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STANDARD

MATERIALS AND PROCESSES CONTROL

Prepared by:
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MATERIAL AND PROCESS CONTROL STANDARD

MSFC-STD-506C

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FOREWARD

The importance of proper material and process control in the fabrication and testing of flight components has been demonstrated in various aerospace and military programs. Past experience has established acceptable requirements for controlling the material and process selections to minimize or eliminate problems in these areas. This document defines the minimum requirements necessary for adequate materials and processes control of all space flight hardware and designated ground support equipment.

It is intended that this document be incorporated in the technical requirements specifications for flight hardware and designated ground support equipment and be revised as necessary to incorporate additions or deletions to reflect current materials and processes control requirements.

Revision C supersedes the previous issue of this specification. This revision reduces the number of MSFC specifications, simplifies material reporting requirements, and adds Data Requirements as necessary.

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to define the minimum requirements for materials and processes for incorporation in space flight hardware procurements, technical programs, and designated ground support equipment.

1.2 SCOPE

This document is primarily directed towards materials and processes used in the design, fabrication, testing, handling, transportation and checkout of flight components for flight vehicle systems, payloads, experiments, designated ground support equipment, and standard parts. It also includes the documentation requirements for approval and selection methods and procuring activity responsibilities.

1.3 APPLICABILITY

This standard is applicable to in-house and contractor materials and process control primarily during definition, design and development, and operational phases of programs/projects.

1.4 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent indicated herein.

1.4.1 National Aeronautics and Space Administration

SP-8603 - Lubrication, Friction, and Wear
NHB 8060.1B - Flammability, Odor and Offgassing Requirements and Test Procedures for Materials in Environments which Support Combustion

1.4.2 George C. Marshall Space Flight Center

MSFC-STD-655 - Standard Weld Filler Metal, Control of
MSFC-SPEC-250A - Protective Finishes for Space Vehicle Structures and Associated Flight Equipment
MSFC-SPEC-455 - Requirements for Adhesive Bonding, Process, and Inspection
MSFC-SPEC-560 - Welding, Steels Corrosion and Heat Resistant
MSFC-SPEC-469 - Heat Treatment of Titanium and Titanium Alloys

1.4.2 George C. Marshall Space Flight Center (Continued)

MSFC-STD-486 - Threaded Fasteners, Torque Limits for
MSFC-SPEC-504A - Welding, Aluminum, and Aluminum Alloys
MSFC-SPEC-522A - Design Criteria for Controlling Stress Corrosion Cracking
MSFC-STD-557 - Threaded Fasteners, 6Al-4V Titanium, Usage Criteria for Spacecraft Applications
MSFC-SPEC-527E/ JSC 09604E - Material Selection Guide for MSFC Spacelab Payloads
No Number - MSFC Lubrication Handbook for Space Industry

1.4.3 Lyndon B. Johnson Space Center

SP-R-0022A - Vacuum Stability Requirements of Polymeric Materials for Spacecraft Applications

1.4.4 Military

Handbooks

MIL-HDBK-5C - Strength of Metal Aircraft Elements
MIL-HDBK-17A - Plastics for Flight Vehicles
MIL-HDBK-23A - Structural Sandwich Composites

Standards

MIL-STD-143B - Order of Precedence for the Selection of Standards and Specifications
MIL-STD-401B - General Test Methods, Sandwich Constructions and Core Materials
MIL-STD-454F - General Requirements for Electronic Equipment
MIL-STD-810C - Environmental Test Methods
MIL-STD-1595 - Aerospace Welder Performance Qualifications

Specifications

MIL-B-7883B - Brazing of Steels, Copper, Copper Alloy, Nickel Alloys, Aluminum and Aluminum Alloys

1.4.4 Military

MIL-S-5002 - Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems

MIL-C-6021G - Castings, Classification and Inspection of
MIL-H-6088E - Heat Treatment of Aluminum Alloys
MIL-H-6875F - Heat Treatment of Steels (Process for aircraft practice)
MIL-H-81200A - Heat Treatment of Titanium and Titanium Alloys
MIL-I-6870E - Inspection Program Requirements, Nondestructive: For Aircraft and Missile Materials and Parts
MIL-I-8950B - Inspection Program Requirements, Nondestructive: For Aircraft and Missile Materials and Parts
MIL-S-8879A - Screw Threads Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-T-9047G - Titanium and Titanium Alloy Bars and Forging Stock

2.0 GENERAL REQUIREMENTS

2.1 POLICY

Materials and processes used in the fabrication of space flight or supporting hardware shall be selected by considering all operational requirements for the particular application and the design engineering properties of the candidate materials. The primary properties that shall be considered include mechanical strength, low and high cycle fatigue, thermal fatigue, thermal stability, fracture toughness, corrosion and stress corrosion behavior, resistance to hydrogen embrittlement, crack growth characteristics, flammability, and habitation environment including offgassing and outgassing. Test data is tabulated in MSFC-HDBK-527/JSC 09604. A procedure shall be established to insure that materials, components, standard parts and processes used in hardware meet the requirements of this specification, with particular emphasis given to vendor designed and off-the-shelf items.

2.1.1 Materials Selection List - Each project shall use a Materials Selection List (MSFC-HDBK-527/JSC 09604) for materials selection during design. The materials in this list are rated based on criteria established in NHB 8060.1, SP-R-0022, MSFC-SPEC-522, etc. The list shall be maintained by MSFC Materials and Processes Laboratory and distributed, as required, to associate contractors, subcontractors and to other NASA Centers. Addition of materials to the list shall require approval as defined in the contract.

2.2 CONTROLLING DOCUMENTS

All materials and processes shall be defined by standards and specifications. Contractors shall select standards and specifications from Government, industry, and company specifications and standards in accordance with MIL-STD-143B except that NASA documents shall be considered first in the order of precedence. Rationale for the selection of company specifications and standards over existing higher order of precedence standards and specifications shall be compiled and maintained for historical record and shall be made available to NASA upon request. The rationale shall include an identification of each higher order of precedence specification or standard examined and a statement of why each was unacceptable. For purposes of order of precedence, commercial materials and processes shall be considered equivalent to company standards. All Government specifications or standards requiring special approval authority by the custodian or preparing activity of the document shall have all approval requests directed to the responsible NASA procuring activity. Such approval requests shall be submitted only when specified herein, or when specifically requested by procuring activity.

2.3 SPECIAL MATERIAL PROBLEMS

Materials or processes which might contribute to deterioration of structural members shall receive special consideration. Deterioration mechanisms which can degrade the life expectancy of parts include, but are not limited to, galvanic corrosion, stress corrosion, hydrogen embrittlement, creep, fatigue (including thermal), flaw growth, oxidation, space vacuum, and radiation exposure. Precautionary measures are included in the requirements of this document, these measures are considered to be minimal, and the contractor is directed to insure that any potential deterioration mechanisms are evaluated, reviewed and resolved prior to production of the related hardware. NASA shall be promptly notified of the presence or discovery of any deterioration mechanisms affecting flight hardware structural integrity and shall be permitted to assist the contractor in the resolution of such problems as necessary.

2.3.1 <u>Compliance Requirements</u> - The contractor shall compile data to establish that all known factors influencing deterioration of the candidate materials have been evaluated in the design. Compliance shall be recorded by reference to this document in the applicable end item specification for the particular assembly or component part. In addition, the contractor shall provide, in his internal specification and procedures, the requirement that all design drawings and revisions contain a materials and processes approval block, or equivalent, to assure that the design has been reviewed and complies with the intent of this document. All data compiled by the contractor to meet the requirements of this paragraph, shall be subject to review and approval by NASA on request.

2.4 FRACTURE CONTROL

2.4.1 Fracture Control Requirement - Structural failures due to crack-like flaws shall be prevented on parts designated as critical to vehicle and crew survival by the application of fracture control to these parts. The identification of fracture critical parts will be based on the parts function, load, environment, life analysis, material, and accessibility for inspection during fabrication and operation of the vehicle. Typical characteristics of a fracture control part are:

a. Failure of the part will cause loss of the vehicle or crew.

b. Predicted operational stresses are a significant fraction of critical stresses considering the load, environment, and life requirements of the part.

c. The part is not routinely accessible for preflight inspection.

