in order to prevent peeling skin from contaminating a part of the surrounding area. The high degree of cleanliness required necessitates the indoctrination of all clean room personnel in the development of the following habits:

(a) Bathe frequently.

(b) Shampoo hair weekly and take action against heavy dandruff.

(c) Wear clean under and outer garments to insure maximum cleanliness.

(d) Avoid scratching or rubbing exposed areas of the body.

(e) Male personnel are to shave daily.

(f) Hands, fingernails, and face shall be kept clean.

5.6.4 Personnel indoctrination. In order to achieve and maintain a high degree of cleanliness and contamination control, it is imperative that all personnel involved in the precision packaging of contamination sensitive articles are properly trained in contamination control and precision packaging techniques. The organization of a training program shall incorporate factors encouraging human motivation into its design. Clean room personnel shall be fully aware of their responsibilities and the consequences of their actions.

5.6.4.1 Training course outline. A minimum course of instruction for all personnel whose activities may bring them in contact with contamination sensitive articles and the packaging of these articles shall contain, as a minimum, the following elements:

(a) Definition of terms associated with contamination control and precision packaging.

(b) A presentation of the need for contamination control and the consequences of contamination.

(c) A discussion of the origin and types of contamination including internal sources created by manufacturing, handling, or packaging activities, external sources present in the prevailing environment, and personnel-created contaminants.

(d) A presentation of the devices and techniques used to achieve and control cleanliness during precision packaging including applications and limitations including:

(1) Various classes of controlled environments, clean rooms, clean work stations, and their design criteria.

(2) Personnel control and occupancy in controlled environments.

(3) Apparel and laundering.

(4) Clean packaging materials and procedures.

(5) Tamper-proof seals on clean closures.

(6) Methods of measuring and verifying contamination levels.

(7) Opening and closing of containers and wraps.

5.6.4.2 Instructors. They should be trained in clean room procedures and clean packaging techniques and should possess current clean room certification.

5.7 Cleanliness verification of packaging materials. Inspection or testing techniques shall be applied to verify that the specified cleanliness level of a precision packaged item is maintained. One type of verification procedure involves monitoring the cleanliness of the intimate packaging materials prior to use and observing precision packaging practices during subsequent packaging operations.

A method for monitoring the cleanliness of clean packaging films is set forth in MSC-SPEC-C-25. The surface cleanliness requirements required by this specification are presented in Table I.

TABLE Ia

Precision packaging materials surface cleanliness requirements

Particulate Distribution Per Square Foot of Surface Tested			Nonvolatile Residue Per Square Foot of Surface Tested
Level	Size Range[3] (Micron)	Quantity[3] (Maximum)	Maximum (mg)
1[1]	0-5	Not Counted[2]	1
	5-15	40	
	15-25	20	
	25-50	6	
	>50	0	
2	0-5	Not Counted[2]	1
	5-15	50	
	15-25	25	
	25-50	10	
	50-100	5	
	>100	0	
3	0-10	Not Counted[2]	1
	10-25	300	
	25-50	50	
	50-100	10	
	100-175	5	
	>175	0	

Note 1 - Level 1 shall apply only to nylon films.

Note 2 - Particles in this range are not counted; however, any obscuring of the filter grid lines shall be cause for rejection.

Note 3 - The particulate size ranges and quantities specified are designed for certain NASA applications. Requirements for other uses may differ and should be specified accordingly.

5.7.1 Visual inspection. No evidence of oil, grease, water, solvents, paints, ink, dirt, metal chips, decals, perservatives, or other foreign matter shall be permitted on either the external surfaces or the internal surfaces of packaging materials when inspection is made with the unaided eye.

5.7.2 Ultraviolet light inspection. The external and internal surfaces of metallic closures shall be examined for evidence of fluorescence under ultraviolet light. Fluorescence areas that continue to fluoresce after hand wipe cleaning with solvent shall not be rejected.

TABLE Ib

Surface Cleanliness Levels

TYPE OF WORK	CLEAN-LINESS NOTE 1	LIGHTING FOOT CANDLES NOTE 2	AIR TEMPERA-TURE NOTE 3	RELATIVE HUMIDITY NOTE 4	DUST CONTROL NOTE 5	VENTILA-TION OR EXHAUST NOTE 6	NOISE NOTE 7 dbA	HABITAT
MACHINE SHOP								
TOLERANCE TO 0.01	CLASS D	70	60-100°F	U	CLASS D	NOTE 6	90	NOTE 8
TOLERANCE TO 0.001	CLASS C	100	65-95°F	U	CLASS C	NOTE 6	80	NOTE 8
TOLERANCE TO 0.0001	CLASS B	200	65-85°F	70% MAX.	CLASS C	NOTE 6	80	NOTE 8
TOLERANCE FINER THAN 0.0001	CLASS BA	500	65-75°F	60% MAX.	CLASS B	NOTE 6	75	NOTE 9
PROPELLANT, CHEMICAL AND POTTING AREA	CLASS B	100	65-95°F	60% MAX.	CLASS B	NOTE 6	80	NOTE 9
PLATING AND HEAT TREATING	CLASS C	70	55-105°F	U	CLASS C	NOTE 6	90	NOTE 8
ELECTRONIC ASSEMBLY	CLASS B	100	65-95°F	30-70%	CLASS B	NOTE 6	75	NOTE 9
MECHANICAL ASSEMBLY								
TOLERANCE TO 0.05	CLASS C	100	65-95°F	U	CLASS C	NOTE 6	75	NOTE 8
TOLERANCE TO 0.001	CLASS B	100	65-95°F	U	CLASS C	NOTE 6	75	NOTE 8
TOLERANCE TO 0.0001	CLASS BA	200	65-85°F	70% MAX.	CLASS B	NOT REQ	70	NOTE 9
TOLERANCE FINER THAN 0.0001	CLASS A	500	65-75°F	30-50%	CLASS A	NOT REQ	70	NOTE 9
INSPECTION STATIONS	EQUAL TO PRODUCT INSPECTED							

1. CLEANLINESS DEFINITIONS
   a. Class D – – Daily Cleanup: Removal of scrap, clean up all spilled oil, etc.
   b. Class C – – Prompt Cleanup: Scrap, oil and residue shall not be allowed to accumulate.
   c. Class B – – Prompt Cleanup: Oil, residue, spilled chemicals removed immediately. Floors, walls and work area shall have hard, grease-resistant, easily cleaned surfaces. Cleanup of equipment and area shall be accomplished after each 24 hours of operation.
   d. Class BA – – Oil, residue, spilled chemicals, and any foreign material which might develop in the area shall be cleaned immediately. Floors, walls, furniture and work areas shall have hard, grease-resistant, easily-cleaned surfaces. Materials to be worked on shall be cleaned of all foreign material prior to acceptance into this area. Flushing or cutting fluids shall be filtered to remove contamination above 30.0 microns. Chips, particles and dust generated during any and all mechanical operation shall be removed during the operation by vacuum. Clean, lint-free smocks are required for operators and inspectors. Complete cleaning and wipe-down of equipment, tools, fixtures and the area shall be accomplished at the end of each 8 hours of operation or each 24-hour period.
   e. Class A – – Cleanliness controlled in accordance with FED-STD-209. Class 100,000.
2. LIGHTING
   Indicated values are minimum light intensity values at the work station. Supplemental lighting shall be used when necessary to improve precision and minimize operator fatigue, but brightness ratios within the operators field-of-view shall not exceed 10 to 1.
3. AIR TEMPERATURE
   Designated temperature limits are the daily average temperature measurements taken in proximity of the work stations.
4. RELATIVE HUMIDITY
   Designated relative humidity shall be as measured at room ambient temperature. "U" indicates uncontrolled relative humidity.
5. DUST CONTROL DEFINITIONS
   a. Class D – – No dust control required.
   b. Class C – – Outside air shall be filtered to remove dust particles. Type of filter is unspecified.
   c. Class B – – Outside and recirculated air shall be filtered to remove dust particles. Filter rating shall be 10 micron maximum.
   d. Class A – – Dust control shall be in accordance with FED-STD-209, Class 100,000.
6. VENTILATION OR EXHAUST
   Forced ventilation or exhaust shall be provided whenever required to minimize operator fatigue.
7. NOISE
   Noise is defined as the average sound level existing at the work station during normal operation when measured with a standard sound-level meter as specified in ANSI S1.4-1971 "A" weighted. Work stations for control of automatic equipment operations, which requires operator loading and unloading only, may exceed the noise limits specified by 10 dbA but not to exceed 90 dbA. Inspection and test work stations shall not exceed the values specified. Work areas for mechanical assembly of tolerances finer than 0.001 which utilize laminar flow benches may exceed by 5 dbA the value specified.
8. HABITAT
   No eating, drinking or personal grooming is allowed in these work areas. Drinking fountains are permissible.
9. HABITAT
   No eating, drinking, smoking or personal grooming is allowed in these work areas. Drinking fountains are permissible.