2.4.2 Fracture Control Plan - A fracture control plan shall be developed to provide the following:

a. Identification of components selected for fracture control on the basis of criticality to structural flight worthiness and susceptibility to cracking or fracture per NASA SP-8040 and NASA SP-8095.

b. Definition of organization responsibilities and procedures relevant to fracture control.

c. Maintenance of a continuing quality assurance activity.

d. Appropriate review, performance appraisal, and control by management.

The fracture control plan shall treat all organizations and disciplines which affect fracture control, and shall be approved by NASA prior to implementation. Examples of organizational responsibilities which could affect fracture control shall include, but not be limited to the following:

a. Design - Fracture critical parts shall be designed using sound and established design procedures which include considerations for minimizing eccentricities and stress concentrations, providing access and clearance for in-service inspections and tests, and part documentation and identification requirements.

b. Materials and Processes - Fracture control considerations shall be an integral part of the materials and processes selection task for critical parts and will include considerations such as toughness, flaw environmental and cyclic growth rates, effects of fabrication and joining processes, environmental effects, and NDE technique capabilities.

c. Structural Analysis - A fracture mechanics evaluation that supplements normal structural static and fatigue analyses will be conducted for all critical parts and will include such considerations as size and location of initial flaws, proof test and/or inspection requirements, definition of fracture test requirements, and analyses of fracture test results.

d. Reliability and Quality Assurance - The reliability and quality assurance system applied to fracture critical parts will verify that materials and parts conform to engineering requirements. Specifically, the capability of NDE techniques to reliably detect initial flaws defined by engineering will be verified based on applicable production experience or by laboratory demonstration with realistic flaws and production or in-service inspection conditions. Other responsibilities include receiving inspection, quality review and reporting, failure documentation, traceability, and personnel certification.

e. Manufacturing - Manufacturing will select and/or establish fabrication techniques to be used in processing fracture critical parts and will insure that these techniques are compatible with fracture control requirements.

f. Tests - Testing which relates to fracture control includes fracture control verification tests, normal static and fatigue structural tests, in-service structural testing and monitoring, and proof tests. Proof testing of all pressure vessels will be mandatory. Consideration will be given to obtaining beneficial fracture control data from the normal static and fatigue structural verification tests.

g. Operations and Maintenance - Operations will prepare a detailed inspection manual for all fracture critical parts as well as maintain an accurate record of service experience. Maintenance will provide environmental or handling control for fracture critical parts including inactive or storage periods, to assure that structural integrity is not degraded.

2.5 MATERIALS AND PROCESSES SELECTION AND VERIFICATION PLAN

The contractor shall prepare a Materials Selection and Verification Plan (see DR-1) defining a proposed method of coordinating and approving all engineering drawings for flight hardware and ground support equipment (GSE) before design concepts are finalized. In addition to this plan, approval of engineering drawings shall include sign-off by the materials and processes discipline for each materials application utilized. The Materials and Processes Selection and Verification Plan shall reflect consideration of the following general requirements:

a. Flow diagrams delineating materials and processes control from design or procurement until flight shall be provided. Such diagrams shall reflect the proposed routing of drawings and revisions through materials evaluation, drawing sign-off, Program Manager approval of deviations, and re-routing resulting from disapproval of the material or application.

b. Procedures for identification and documentation of all material and process usages shall be provided (see attached DR's). Such procedures and format will depend upon the specific hardware required by contract, but shall cover both the original design and subsequent changes. As a minimum, materials, parts and components must be identified by trade name, usage environment, thickness, surface area, and detail drawing or part number, temper and form for metals and specification number shall be specified. This list shall be submitted to NASA for review as specified in the applicable DR. This list shall, in addition, reflect consideration of all aspects of the usage environment as applicable, intermittent exposure, protective measures, coatings and finishes, odor, offgassing, outgassing, corrosion, stress corrosion, flammability, lox/gox compatibility, hydrogen embrittlement and inherent resistance to the use of environment such that sufficient information to establish a selection rationale is provided. Where batch testing in lox/gox is required before material qualification can be determined, certification of the batch test shall be provided to the procuring activity upon request.

2.5.1 Material Usage Agreement (MUA) DR-2 - A procedure shall be established as part of the Materials and Processes Selection and Verification Plan whereby MUA's are submitted for each usage of a material or process that does not meet the requirements of this standard. These MUA's shall be signed by the Program Manager for that hardware. This procedure shall include methods of identifying documentation and submittal to NASA for approval of these usages prior to inclusion in final design. It should also address ways of informing NASA of these usages as soon as they are identified. The information specified on the MUA is required, as a minimum. This must include sufficient rationale to assess these usages.

2.5.2 Vendor Hardware - A procedure to ensure that all materials and processes are covered by the requirements of this specification, with emphasis given to vendor designed and off-the-shelf items and vendor furnished items, shall be established by the contractor. This procedure shall also include special consideration for off-the-shelf hardware where detail materials and processes information may not be available or it may be impractical to impose all the detail requirements specified in this standard. This procedure shall include provisions for ensuring that this hardware is satisfactory from an overall materials and processes standpoint.

2.6 PROCESS SPECIFICATIONS

A list of all process specifications, with critical process specifications designated, as specified in the attached DR-3 and utilized in construction of flight level hardware shall be submitted to the procuring activity in accordance with a schedule to be established in the contract. All process specifications are subject to review and approval by NASA.

2.7 MATERIALS APPLICATION AND EVALUATION BOARD (MAEB)

An MAEB shall be established for each MSFC project to disposition materials and processes that do not meet requirements. The membership of this board shall consist of the following as a minimum, Chairman - Director, Materials and Processes Laboratory; Secretary - Chief, Materials Selection and Control Office; one member from Chief Engineers Office; one member from the Project Office; and the Materials and Processes Laboratory Lead Engineer.

2.8 MANUFACTURING PLAN

Each project shall prepare for NASA approval a Manufacturing Plan as defined in the attached DR-4.

3.0 DETAIL REQUIREMENTS

3.1 METALS

MIL-HDBK-5 shall be the basic document defining strength allowables, and mechanical and physical properties of metallic materials. A word of caution is in order. Most procurement specifications, inspection and property requirements are optional, therefore, it is imperative that these requirements be specified in the procurement document.

3.1.1 Aluminum - Maximum use shall be made of alloys, heat treatment and coatings that minimize susceptibility to general corrosion, pitting, integranular, and stress corrosion. Aluminum alloys 2020-T6, 7070-T6, and 7178-T6 shall not be used for structural applications unless specifically approved by the procuring activity. The use of 7075-T6 sheet materials is allowed provided short transverse loads (design, fitup, thermal, and residual) are below acceptable stress corrosion limits and that proven corrosion protection systems are provided. Other forms of 7075 shall be heat treated to the -T73 temper. The use of aluminum alloys is also subject to the requirements of paragraph 3.2.5 as specified herein.

3.1.1.1 Heat Treatment - Heat treatment of aluminum alloys shall be in accordance with MIL-H-6088 except that for 2219 alloy the maximum quench delay times permitted may be exceeded only if performance tests prove all parts will be above 900°F when quenched.

3.1.2 Steels - Steels heat treated to strength levels of 180 ksi ultimate tensile strength or above shall be approved for each application by the NASA procuring activity.

3.1.2.1 Heat Treatment - Heat treatment of steels shall be in accordance with MIL-H-6875. Heat treatment procedures not included in MIL-H-6875 shall be approved by the NASA procuring activity. All high strength steel parts heat treated at or above 180 ksi ultimate tensile strength shall include appropriate test coupons or specimens from the same heat of material as the part. These coupons or specimens shall accompany the part through the entire fabrication cycle, to assure that required properties are obtained. Steel parts which have been acid cleaned, plated, or exposed to other hydrogen producing processes shall be subjected to the following requirements.

a. Those having a hardness of Rockwell C35 to C41 shall be baked at 375 ± 25°F (191 ± 14°C) for 4 hours or more.

b. Those having a hardness of Rockwell C41 or higher shall be baked at 375 ± 25°F (191 ± 14°C) for a minimum of 23 hours. In addition to baking, these parts shall pass the qualification test for hydrogen embrittlement as specified in MIL-S-5002.

3.1.2.2 Drilling and Grinding of High Strength Steels

The drilling of holes, including beveling and spot facing, machining, grinding, or reaming in martensitic steel hardened to 180 ksi ultimate tensile strength or above shall be avoided. When such operations are unavoidable, carbide tipped tooling and other techniques necessary to avoid formation of untempered martensite shall be used. Microhardness and metallurgical examination if untempered martensitic areas are formed as a result of the specific operation performed.