5.7.3 Rinse test inspection. Bags for precision packaging applications shall be sampled in accordance with the following requirements, unless otherwise specified.

5.7.3.1 Preparation. The open end of the bag shall be heatsealed. Using surgical scissors or sharp blade, cut off one corner of the bag so that an opening not over 3/4 inch in length is created.

5.7.3.1.1 Plastic tubing bags shall be sealed at both ends of a length to give an inside test area of approximately one square foot and sampled for rinse test as for bags.

5.7.3.1.2 Plastic film (flat roll stock) shall be cut carefully with surgical scissors or a sharp blade to a length of 12 inches. The section shall be folded in half, sealed into a bag form in such a manner as to minimize exposure of the interior to airborne particles, and sampled for rinse test as for bags.

5.7.3.2 Rinsing. Through the opening created in preparation for the rinse test, 100 ml of solvent (MSFC-SPEC-237A) per square foot of interior surface shall be introduced from a wash bottle or similar apparatus. 100 ml of solvent will be utilized on bags having less than one square foot of surface area. The opening shall then be closed. The exterior of the bag shall then be rinsed down with the same agent to prevent exterior particles from being picked up when the bag is decanted. The cleaning agent within the bag shall be agitated by a gentle but rapid sloshing.

5.7.3.3 Collection of sample. The cleaning agent within the bag shall be poured out through the same opening, held shut during rinsing or outside, onto a microporous 0.45 or 0.8 micron membrane filter, 47 mm diameter.

5.7.3.4 Testing. The effluent of the rinse test shall be examined for particulate matter by the particle count method in accordance with ARP 598, MSC-SPEC-C-14, or equivalent. The nonvolatile residue of the solvent rinse shall be determined in accordance with ASTM D-2109-64. Individual bags or pieces of material tested for cleanliness shall not be used to package precision cleaned items.

5.7.3.4.1 Particle count method. Particles are to be counted and tabulated in the following order: fibers, particles greater than 100 microns, 50-100 microns, 25-50 microns, 15-25 microns, and 5-15 microns. This method shall not be used for counting particles smaller than 5 microns. Fibers are counted as particles unless their length exceeds 100 microns. The size of a particle is determined by its greatest dimension.

Apparatus needed for this method includes:

(a) Binocular microscope with ocular-objective combinations to obtain 40 to 45X and 90 to 150X magnifications. The latter objective shall have a numerical aperture of 0.15.

(b) Normal counter.

(c) Microscope lamp, high intensity.

(d) Ocular micrometer scale.

(e) Stage micrometer, standard 0.01 to 0.1 mm scale.

Absolute counting of particles shall be accomplished as follows:

(a) Using forceps, position filter disc on filter disc holder and place on microscope stage.

(b) Adjust the microscope lamp intensity to obtain maximum particle definition.

(c) A magnification of approximately 45S shall be used for counting particles 25 microns or larger, approximately 90X for particles smaller than 25 microns.

(d) Using the microscope's horizontal and vertical traversing stage adjustments, systematically scan and count all particles on the entire filtering area of the filter disc, scanning each specified size range separately.

(e) Record results of particle count of appropriate data sheet and validate by initials or quality control stamp.

5.7.3.4.1.1 Statistical methods may be employed provided that the method shows agreement with the values of certified standard samples. To obtain the number of particles of a given size range, the number of particles on a representative number of grid squares on the filter disc is counted. From this count, the total number of particles which would be present statistically on the total effective filtration area of 100 imprinted grid squares is calculated.

(a) Using forceps, position filter disc on filter disc holder and place on microscope stage.

(b) Adjust the microscope lamp intensity to obtain maximum particle definition.

(c) Using the microscope's horizontal and vertical traversing stage adjustments, rapidly scan the filter disc to assure that particulate contamination is evenly distributed. Estimaate the particulate population before proceeding with a count.

(d) If the total number of particles of a given particle size range is estimated to be between 1 and 50, count the number of particles over the entire effective filtering area.

(e) If the total number of particles of a given particle size range is estimated to be over 50, count the number of particles in 20 randomly-chosen grid squares and multiply this number by 5 to obtain the total statistical particle count.

5.7.3.4.2 Nonvolatile residue of solvent. The methods presented in ASTM-D-2109 shall be used for determining the nonvolatile matter in halogenated organic solvents and admixtures thereof.

5.8 Receiving inspection. In addition to monitoring the cleanliness of packaging materials and operations, the effectiveness of clean packaging is also verified by monitoring the cleanliness of the part immediately after its removal from the clean package. The receiving inspection, required by the quality control provisions established for the effected item, shall be performed in a clean area by qualified and authorized receiving inspection personnel. Receiving test sample packages shall be selected at random to determine that the requirements are being met on a quality control basis.

Tables IIa and IIb provide a uniform criteria for specifying and determining product for specifying product cleanliness, based on contaminant size, distribution, and count.

The cleanliness levels of Tables IIa and IIb shall apply to surfaces, assemblies, components, or fluids. The following units of measure shall be used:

(a) Surfaces - Particles categorized by size and count per square foot of significant surface area. Nonvolatile residue in milligrams per square foot of significant surface area.

Note: Area may be estimated. Particle counts may be determined statistically as provided in para. 5.7.3.4.1.1.

(b) Assemblies and components - Particles categorized by size and count per square foot of significant surface area. Nonvolatile residue in milligrams per square foot of significant surface area.

Note: Areas less than one square foot shall be considered as one square foot. Area may be estimated.

(c) Liquid - Particles categorized by size and count per 100 milliliters of fluid. Nonvolatile residue measured in milligrams per 100 milliliter of fluid sample.

(d) Gas - Particles categorized by size and count per cubic foot of gas.

5.8.1 Cleanliness inspection techniques. Various tests and techniques are used to verify the cleanliness of a precision packaged item. Table III presents the techniques required by MIL-STD-1246 for testing of cleanliness of surfaces, assemblies and components, liquids and gases. These tests, of demonstrated equivalents, may be used. Other inspection techniques which may be considered for use are described in the following sections.

5.8.1.1 Visual inspection. External surfaces and accessible internal surfaces shall be visually inspected for contaminants such as particles, moisture, corrosion, scale, and oil. A special light source or borescope is needed to inspect internal surfaces.

5.8.1.2 Microscopic inspection. External surfaces shall also be inspected with a microscope to verify surface cleanliness.

5.8.1.3 Purging. In some systems or assemblies, internal and inaccessible surfaces and confined areas shall be monitored by administering a purge gas and testing the gas as it is expelled from the system. A dry, filtered, inert gas shall be used for this purpose. The three contaminants most commonly monitored by this method are:

(a) Particulates - Particulates are entrapped on a membrane filter and sized and counted by use of a microscope and ocular micrometer.

(b) Moisture - Moisture is measured by a moisture meter in parts per million by volume, by the dewpoint method in degrees celsius (C) or other acceptable methods.

(c) Condensable hydrocarbons - Condensable hydrocarbons are measured by the scrubber method or other acceptable method.

5.8.1.4 Continuity check. Electrical components and assemblies shall be given a continuity check.

5.8.1.5 Functional test. Functional tests, although not considered a true test of clean packaging effectiveness since it does not consider handling damage or contamination introduced during assembly, may be sufficient for some applications. Functional tests involve removing clean packaged components from their packages, assembling them into a system, and conducting a functional test of the complete system.