3.1.2.3 Corrosion Resistant Steels - Unstabilized austenitic stainless steels may be used up to 700°F (371°C). Welded assemblies shall be solution heat treated after welding, except for the stabilized or low carbon grades 321, 347, 316L and 304L. Caution shall be exercised in using 400 series stainless steels to minimize hydrogen embrittlement, corrosion, and stress corrosion.

3.1.2.4 Precipitation Hardening Steels - Many of the precipitation hardening (Ph) stainless steels are susceptible to stress corrosion and hydrogen embrittlement in certain heat treated conditions and these tempers shall be avoided. Heat treatments are critical with many of these steels and improper control can result in exceeding the threshold for stress corrosion resistance. The design activity shall assure that controlled processing procedures are used for these steels and shall maintain processing and procurement records, as appropriate, for reference. Precipitation hardening steels shall also conform to the requirements of MSFC-SPEC-522.

3.1.3 Titanium - Most titanium alloys have limited hardenability with section size and should not be used in sections which exceed their specified limits. The variation of mechanical properties with section size as heat treated is indicated in Table II and III of MIL-T-9047 (USAF). For candidate titanium alloys other than those listed in MIL-T-9047 (USAF), similar information shall be obtained by the contractor and approved by NASA prior to final selection. The surfaces of titanium parts shall be machined or chemically milled to eliminate all contaminated zones formed during processing.

3.1.3.1 Heat Treatment - Heat treatment of titanium and titanium alloy parts shall meet the requirements of MSFC-SPEC-469. For titanium alloys not covered by MSFC-SPEC-469, heat treatment shall meet the requirement of MIL-H-81200.

3.1.3.2 Titanium Contamination - The use of cleaning fluids and other chemicals that are detrimental to performance of titanium or titanium alloy parts shall be avoided. Surface contaminants that might induce stress corrosion, hydrogen embrittlement, or reduce fracture toughness are: hydrochloric acid, cadmium, silver, chlorinated cutting oils and solvents, methyl alcohol, mercury, and compounds containing mercury. The use of these substances on or with titanium is prohibited.

3.1.3.3 Fretting of Titanium - Titanium alloys are susceptible to the reduction of fatigue life by fretting at interfaces between titanium alloys or titanium and other metal parts; therefore, structural applications of titanium shall be designed to avoid fretting.

3.1.3.4 Titanium Fasteners - Titanium fasteners shall meet the requirements of MSFC-STD-557. See paragraph 3.2.6.4 for additional requirements.

3.1.4 Magnesium - Magnesium alloys shall not be used except in areas where minimal exposure to corrosive environments can be assured and protection systems can be maintained with ease and high reliability. Magnesium alloys shall not be used in the primary flight control system, for landing gear wheels, for primary structure, or in other areas subject to wear, abuse, foreign object damage, abrasion, erosion, or at any location where fluid or moisture entrapment is possible.

3.1.5 Beryllium - Beryllium and beryllium alloys shall be restricted to applications in which their properties offer definite performance and cost advantages. Additionally, the capability of beryllium parts to provide reliable service and predictable life must be demonstrated by preproduction test under simulated service conditions, including any expected corrosive environments. Design of beryllium parts shall include consideration of its low impact resistance and notch sensitivity, particularly at low temperatures, and its directional material properties (anisotropy) and sensitivity to surface finish requirements.

3.1.6 Mercury - Mercury and many compounds containing mercury can cause accelerated stress cracking of aluminum and titanium alloys. The use of temperature sensing devices, electrical devices, and any other device containing mercury or compounds of mercury shall be prohibited as installed equipment or for usage during fabrication of space flight structures and subsystems.

3.1.7 Refractory Metals - Since engineering data on refractory alloys are limited, especially under extreme environmental usage for spacecraft, appropriate tests shall be performed to characterize such materials for the intended application. Results of such tests and related engineering data shall be compiled and made available to the NASA procuring activity upon request. Application of refractory alloys shall be approved by the NASA procuring activity.

3.1.8 Superalloy (Nickel-Based and Cobalt-Based) -

Nickel-base and cobalt-base superalloys possess various combinations of high temperature mechanical properties and oxidation resistance up to approximately 2000°F. Many of these alloys also have excellent cryogenic temperature properties. Selection of a superalloy for a given application shall be based on tests of the material in an environment which simulates that expected in service. Some nickel-base alloys are susceptible to sulfur embrittlement. Therefore, any foreign material which could contain sulfur, such as oils, grease and cutting lubricants shall be removed by suitable means prior to heat treatment or high temperature service. Some of the precipitation hardening superalloys are susceptible to alloying element depletion at the surface in a high temperature, oxidizing environment. This effect shall be carefully evaluated when thin sheet is used, since a slight amount of depletion could involve a considerable proportion of the effective cross-section of the material.

3.1.9 Other Metals - In addition to the requirement of this document, the contractor shall meet the metallic materials requirements specified in the applicable contractual document for the particular hardware or subsystem.

3.2 SPECIAL METALLIC MATERIALS REQUIREMENTS

3.2.1 Forgings _ Because mechanical properties are maximum in the direction of material flow during forging, techniques shall be used that produce an internal grain flow pattern such that the direction of flow in all stressed areas is essentially parallel to the principle tensile stresses. The grain flow pattern shall be essentially free from reentrant and sharply folded flow lines. After the forging technique, including degree of working is established, the first production forging shall be sectioned to show the grain flow patterns and to determine mechanical properties at control areas. The procedure shall be repeated after any change in the forging technique. The information gained from this effort shall be utilized to redesign the forging as necessary. These data and results of tests shall be retained by the contractor and be made available for review by NASA on request. Forgings shall be graded according to the criteria in MIL-I-8950.

3.2.2 Castings - Castings shall be graded according to the criteria in MIL-C-6021. Castings shall not be used without prior approval of the procuring NASA agency.

3.2.3 Residual Stresses - Residual stresses are normally induced into manufactured parts as a result of forging, machining, heat treating, welding, or special metal removal processes. Residual stresses are generally controlled or minimized during the fabrication sequence by special heat treatment such as annealing, peening, and stress relieving. Even with in-process controls to minimize the potential buildup of residual stresses, the final production parts will usually contain some residual stresses. These stresses may be harmful in structural applications when the part is subjected to fatigue loading, additive operation stresses, or corrosive environment. Therefore, every available effort should be made by the contractor to eliminate or minimize residual stresses from finished structural parts.

3.2.4 Sandwich Assemblies - Sandwich assemblies shall be designed to prevent the entrance and entrapment of water or other contaminants into the core structure. Perforated or other core configurations which could allow moisture transfer shall not be used unless approved by NASA. Sandwich assemblies shall satisfy the requirements of MIL-HDBK-23 and test methods for sandwich constructions and core materials shall meet the requirements of MIL-STD-401. Should materials not covered by the above specifications be required for high temperature or other special applications, NASA approval shall be obtained prior to final selection and design.

3.2.5 Stress Corrosion Factors - The criteria of MSFC-SPEC-522 shall be used to select metallic materials to control stress corrosion cracking. It is recognized that for many applications involving unfamiliar materials, or unusual combinations of materials and environments, existing data on stress corrosion susceptibility will be insufficient. To ensure adequate stress corrosion resistance in these situations, it will be necessary to conduct a detailed evaluation of susceptibility. The results must be submitted to NASA for review, and NASA approval will be required before the material can be used or incorporated in a design under the circumstances in question. The medium for submittal will be the Materials Usage Agreement (MUA). In addition, all materials applications other than those explicitly approved according to the criteria set forth in this document will be predicated on NASA approval of an MUA submitted either by prime contractor or by a subcontractor through the prime. The MUA will contain the information specified on the Stress Corrosion Evaluation Form, attached as Appendix C of MSFC-SPEC-522, along with any other information deemed necessary for the accurate assessment of the potential for stress corrosion failure. Where possible, similar usages of the same or similar alloys should be submitted on a single MUA. Alloys and heat treatment which result in high resistance to stress corrosion cracking shall be utilized in all structural load carrying applications. Particular emphasis shall be in the area of design, fabrication, and installation of parts to prevent the sustained surface tensile stresses for exceeding the stress corrosion threshold limitations for the particular material and grain-flow orientation. Stress corrosion threshold values are generally determined by actual testing.