5.8.2 Rejection and retest. Failure of any test sample to conform to any one of the requirements of the receiving inspection shall be cause for rejection of the lot represented. Hardware which is rejected shall

TABLE II

Classification of product cleanliness levels

Table IIa			Table IIb Non Volatile Residue	
Cleanliness Level	Range Surface and Fluids	Quantity of Particulates	Level	Quantity NVR
10	5	Less than 3	A	Less than 1.0 mg
25	5 15 25	21 Less than 4 1	B	1.0 mg to 2.0 mg
50	5 15 25 50	180 25 7 1	C	2.0 mg to 3.0 mg
100	15 25 50 100	280 75 11 1	D	3.0 mg to 4.0 mg
200	15 25 50 100 200	4100 1100 180 16 1	E	4.0 mg to 5.0 mg
300	25 50 100 250 300	7000 1000 90 3 1	F	5.0 mg to 7.0 mg
500	50 100 250 500	11000 950 25 1	G	7.0 mg to 10.0 mg
750	100 250 500 750	6500 170 7 1	H	10.0 mg to 15.0 mg
1000	250 500 750 1000	1000 45 7 1	J	15.0 mg to 25.0 mg

be reprocessed and resubmitted for acceptance. All items shall be repacked to maintain cleanliness, whether or not they are rejected, in order to minimize possible rework costs.

TABLE III

Procedures for measurement of cleanliness levels (MIL-STD-1246)

Surfaces, Assemblies and Components	Liquids	Gases
ASTM-F-24	ASTM-D-2391	SAE-ARP-743
ASTM-D-2429	ASTM-D-2390	ASTM-F-25
ASTM-D-2391	SAE-ARP-598	ASTM-D-2544
ASTM-D-2390 or		ASTM-D-2390
SAE-ARP-598		

5.8.3 Log book record. A log book record shall be maintained of all incidents of opening packages or closures for inspection purposes to insure traceability in the event contamination should occur. The record shall show the date, responsible person, reason for opening, the condition of reclosing, and the disposition of the article.

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SECTION 6

PACKAGING PROCEDURES

6.1 General procedures.

6.1.1 Requirements. These procedures apply to hardware cleaned for hydraulic, fuel, oxidizer, or related pneumatic systems.

6.1.2 Materials.

Fluorohalocarbon film, 2-mil, tested in accordance with MSFC-SPEC-106A.	MSFC-SPEC-456
Nylon 6 film, 2-mil	MSC-C-12A
Polyethylene, 6-mil tinted antistatic film.	FED-SPEC-L-P-378, Type II
Tape	RED-SPEC-PP-T-60, Type I, Class I
Nitrogen gas	MIL-SPEC-BB-N-411

6.1.3 Packaging procedure for service media. The following materials for packaging shall apply with regards to the service media.

(a) All component parts, subassemblies, and assemblies utilized in oxygen systems or other sensitive high energy system, shall require material meeting MSFC-SPEC-456. Bags made of this material must be sealed on all sides, never centerfolded.

(b) All other system parts shall require nylon 6 as intimate wraps or outlet port coverings.

(c) Packaging materials shall be cleaned to such a level sufficient to maintain the cleanliness of the precision clean item.

(d) Metallic closures shall be of the same material group as the hardware to prevent corrosion due to dissimilar metal contact. Precision mating surfaces shall be protected with crush washers or teflon gaskets.

6.1.4 Type I closures - externally cleaned items. Type I closures shall be applied to externally cleaned items such as valves, seals, springs, filter

elements, washers, pins, nuts, bolts, and fittings.

6.1.4.1 Sealing of openings. When the externally cleaned item has fittings or other openings leading to cleaned inner surfaces, the item shall be purged and all fittings and other openings shall be capped, plugged, or otherwise sealed in accordance with Type II closures.

6.1.4.2 Intimate cushioning.

(a) Heavy items or items having threads, sharp points, or edges which could puncture or otherwise damage the barrier bags, shall be overwrapped with a sufficient amount of nylon 6 or fluorohalocarbon film for LOX compatability to form a cushion.

(b) Secure the cushioning film with tape whose adhesive shall not come in contact with the precision cleaned item.

6.1.4.3 Intimate packaging.

(a) Place the part with its cushioning into a bag.

(b) The interior of the bag and cushioned item shall be purged with nitrogen gas (GN_2) immediately prior to evacuation and heat sealing.

(c) Gently compress bag around the item to force out excess nitrogen gas.

(d) Heat seal bag.

Note: Due to applicable vendor requirements, it may be necessary to pull a vacuum on the intimate gag. Process as follows:

(e) Insert vacuum pump tube needle, at a corner location of the bag, pull vacuum until bag collapses firmly about the enclosed part, remove needle and immediately heat seal corner of bag.

(f) Apply tamperproof seal, at heat sealed end of bag, if required.

Note: Certification tags or decals containing identification, inspection, and cleanliness information may be used as tamperproof seals if applied in such a manner as to detect opening or tampering with the intimate package.

6.1.4.4 Secondary packing.

(a) Select, or fabricate, proper size bag.

(b) Place intimate package in environmental bag.

(c) Gently but effectively compress bag with hands to force out excess air.

(d) Place certification card into bag if not covered by 6.1.4.3.

(e) Heat seal bag.

Note: Due to applicable vendor requirements it may be necessary to pull vacuum on the environmental bag. Process as follows:

(f) Insert vacuum pump tube needle at a corner of environmental bag, pull vacuum until bag collapses firmly about enclosed bagged part, remove needle and immediately heat seal corner of bag.

(g) When bags are not practical, completely wrap with polyethylene film and secure with tape.

6.1.5 Type II closures - internally cleaned items. Type II shall be applied to those items which cannot normally be heat sealed in a transparent film bag because of size, weight, or configuration and have precision cleaned interior surfaces only. Type II closures are to be used on such items as valves, regulators, transducers, and instruments. All fittings or other openings leading to precision cleaned inner surfaces shall be capped, plugged, or otherwise sealed.

6.1.5.1 Capped or plugged closures.

(a) Select threaded caps for male thread connections and threaded plugs for female thread connections. The cap and/or plug shall meet the cleanliness requirements of the interior surface to be protected.

(b) Carefully mate the cap or plug to the connection by applying a minimum of torque to seat and seal the closure.

(c) The item may be purged with dry nitrogen prior to sealing the final closure.

6.1.5.2 Film shut closures. These closures shall be applied to openings which cannot be sealed with caps or plugs.

(a) Apply a double layer of film compatible with the service media over inlet and outlet ports, fitting ends, and other openings.

(b) Secure each layer of film in place with a minimum of two tight wraps of tape. The tape will not contact the body of the item.

6.1.5.3 Secondary packaging.

(a) Completely wrap each item with sealed openings with antistatic polyethylene film.

(b) Secure with tape or heat seal where practicable.

Note: Sealing of items that may be exposed to temperature variations during transport and storage shall be adequate to prevent the internal volumes of the item from breathing.

Note: The size of the part being packaged by Type II shall be the deciding factor with regards to the environmental bagging. When feasible, parts that measure four inches or less in any direction shall be placed in an environmental package.

(c) Select, or fabricate, proper size bag.

(d) Place intimate taped part into environmental bag.

(e) Gently, but effectively, compress bag with hands to force out excess air.

(f) Place certification card into bag.

(g) Heat seal bag. Do not pull vacuum.

6.1.6 Type III closures - hose and tube assemblies. Type III closures shall be applied to pipes, ducts, expansion joints, and hose and tube assemblies where external surfaces do not require critical or visual cleanliness. The items shall be purged internally and sealed to preserve their cleanliness. Each fitting shall be sealed with the appropriate plastic closure compatible with the intended service media.

6.1.6.1 Film closures of openings.

(a) Purge the item with nitrogen gas.

Note: Prior to application of film closures on openings of tube assemblies and other items that contain "B" nuts and sleeves, move "B" nuts and sleeves approximately two inches and secure with tape.

(b) Apply a double layer of film over opening of item.

(c) Secure each layer of film with tape.

(d) Reinforce openings over 2 inches with tape or other suitable means.

6.1.6.2 Secondary packaging.

(a) Apply a film of antistatic polyethylene film over the item and closures.

(b) Secure film with tape.

Note: The size of the part being packaged by Type III closures will be the deciding factor with regards to the environmental package. When feasible, parts shall be placed in an environmental bag. Process as follows:

(c) Select, or fabricate, proper size bag.

(d) Place part with film closure into environmental bag.

(e) Gently, but effectively, compress bag with hands to force out excess air.

(f) Place certification card into bag.

(g) Heat seal bag.

Note: Parts with large flange areas (four inches and greater) may require special handling and processing. When this is the case a special packaging and handling process will be issued with regards to the part involved.

6.2 Secondary packaging for field force protection. When hardware is identified on its drawing as being susceptible to damage from electrostatic, electromagnetic, magnetic, or radioactive field forces, protection shall be provided par NAS 853.