<u>NOTE</u>: Sustained surface tensile stresses are defined as the algebraic sum of all the continuous tension and compression surface stresses resulting from any source such as heat treatment, forming, assembly, and in some cases design.

3.2.5.1 <u>Steel Alloys</u> - Carbon and low alloy steel with ultimate tensile strengths below 180 ksi are generally resistant to stress corrosion cracking. Austenitic stainless steels of the 300 series are generally resistant. Martensitic stainless steels of the 400 series are more or less susceptible depending on composition and heat treatment. Precipitation hardening stainless steels vary in susceptibility from extremely high to extremely low depending on composition and heat treatment. The susceptibility of these steels is particularly sensitive to heat treatment, and special vigilance is required to avoid stress corrosion cracking problems.

3.2.5.2 <u>Aluminum Alloys</u> - Many aluminum alloys exhibit excellent resistance to stress corrosion cracking in all standard tempers. However, the high strength alloys, which are of primary interest in aerospace applications, must be approached cautiously. Some are resistant only in the longitudinal grain direction, and the resistance of others varies with the specific temper. Because metallurgical processing of aluminum alloys usually results in a pronounced elongation of grains, the variation of susceptibility with grain orientation is more extensive than for other metals. Also, because of conventional processing methods designed to optimize strength, residual stresses, especially in thick sections, are usually greater in aluminum products that in wrought forms of other metals. It is for this reason that wrought, heat treatable aluminum products specified for use in the fabrication of hardware should be mechanically stress relieved (the TX5X or TX5XX temper designations) whenever possible.

Both the residual stress distribution and the grain orientation must be carefully considered in designing a part to be machined from wrought aluminum. Machining will not only alter the stress distribution, it may also result in the exposure of a short transverse region on the surface of the finished part which will see tension in service.

3.2.5.3 Copper - Natural atmospheres containing pollutants of sulfur dioxide, oxides of nitrogen, and ammonia are reported to cause stress corrosion cracking of some copper alloys. Chlorides present in marine atmospheres may cause stress corrosion problems but to a lesser extent than the previously listed pollutants, which indicates that industrial areas are probably more aggressive than marine sites to copper base alloys. Many copper alloys containing over 20 percent zinc are susceptible to stress corrosion cracking even in the presence of alloying additions which normally impact resistance to stress corrosion.

3.2.5.4 Nickel - As a class, alloys with high nickel content are resistant to stress corrosion cracking.

3.2.6 Corrosion Prevention and Control - All parts, assemblies, and equipment, including spares, shall be finished to provide protection from corrosion in accordance with the requirements of MSFC-SPEC-250. The contractor shall apply acceptable corrosion prevention and control measures and insure that they are properly integrated during system definition, engineering development, design, and operational phases. All corrosion prevention and control measures initiated by the contractor are subject to review and approval by NASA on request. Acceptable corrosion prevention and control measures shall be implemented and such controls shall be integrated into system definition, engineering development, and design and operational phases. Some specific corrosion control measures that shall be implemented include, but are not limited to, the following:

a. All permanently installed, non-removable fasteners penetrating surfaces located in exterior or interior corrosive environments shall be installed with a corrosion inhibiting primer or sealant. Quick release fasteners and removable fasteners penetrating surfaces in exterior or interior corrosive environments, shall be so designed and installed to provide a seal which will prevent moisture or fluids from entering the fastener hole. Sealants used in this manner shall be compatible with the media which they contact. Other techniques for corrosion prevention at the fastener interface may be used subject to review and approval by the NASA procuring activity.

b. Joints and seams located in exterior or interior corrosive environments, including those in landing gear wells, control surface wells, attachment wells, and structure under fairing shall be faying surface sealed. Selection and use of sealants shall be subject to the provisions of Section 3.2 herein. Removable panels and access doors in exterior or interior corrosive environments shall be sealed either by mechanical seals or by separable faying surface sealing.

3.2.6.1 Corrosion Prevention and Control Review - Periodic reviews at the major contractor or subcontractor's facilities shall be conducted to evaluate the adequacy of the subcontractor's efforts in corrosion prevention and control. These reviews shall be conducted by the contractor's office of prime responsibility for corrosion prevention and control, and MSFC personnel or their designated alternates shall be invited to participate. Scheduling of reviews shall be as frequent as deemed necessary by the contractor or MSFC, but not less frequent than annually. The contractor shall correct any discrepancies observed during these reviews.

3.2.6.2 Steel - All parts including fasteners made from low alloy high strength steel shall require protection which shall be applied by a process which has been proven to be nonembrittling to high strength steels, and which is compatible with the space environment.

3.2.6.3 Sealing - All joints and seams located in exterior or interior corrosive environments, including those in landing gear wells, and structure under fairing shall have all faying surfaces sealed. The use of any sealant not covered by a published specification is subject to review and approval by NASA. Removable panels and access doors in exterior or interior corrosive environments shall be sealed either by mechanical seals or by separable faying surface sealing.

3.2.6.4 Threaded Fasteners - Unless otherwise specified, threaded fasteners shall be supplied with threads in conformance with FED-STD-H28/2 (UN/UNR), FED-STD-H28/4 (MIL-S-8879, UNJF), FED-STD-H28/21 (METRIC/M,MJ), ASME B1.1 (UN,UNR), and ASME B1.21M (METRIC MJ) as applicable in hardware design. See 3.1.3.4 for additional titanium requirements. SCN 2

3.2.6.4.1 Fastener Installation - The installation of mechanical fasteners and associated parts shall meet the requirements of MSFC-SPEC-250 and MSFC-STD-486.

3.2.6.4.2 Fastener Reuse - Threaded fastener reuse shall be defined by standards. Fasteners as referred to herein include all threaded bolts, screws, studs, nuts, anchor nuts, washers and inserts.

3.2.7 Flammability, LOX/GOX, and Propellant Compatibility

As a general requirement for all metallic materials, the contractor shall obtain data on analyses as necessary to meet the requirements of NASA document NHB 8060.1, "Flammability, Odor and Offgassing Requirements and Test Procedures for Materials in Environments which Support Combustion." All materials used in these environments (worst case use environment, for example, pressure, oxygen concentration, temperature, etc.) shall require the approval of NASA prior to incorporation in the design.

3.3 NONMETALLIC MATERIALS

3.3.1 Selection Criteria - Nonmetallic materials must be selected and tested with primary consideration of the design engineering properties of candidate materials and the operational requirements for each particular application. Special consideration should be given to materials life and aging characteristics in its storage and intended use environment. Specifications controlling composition and processing must insure a reproducible product that is related to the design and physical data being used. Compatibility with temperature, pressure, radiation, vacuum, fluid, or gas environments must be evaluated and tested or sufficiently documented. Tests for compatibility with hazardous fluids or gases such as oxygen or hydrogen must consider energy sources available in the proposed system which could initiate adverse reactions.

3.3.2 Flammability, Lox/Gox, Toxicity, Odor, and Propellant Compatibility

As a general requirement for all nonmetallic materials, the contractor shall obtain data or analyses as necessary to meet the requirements of the most recent issue of NASA document NHB 8060.1, "Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments which Support Combustion." Materials not meeting the requirements of NHB 8060.1 for the worst case use environment (for example: pressure, oxygen concentration, ambient temperature, etc.) shall require the approval of NASA prior to incorporation in the design.

3.3.3 Static Age Life - Wherever possible, materials shall be selected for a minimum of 10 years of static age life. Static age life shall include storage life and installed life in a nonoperating mode in an ambient environment. Materials which do not meet this requirement but must be used for functional reasons shall be identified, including any storage life restrictions. Elastomeric materials shall be cure dated for tracking purposes.

3.3.4 Useful Age Life - Materials shall be evaluated to determine if the useful life requirement of the component will be met. All materials not capable of meeting this requirement shall be identified and tracked.

3.3.5 Volatile Condensable Matter (VCM) - Polymeric materials which are exposed to space vacuum and used near critical surfaces shall not contaminate these surfaces. These materials shall meet the requirements of SP-R-0022A.