6.2.1 Electrostatic protection. Electrostatic protection shall be provided by a bag or wrap fabricated from an identifiably colored homogeneous antistatic plastic film having sufficient conductivity on all surfaces to permit controlled bleed-off of static charges to ground, without the production of a spark. Cushioning materials used with electrostatic sensitive devices shall also be homogeneously antistatic and noncorrosive.

6.2.2 Electromagnetic protection. Electromagnetic protection shall be provided by an intimate package of antistatic plastic and environmental package with aluminum foil or a bag fabricated from a laminate containing aluminum foil such as those conforming to MIL-B-131. Foil laminate bags shall be constructed by center folding a single sheet of material of proper size to eliminate possible capacitor effects. Figure 1 shows the construction of the environmental package.

Caution: In no case shall the aluminum foil be allowed to come into direct contact with the device.

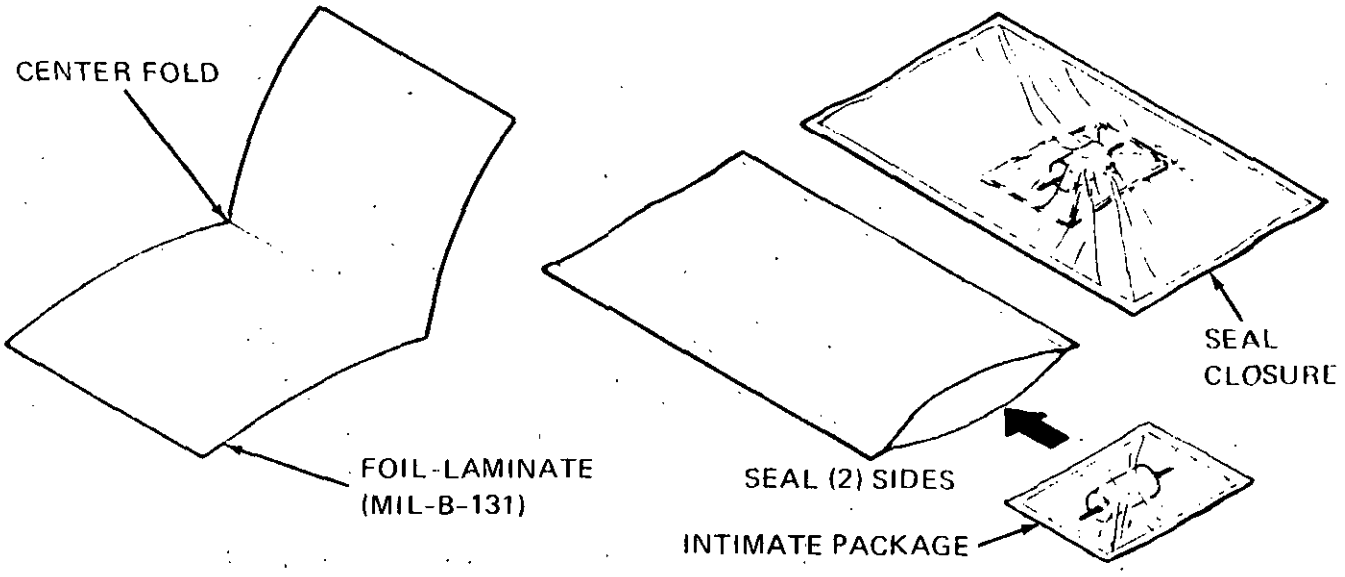

Figure 1. Construction of environmental package for electromagnetic protection

6.2.3 Magnetic protection. Magnetic protection of an item shall be provided by first packaging the item according to procedures to electrostatic protection (6.3.1). When required, additional protection against simple magnetic fields (as opposed to RF or electromagnetic radiation) shall be provided by enclosing the packaged item in materials composed of magnetic materials. These materials shall be sufficient thickness to provide the degree of protection required by the particular item.

6.2.4 Radioactivity protection. Protection against radiation from radioactive sources may be provided by first packaging the item according to the procedures for electrostatic protection (6.3.1). When specified, further protection may be provided by completely enclosing the item in materials of lead or lead filled compositions. These materials must be of sufficient thickness to provide the degree of protection required by the particular item.