3.3.6 Moisture and Fungus Resistance - All materials, particularly nonmetallics, shall be submitted to fungus resistance testing and/or screening prior to selection and qualification for use in components, subassemblies, assemblies, and systems. Materials which are non-nutrient to fungi as defined by MIL-STD-810, Method 508 shall be used. When fungus nutrient materials must be used, they shall be hermetically sealed or treated to prevent fungus growth for a period of ten years. Materials not meeting this requirement shall be identified including any action required such as inspection, maintenance, or replacement periods. Fungus treatment shall not adversely affect unit performance or service life or constitute a health hazard to higher order life. Materials so treated shall be protected from moisture or other environments that would be sufficient to leach out the protective agent. Fungus inert materials are listed in MIL-STD-454.

3.3.7 Elastomeric Materials - Elastomeric components shall have adequate resistance to aging, low temperature, ozone, heat aging, polymer reversion, working fluids, lubricants, and propellants for the system. Natural rubber shall not be used in any form for flight hardware or critical GSE unless approved by procuring activity. Extreme caution shall be exercised in specifying o-rings and similar seals for dynamic applications in cryogenic environments. The best low temperature silicone rubber materials generally tend toward brittleness in the neighborhood of -120°C (-184.0°F). Other generic classes of rubber materials become brittle at even higher temperatures. When o-rings are lubricated for either ease of installation or dynamic performances, the lubricant can cause severe swelling and/or strength degradation of the rubber material. Elastomeric materials conditionally specified for use in hazardous environments, such as liquid or gaseous oxygen environments, are usually approved for such service on the basis of batch testing and certification per NHB 8060.1.

3.3.8 Other Nonmetallic Materials - Nonmetallic materials employed in electronic circuitry, such as printed circuit boards, conformal coatings, and potting materials shall meet specific physical, thermal, mechanical, and dielectric properties established in appropriate specifications. Many of the urethane potting and molding materials in general use are sensitive to reversion under high humidity and elevated temperatures. Caution must be used to select reversion-resistant urethanes. This application would be especially critical for GSE applications in high humidity locations. When certain types of RTV silicones are used in thick sections as potting or embedding materials they are subject to reversion at elevated temperatures. This is especially critical when the embedment is a sealed configuration. RTV silicones are available which are completely resistant to this type of reversion and should be specified for these specifications. The standard one-art RTV silicone sealant/adhesive cure by reaction with atmospheric moisture with the release of acetic acid. This could cause corrosion of copper or other electronic packaging components. In the cases of possible corrosion, those RTV one-part sealants should be specified which do not liberate corrosive acids. The inhibition of cure of certain types of RTV silicones by other types is well established and must be considered in any electronics packaging design.

When electronic modules or printed wiring boards with fragile components are to be potted or coated, appropriate care must be taken to protect the components from mechanical stresses developed in the potting or coating material. Caution should be exercised when using microballon-filled, epoxy module potting materials (syntactic foams) in thick sections. Density gradients sometimes develop which result in high residual stress concentrations in the potting followed in some cases by cracking. Extreme caution should be exercised in the selection of conformal coating material for printed wiring boards. In a number of instances, the conventional thickness of coating (10-15 mils) have resulted in damage to components and solder connections. The film coating (2-4 mils) should be considered whenever appropriate for the application.

3.3.9 Foam Plastics, Rigid Plastics and Films -

Many special products of this type have properties specific to a given thermal and manufacturing history. For example, the crystallinity of certain polymers has a pronounced effect upon their mechanical and thermal properties. The degree of crystallinity is in many cases dependent upon the thermal and processing history. Many plastic foam and film products are anisotropic. Mechanical and other properties can vary with direction of measurement in the cure of both films and foams. Many manufacturers incorporate specific additives into commercial plastics intended to improve certain properties for unusual or extreme service conditions. For example, additives are commonly employed to render certain grades or styles of plastics stable to ultraviolet radiation. When unusual or extreme exposure conditions are anticipated, consultation with appropriate specialists should be undertaken to select the proper material and grade or type. Certain types of rigid plastics are vulnerable to a particularly destructive mode of failure known as solvent crazing. This phenomenon occurs most frequently when stressed plastic samples or components are exposed to bulk organic liquids or high vapor concentrations. Following such exposure, the surface of the plastic develops a characteristic pattern of cracks, sometimes visible only under polarized light. Solvent induced cracks constitute critical flaws in the sense that they can lead to failure at stress levels well below the ultimate strength. Therefore, extreme caution must be exercised in specifying rigid plastics for applications where they may be subject to accidental or deliberate exposure to bulk liquids.

Foamed plastics shall not be used for metal skin reinforcement in structural components, nor as a core material in sandwich structural components other than all plastic sandwich parts, low density filler putties, or syntactic foams.

3.3.10 Glass Fiber Reinforced Plastics - Glass fiber reinforced plastic parts shall be designed using the guidelines of MIL-HDBK-17A. Special applications not included in MIL-HDBK-17A required NASA review and approval. Some reinforced plastics, notably fiberglass, graphite, and to a lesser extent boron reinforced epoxy materials, manifest progressive mechanical property changes which are a function of the time-temperature-humidity exposure history of the material or component. Interlaminar shear properties of these materials are particularly affected, and this characteristic must be anticipated during the design.

3.3.11 Lubricants - NASA SP-8063 and MSFC Lubrication Handbook for the Space Industry shall be used as guides in the design and application of lubricants for space flight systems and components. Lubricant outgassing requirements may be imposed by contract; if so, the contractual requirements must be satisfied. However, where no specific outgassing requirement exists, but where outgassing must or should be controlled or minimized, Johnson Space Center (JSC) specification SP-R-0022A and MSFC-HDBK-527/JSC 09604 should be used as guidelines in the selection of lubricants.

It shall be the responsibility of the in-house or contractor's design organization to prevent contamination of critical adjacent hardware, i.e., mirrors, lenses, other experiments, etc., by lubricants' outgassing vapors or lubricant creep or their natural wetting and wicking tendencies. The design organizations can accomplish this by the use of hermetic or labyrinth seals, directed overboard vent lines, the overall design of the hardware, etc., plus their choice and use of lubricants.

3.3.12 Adhesives - All adhesives shall meet material specification requirements that define minimum adhesive performance parameters and test methods appropriate thereto. The adhesive shelf life, storage and packaging, pot life, and mixture stoichiometry requirements shall be specified to assure an adequate and reproducible adhesive product. The successful use of adhesives demands absolute conformity with the materials and processes specification and with all elements or steps of the bonding (processing) specifications. Certain adhesives, notably the polyurethane type extensively used for cryogenic service, are vulnerable to temperature and humidity induced property changes over a period of time. Although these effects appear partially reversible, allowances must be made for them in design.

3.3.13 Glass and Ceramics - Structural applications of glass and ceramic materials shall be based on careful selection criteria. In general, design strength values shall be selected on known probabilities of failure, (i.e., by analysis, or proof testing of each part, including considerations of fracture mechanics analysis). Engineering data to verify the selection for each application shall be subject to review and approval by the NASA procuring activity.

3.4 ADVANCED COMPOSITE MATERIALS

Advanced composite materials may be used for structural applications where design performance and economical requirements justify their selection. All applications of advanced composite materials shall be reviewed and approved by NASA on request.

3.5 PROCESSES

3.5.1 Adhesive Bonding - Adhesive bonding shall meet the requirements of MSFC-SPEC-445. Validation of adhesive is required prior to use only when the shelf life or storage condition specified in the controlling materials specification has been exceeded. Utilization of materials and processes in conformance with these requirements is not to be construed as assurance that bonded assemblies will perform their intended function for the required life of the component. Therefore, the contractor shall conduct simulated service tests to demonstrate that the materials and processes selected will provide the desired properties for the entire life of the component. Extreme caution shall be exercised in the cleaning preparation and control of surfaces for bonding to preclude contamination from any source. Silicones are of particular concern and should be excluded from bonding areas not specifically dedicated to their use and control.

3.5.2 Welding - The design selection of parent materials and weld methods shall be based on considerations of weldments, including adjacent heat affected zones, as they affect operational capability of the parts concerned. Welding equipment procedures and materials shall be selected to provide the required weld quality, minimum weld energy input, and protection of the heated metal from contaminants. The suitability of the equipment, processes, welding supplies and supplementary treatments selected shall be demonstrated through qualification testing of welded specimens representing the materials and joint configuration of production parts. As a minimum requirement, welding operators shall be qualified in accordance with MIL-STD-1595. In addition, the contractor shall provide the necessary training and qualification requirements to certify each operator and the applicable welding equipment for specific welding tasks required of critical space flight hardware such as pressure vessel weldments, tubing weldments, and other primary structural components. The contractor training and certification requirements, including appropriate weld schedules and procedures are subject to review and approval by NASA on request prior to performing the first production weld on all critical or primary structural components. Techniques, such as partial penetration pass welds from two sides, which have the potential for building in undetectable flaws, shall not be used in any design or fracture critical application.