6.3 Physical protection during receiving inspection.

6.3.1 Pneumatic, fuel, LOX, and hydraulic systems. During receiving inspection, components of pneumatic, fuel, liquid oxygen, and hydraulic systems shall be protected to prevent damage and minimize contamination as follows:

(a) Examine the environmental bag for visible damage to determine acceptance or rejection of the item.

(b) Open the environmental bag under conditions to maintain cleanliness in a manner that shall permit resealing of the bag.

(c) When a pneumatic test or purge is required during the functional inspection, use either dry nitrogen or dry filtered air as the test or purge medium.

(d) Covers that have been removed shall be replaced with new material immediately following the completion of the inspection when practical.

(e) After the receiving inspection is completed, replace the component in the environmental bag. Place an identification tag with assembly and handling restrictions, identification information, acceptance stamp and manufacturer's name in the bag in a position that shall permit clear visibility of the information and prevent corrosion interaction. Purge the bag with nitrogen and heat seal the bag.

(f) Overpackage the component as necessary to prevent damage during handling, shipping, and storing operations.

6.3.2 Gas bearing and slosh measuring systems. Components of gas bearing and slosh measuring systems shall be protected during receiving inspection as pneumatic system components except that the gas supply shall be specified and determined by MSFC-PROC-195.

6.3.3 Electronic components. Electronic components shall be protected during receiving inspection as follows:

(a) Remove the item from the package.

(b) Open the plastic bag in a manner that shall permit resealing of the bag.

(c) Remove the protective caps and plugs only as necessary to perform inspections.

(d) Attach an approved mating connector to each electrical plug or receptacle before test connections are made.

Caution: Do not touch or attach a probe, test lead, or test clip to any connector pin or socket of any harness, cable, component, or equipment at any time for tests, checkout, or any other purpose.

(1) Use wiring harnesses and mating connectors that are approved by the responsible design agency to connect components to testing fixtures for all testing operations.

(2) Use a receiving checkout procedure that has been approved by the responsible design agency for all receiving tests.

(e) Replace protective caps and plugs immediately following completion of tests.

(f) Place component in the plastic bag. Place an identification tag with acceptance stamp, identification, manufacturer's name, and handling restrictions in a position that permits clear visibility of the information and prevents corrosion interaction.

(g) Seal plastic bag in a controlled area.

(h) Overpackage the component as necessary to prevent damage during handling, shipping, and storing operations.

(i) Attach identification and warning tags to exterior of package as applicable.

3.4 Stock room storage. During stock room storage, components shall be protected as follows:

(a) Store in an approved storage area.

(b) Protect manufacturer's identification, nomenclature, part number and assembly restriction markings. Observe all package warnings during handling and attaching operations.

(c) Provide for periodic reinspection of components to insure that components are adequately protected, and provide for compliance with the latest applicable protection drawings and specifications.

(d) Warning labels and storage and stacking instructions shall be observed as applicable.

6.5 Physical protection for transportation. Precautions shall be taken to insure that clean packages or closures are properly identified and protected from damage during handling, intraplant transportation, and shipping. Such precautions may include but not be limited to the following devices:

(a) Durable overpack.

(b) Shock resistant mountings.

(c) Bright colored, well marked containers, labels, or wrapping material for warning purposes.

(d) Specially made or adapted containers, tote boxes, or trays to provide protection and convenience of handling.

(e) Specially built or adapted transportation which will offer suitable protection to the subject item.

(f) Written instructions posted in an obvious position directing special handling, storing, or transportation procedures.

IDENTIFICATION OF INTEREST IN DOCUMENT BY ACTIVITY

Custodians:

Army - MI
Navy - AS
Air Force - 84

Review Activities:

Army - EL, MR, MU, WC
AT, AV, ME
Navy - SA, SH
Air Force - 11, 12, 13, 15, 16,
17, 19, 43, 79

User Activity:

Army
Navy
Air Force

Preparing Activity:

Army - MI

Project No. - FSC 3694 0018

Defense Supply Agency:

GS, PS, ES

Civilian Agencies:

NASA - MSFC, KSC, MSC,
GSFC
DOT - FAA
GSA

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Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

   ☐ YES ☐ NO (If "yes", in what way?)

4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)

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DATE

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