3.5.2.1 Weld Repair - Weld repairs shall be minimized by discriminatory selection of acceptable methods, procedures, and specifications which shall be reviewed by NASA during the initial design review activities with the contractor or subcontractor. Weld repair is limited to the repair of welding defects in a production weld as revealed by inspection. Weld repair does not include the correction of dimensional deficiencies by weld buildup or "buttering" of parts in areas where the design did not provide a welded joint. All weld repairs shall be fully documented to facilitate NASA review on request. Documentation shall include, as a minimum, weld procedures and schedules, location of repair, nature of problem, and appropriate inspection and qualification requirements for acceptance. The quality of repair welds shall be confirmed by 100 percent inspection of both surface and subsurface, using visual, dimensional and nondestructive testing techniques. The repair of welds in high performance or critical parts is not acceptable unless appropriately reviewed and approved by a cognizant materials review committee, whose membership includes a delegated representative of NASA. The results of the committee action are subject to review by NASA on request.

3.5.2.2 Weld Filler Metal - Weld rod or wire used as filler metal on structural parts shall be fully certified and documented per the requirements of MSFC-STD-655 for composition, type, heat number, manufacturer, supplier, etc., as required to provide positive traceability to the end use item. In addition, for flight hardware welds, qualitative analysis and nondestructive testing shall be conducted on segments of each filler rod or wire per requirements of MSFC-STD-655 to assure that the correct filler metal is used on each specific welding task.

3.5.2.3 Aluminum Welding - The welding of aluminum alloys for high strength applications shall meet the requirements of MSFC-SPEC-504. Alternate welding specifications are allowed only if sufficient data are available to substantiate that the specification is satisfactory for the intended application. Alternate welding specifications and supporting data must be approved by NASA on request.

3.5.3 Brazing - Brazing shall meet the requirements of MIL-B-7883. Subsequent fusion welding operations in the vicinity of brazed joints or other operations involving high temperatures which affect the brazed joint is prohibited. Brazed joints shall be designed for shear loading and shall not be relied upon for strength in tension for structural parts. A word of caution is in order regarding the brazing of 300 series CRES in a carbonizing atmosphere. During all brazing operations using hydrogen atmosphere every precaution should be taken to ensure no form of carbon exists in the oven. Parts with thin cross sections (such as bellows) can be sensitized during short exposure to carbon environments.

3.5.3.1 Braze Filler Metal - Braze rod, wire, foil or powder shall be fully certified and documented per the requirements of MSFC-STD-969 for composition, type, heat number, manufacturer, specification, etc. as required to provide positive traceability to the end use item. In addition, for flight hardware brazing, verification at the lowest level of control, e.g. each rod, coil of wire, or container of powder, shall include quantitative analysis and nondestructive testing per the requirements of MSFC-STD-969.

3.5.4 Soldering - Soldering shall not be used for structural applications unless reviewed and approved by the procuring activity.

3.5.5 Welding of Steel Alloys - Welding of steel alloys shall meet the requirement of MSFC-SPEC-560.

3.6 MATERIALS NONDESTRUCTIVE INSPECTION

The nondestructive evaluation (NDE) activities associated with aerospace hardware shall meet the basic requirements of MIL-I-6870. A nondestructive inspection (NDI) plan shall be prepared and retained by the contractor, available for review by MSFC upon request. This plan shall present the scheme for establishing the nondestructive inspection/test (NDI/NDT) requirements, and implementation procedures to meet these requirements. It shall include:

a. The means of coordinating design requirements with NDI/NDT requirements and capabilities.

b. Acknowledgement of all NDI/NDT to be implemented.

c. The means of preparing, revising, and controlling company NDI/NDT specifications and procedures.

d. The means of implementing NDI/NDT specifications and procedures, including personnel certification, facilities qualification, technique certification, and recertification and control.

e. The means of coordinating applicable NDI/NDT specifications and procedures with MSFC, i.e., submittal of contractor generated NDI/NDT specifications for MSFC review and retention, and contractor retention of NDI/NDT procedures subject to NASA request.

f. The means of implementing periodic service life NDI/NDT, if required.

g. Acknowledgement of components designated for fracture control and the means of controlling associated NDI/NDT specifications and procedures, when a Fracture Mechanics/Control Program is contractually required.

Nondestructive inspection techniques employed on materials and processes shall meet the requirements of MIL-I-6870 for penetrant, magnetic particle, radiographic, eddy current, and ultrasonic inspection. Inspection techniques for castings shall meet the requirements of MIL-C-6021.

3.7 MATERIALS REQUIRING CONTROLLED ENVIRONMENTS

Materials requiring controlled environments while in ground storage to insure adequate performance in flight shall be defined for concurrence by the procuring activity. Information on required environments and potential degradation of the material expected from uncontrolled conditions shall be provided by the contractor.

3.8 MATERIALS FOR USE IN SPECIAL ENVIRONMENTS

Specifications covering materials for use in hazardous or special environments do not automatically void other material specifications. Each requirement shall be met as dictated by the specific applications and the total system criteria unless otherwise approved by special waiver/MUA.

3.9 CONTAMINATION CONTROL

The contractor shall submit a contamination control plan per the requirements of DR-6.

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DATA REQUIREMENT (DR)

Field	Content
1. DATA PROCUREMENT DOC. NO. / ISSUE	
2. TITLE	Materials and Processes Selection and Verification Plan
3. OPR	
4. DR NO. / PAGE / DATE / REV.	M&P-1 / 1

SUBMITTAL REQUIREMENTS

Field	Content
5. TYPE	1
6. FREQUENCY OF SUBMISSION	As Required
7. DISTRIBUTION	
8. INITIAL SUBMISSION	Two weeks prior to PDR
9. AS OF DATE	
10. REMARKS	

DATA REQUIREMENT DESCRIPTION

Field	Content
11. STANDARD DRD TITLE	
12. STD DRD NO. / REV / PAGE / DATE	
13. USE	To define the objectives, procedures, logic, and management controls of the contractor's materials and processes control and verification program, and the contractor's interfaces with the procuring activity necessary in the operation of the plan.
14. INTERRELATIONSHIP	
15. REFERENCE	

16. PREPARATION INFORMATION:

16.1 SCOPE

A document shall be provided which defines the objectives, logic procedures, required actions, responsibilities, and management controls the contractor will use in establishing and maintaining a Materials & Processes Selection and Verification Plan.

16.2 APPLICABLE DOCUMENTS

MSFC-STD-506, MSFC-SPEC-522, JSC SP-R-0022A

16.3 CONTENTS

The plan shall describe the contractors activities involved in the identification, evaluation, documentation, and reporting of material usages in space flight hardware. It shall define the necessary interfaces with the procuring activity in the operation of this plan. As a minimum, the plan shall cover the following:

MSFC - Form 3461-5 (Rev August 1970)

DR-1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

2. TITLE:	3. OPR:	1. DATA PROCUREMENT DOC. NO. ISSUE / 4. DR NO. PAGE DATE REV.
Materials& Processes Selection and Verification Plan		M&P-1 2

DATA REQUIREMENT DESCRIPTION - CONTINUATION

11. STANDARD DRD TITLE:

12. STD DRD NO. REV PAGE DATE

13. PREPARATION INFORMATION:

a. Contractor's Organization - Authority shall be assigned to an individual or group who shall be responsible for review and approval of all materials and processes called out on all drawings prior to release and that these materials and processes meet the requirements of the referenced documents.

b. Materials Identification - Identification and documentation of material used, both in original design and in any change.

c. Processes Identification - Identification and documentation of processes used, both in original design and in any change.

d. Usage Evaluation - Documentation of materials and processes used and the comparison of test data to establish selection of test requirements.

e. Testing - Logic, procedures, and data documentation for any proposed test program to support materials screening and verification testing. Any material/process testing to be performed by the contractor will require prior NASA approval.

f. Hazard Removal - Procedure involved in the removal of identified hazards.

g. MUA Procedures - Procedures involved in documenting and approving materials/processes that do not meet the established requirements but are proposed for use in the spacecraft due to lack of replacement materials or other considerations.

h. Formal Review Procedures - Procedures used to summarize the status of materials and processes to permit certification of acceptability of a given design or a given configuration at NASA designated hardware milestone reviews, such as PDR's, CDR's, FACI's, CARR's, FRR's, etc. The contractor shall have available the following information in support of the end-item milestone reviews as applicable: Standard Materials Worksheet packages; Materials Deviations Summary (Drawings and Drawing Tree); Material Test Data and Usage Rationale Summary; Materials Review Board Action Status; Preliminary Materials Lists; and Final Materials List.

i. Plan Content - Contractor shall address each paragraph of MSFC-STD-506 and indicate how he will implement.

j. New Technology - Identify areas of new test technology or technique improvement for consideration.

MSFC - Form 3461-6 (Rev August 1970)

DR-1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

2. TITLE:	3. OPR:	1. DATA PROCUREMENT DOC. NO. ISSUE / 4. DR NO. PAGE DATE REV.
Materials & Processes Selection and Verification Plan		M&P-1 3

DATA REQUIREMENT DESCRIPTION - CONTINUATION

11. STANDARD DRD TITLE:	12. STD DRD NO. REV PAGE DATE

16. PREPARATION INFORMATION:

The contractor/supplier shall define in the selection and verification plan a systematic and continuing program to report and control materials and process use, status, test, evaluation, substitution, and verification. The final selection and verification plan shall be approved by NASA.

16.4 FORMAT

Format shall be consistent with the contents of paragraph 16.3 of this DR.

16.5 MAINTENANCE

Update by change page or complete reissue.

MSFC - Form 3461-6 (Rev August 1970)

DR-2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

1. DATA PROCUREMENT DOC. NO.	ISSUE

2. TITLE:	3. OPR:	4. DR NO.	PAGE	DATE	REV.
Material Usage Agreements (MUA's)		M&P-2	1		

SUBMITTAL REQUIREMENTS

5. TYPE: 1

6. FREQUENCY OF SUBMISSION: As Required

7. DISTRIBUTION:

8. INITIAL SUBMISSION: As identified in design

9. AS OF DATE:

10. REMARKS:

DATA REQUIREMENT DESCRIPTION

11. STANDARD DRD TITLE:

12. STD DRD NO. REV PAGE DATE

13. USE: For MSFC review and approval of all material usages which do not comply with contractual specification requirements. If components have been utilized in a simiiar application, the contractor can propose, thru MUA's that the component be approved on the basis of compatibility without a detailed material callout.

14. INTERRELATIONSHIP: Materials & Processes Selection and Verification Plan

15. REFERENCE:

16. PREPARATION INFORMATION:

16.1 SCOPE

This DR establishes content, format, maintenance, and submittal requirements for Material Usage Agreements (MUA's).

16.2 APPLICABLE DOCUMENTS

MSFC-STD-506, MSFC-SPEC-522, NHB 8060.1, JSC SP-R-0022

16.3 CONTENTS

The MUA's shall contain the information required by MSFC Form 551 (copy attached) with each of the applicable block completed. The form shall be dated and submitted to MSFC with the program contract manager's signature entered in the Program Manager block. Detailed treatment of the material application and rationale for usage acceptability shall be submitted to the extent necessary for MSFC evaluation.

MSFC - Form 3461-5 (Rev August 1970)

DR-2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

1. DATA PROCUREMENT DOC. NO.	ISSUE

2. TITLE:	3. OPR:	4. DR NO.	PAGE	DATE REV.
Material Usage Agreements (MUA's)		M&P-2	2	

DATA REQUIREMENT DESCRIPTION - CONTINUATION

11. STANDARD DRD TITLE:	12. STD DRD NO.	REV	PAGE	DATE

16. PREPARATION INFORMATION:

16.4 FORMAT

MSFC Form 551 (Feb. 1983) is the acceptable format for submittal of MUA data.

16.5 MAINTENANCE

The contractor shall maintain such files as necessary for tracking, reporting status, and traceability of submittals and response to the MUA provided to MSFC.

MSFC - Form 3461-6 (Rev August 1970)

MATERIAL USAGE AGREEMENT	C	USAGE AGREEMENT NO.:	REV	PAGE OF

PROJECT:	SUBSYSTEM:	ORIGINATOR:	ORGANIZATION:

DETAIL DRAWING (S)	USING ASSEMBLY (S)	ITEM DESCRIPTION	ISSUE

MATERIAL	TRADE NAME	SPECIFICATION	MANUFACTURER

THICKNESS	WEIGHT	EXPOSED AREA	LOCATION	ENVIRONMENT		
			HABITABLE ☐	PRESSURE	TEMPERATURE	MEDIA
			NONHABITABLE ☐			

APPLICATION

RATIONALE:

ORIGINATOR:	PROGRAM MANAGER:	DATE:

MATERIALS APPLICATIONS EVALUATION BOARD DISPOSITION

	DATE	APPROVE	REJECT	DEFER	MAEB MINUTES
CHAIRMAN:					
CHIEF, EH02:					
SECRETARY:					

REMARKS:

MSFC - Form 881 (Rev. February 1983)

MSFC-SPEC-522A

APPENDIX C

STRESS CORROSION EVALUATION FORM

1. Part Number ____________________

2. Part Name ____________________

3. Next Assembly Number ____________________

4. Manufacturer ____________________

5. Material ____________________

6. Heat Treatment ____________________

7. Size and Form ____________________

8. Sustained Tensile Stresses-Magnitude and Direction

   a. Process Residual ____________________

   b. Assembly ____________________

   c. Design, Static ____________________

9. Special Processing ____________________

10. Weldments

   a. Alloy Form, Temper of Parent Metal ____________________

   b. Filler Alloy if none, indicate ____________________

   c. Welding Process ____________________

   d. Weld Bead Removed-Yes ( ), No ( ) ____________________

   e. Post-Weld Thermal Treatment ____________________

   f. Post-Weld Stress Relief ____________________

11. Environment ____________________

MSFC STD 506C

MSFC-SPEC-522A

APPENDIX C (CONTINUED)

12. Protective Finish____________________

13. Function of Part____________________

____

14. Effect of Failure____________________

____

15. Evaluation of Stress Corrosion Susceptibility____________________

____

16. Remarks:____________________

____

DR-3

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

DATA PROCUREMENT DOC.
1. NO. ISSUE

2. TITLE: Material & Process Specification List

3. OPR:

4. DR NO. PAGE DATE REV.
M&P-3 1

SUBMITTAL REQUIREMENTS

5. TYPE: 1

6. FREQUENCY OF SUBMISSION: Quarterly update, negative replies are required when there are no revisions during quarter.

7. DISTRIBUTION:

8. INITIAL SUBMISSION: Two weeks prior to PDR.

9. AS OF DATE:

10. REMARKS:

DATA REQUIREMENT DESCRIPTION

11. STANDARD DRD TITLE:

12. STD DRD NO. REV PAGE DATE

13. USE: To identify all material and process specifications used in fabrication, control and inspection of the materials and articles fabricated under this contract.

14. INTERRELATIONSHIP:

15. REFERENCE:

16. PREPARATION INFORMATION:

16.1 SCOPE

This DR establishes the content, format, maintenance, and submittal requirements for a list of all materials and process specifications.

16.2 APPLICABLE DOCUMENTS

MSFC-STD-506

16.3 CONTENTS

A list of all material and process specifications shall be submitted. The list shall contain the following information as a minimum for each specification:

a. Specification/procedure title and author.

b. Identification of revisions and updates.

MSFC - Form 3461-5 (Rev August 1970)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

2. TITLE: Material & Process Specification List	3. OPR:	1. DATA PROCUREMENT DOC. NO. ISSUE
		4. DR NO. PAGE DATE REV. MAP-3 2

DATA REQUIREMENT DESCRIPTION - CONTINUATION

11. STANDARD DRD TITLE:	12. STD DRD NO. REV PAGE DATE

16. PREPARATION INFORMATION:

c. Title, revision and identification of subcontractor documents excluding standard parts (EEE, MS, etc.)

d. Designation of which process specifications are critical* to fabrication, control and inspection of the contract end items. SCN 1

16.4 FORMAT

The contractor's format shall be used.

16.5 MAINTENANCE

As required by MSFC.

* A critical process is an operation, treatment or procedure used as a step in manufacturing, testing or inspection that, if improperly or inadequately performed, can have a significant performance effect on any of the following: SCN 1

- Hardware identified on the Critical Items List (CIL)
- Hardware designated for fracture control
- Ordnance hardware
- Hardware where design conformance is not assured by inspection or test
- Hardware which has a high technical risk, i.e. stringent technical performance requirements in its intended application relative to state-of-the-art techniques for the item

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION DATA REQUIREMENT (DR)		DATA PROCUREMENT DOC. 1. NO. ISSUE
2. TITLE: Plan, Manufacturing	3. OPR:	4. DR NO. PAGE DATE REV. M&P-4 1

SUBMITTAL REQUIREMENTS

5. TYPE: 1	6. FREQUENCY OF SUBMISSION: One time with revisions.
7. DISTRIBUTION:	8. INITIAL SUBMISSION: 60 days after contract award.
9. AS OF DATE:	
10. REMARKS:	

DATA REQUIREMENT DESCRIPTION

11. STANDARD DRD TITLE:		12. STD DRD NO. REV PAGE DATE
13. USE: To provide visibility to MSFC management that the contractor fully understands the magnitude of the job to be done and has provided a reasonable plan of action to ensure that projected schedules can be realized.	14. INTERRELATIONSHIP: Assembly and Verification Plan Make or Buy Plan	15. REFERENCE:

16. PREPARATION INFORMATION:

16.1 SCOPE

This DR establishes the content, format, maintenance, and submittal requirements for a deliverable Manufacturing Plan.

16.2 APPLICABLE DOCUMENTS

MSFC-STD-506 Standard, Material and Process Control

16.3 CONTENTS

The plan shall define the objective, methods and procedures, schedules, and logical flows to be used to manufacture the deliverable hardware. The plan shall logically describe the sequence of events for hardware production and present solutions to unusual requirements such as handling, packaging, shipping, cleaning, refurbishment, etc. Specifically, the plan shall contain:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION DATA REQUIREMENT (DR)		1. DATA PROCUREMENT DOC. NO. ISSUE
2. TITLE: Plan, Manufacturing	3. OPR:	4. DR NO. PAGE DATE REV. M&P-4 2

DATA REQUIREMENT DESCRIPTION - CONTINUATION

11. STANDARD DRD TITLE:	12. STD DRD NO. REV PAGE DATE

16. PREPARATION INFORMATION:

16.3 CONTENTS (Continued)

a. Procurements - All major components/assemblies to be procured rather than manufactured in-house shall be identified. Long lead time procurements shall be identified as well as any specific risks associated with sole source or proprietary or one source only items.

b. Tooling - Concepts, illustrations and logical flow plans shall be provided which clearly define tooling concepts for both detail parts fabrication and component assembly and which demonstrate that all manufacturing processes and assembly methods are fully understood. Requirements for interface drill jigs or other mating schemes shall be fully defined. Unusual tooling requirements or equipment and facility needs shall be defined.

c. Schedule - A detail schedule shall be provided showing milestone dates in order to ensure that deliverable item end dates will be met.

d. Critical Processes - All processes, methods, facilities or tooling and skills critical to success shall be identified. The schedule should fully reflect required availability milestone dates of all project critical items. Processes that are new or unique or any that are unfamiliar are to be identified and reasons explained why these processes are to be used.

MSFC-STD-506 shall be used as a guide in preparing the plan.

16.4 FORMAT

Format shall be consistent with the contents of paragraph 16.3 of this DR.

16.5 MAINTENANCE

Update by change page or complete reissue.

DR-5

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

1. DATA PROCUREMENT DOC. NO. ISSUE

2. TITLE: List, Material Identification Usage

3. OPR:

4. DR NO. PAGE DATE REV.: M&P-5 1

SUBMITTAL REQUIREMENTS

5. TYPE:

6. FREQUENCY OF SUBMISSION: Revise and submit quarterly

7. DISTRIBUTION:

8. INITIAL SUBMISSION: Two weeks prior to PDR.

9. AS OF DATE:

10. REMARKS:

DATA REQUIREMENT DESCRIPTION

11. STANDARD DRD TITLE:

12. STD DRD NO. REV PAGE DATE

13. USE: To identify all material usages contained in the end item excluding piece part electronics and except as approved by MUA.

14. INTERRELATIONSHIP: Materials and Processes Control Plan (M&P-1)

15. REFERENCE:

16. PREPARATION INFORMATION:

16.1 SCOPE

This DR establishes content, format, maintenance, and submittal requirements for the Material Identification Usage List (MIUL).

16.2 APPLICABLE DOCUMENTS

NHB 8060.1, JSC SP-R-0022, MSFC-SPEC-522, MSFC-STD-506

16.3 CONTENTS

The MIUL shall comply with MSFC-STD-506.

a. Detail drawing and dash number

b. Next assembly and dash number

c. Change letter designation

MSFC - Form 3461-5 (Rev August 1970)

DR-5

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

2. TITLE:	3. OPR:	1. DATA PROCUREMENT DOC. NO. ISSUE
List, Material Identification Usage		4. DR NO. PAGE DATE REV. M&P-5 2

DATA REQUIREMENT DESCRIPTION - CONTINUATION

11. STANDARD DRD TITLE:	12. STD DRD NO. REV PAGE DATE

16. PREPARATION INFORMATION:

d. Drawing source (contractor or vendor)

e. Material form

f. Material manufacturer

g. Material manufacturer's designation

h. Material specification

i. Process specification

j. Environment

k. Weight

l. Surface area

16.4 FORMAT

The format will be selected from the attached forms.

16.5 MAINTENANCE

The MIUL shall be maintained by change page or complete reissue.

MSFC - Form 3461-6 (Rev August 1970)

EH140

PREPARED BY		DATE
ASSOC CONTR	DOCUMENT/PART NO.	R/L

MATERIALS USAGE ENTRY SHEET
MATERIALS INFORMATION

LINE NO	MATERIAL CODE	OVERALL EVALUATION										MATERIAL WEIGHT LBS	MATERIAL SURFACE AREA SQ IN	MATERIAL THICKNESS IN	OVERALL CONFIG TEST REPORT	SYSTEM ENVIRONMENT DATA				
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CORR	[illegible]	[illegible]	[illegible]					FLUID TYPE	MAX SYS PRES PSIA	MIN SYS PRES PSIA	MAX MATL TEMP DEG F	MIN MATL TEMP DEG F

LINE NO	T/W	TEST MUA DOCUMENT	MATERIALS SPECS SUPPORT DOCUMENT	MANUFACTURER'S DESIGNATION	CURE CODES			
					FL	TOX	TVS	FSC

LINE NO	PROCESS SPECIFICATION

APPROVALS		
ORIGINAL	INIT	DATE
METALS		
NONMETALS		

MATERIALS USAGE ENTRY SHEET
HEADER/NEXT ASSEMBLY INFORMATION

PREPARED BY		DATE					
ASSOC CONTR	DOCUMENT/PART NO.	R/L	FRAC	PROJECT	SYSTEM	SUBSYSTEM	TEMP RANGE: MIN DEG F / MAX DEG F

ENVIRONMENT: % O2	% N2	PRESSURE—PSIA	DOCUMENT TITLE

CRITI-CALITY	REMARKS

NA SEQ	NEXT ASSEMBLY	DASH	NA SEQ	NEXT ASSEMBLY	DASH	NA SEQ	NEXT ASSEMBLY	DASH

MATERIALS USAGE MODIFICATION/UPDATE SHEET

REVISED BY	DATE
EXISTING ASSOC CONTR CODE	
EXISTING DOCUMENT/PART NO	
EXISTING REVISION LETTER	

ASSOC CONTR	DOCUMENT/PART NO	R/L	FRAG	PROJECT	SYSTEM	SUBSYSTEM	TEMP RANGE MIN DEG F	TEMP RANGE MAX DEG F

ENVIRONMENT % O_2	ENVIRONMENT % N_2	ENVIRONMENT PRESSURE—PSIA	DOCUMENT TITLE

CRITICALITY	REMARKS

NA SEQ	NEXT ASSEMBLY	DASH	NA SEQ	NEXT ASSEMBLY	DASH	NA SEQ	NEXT ASSEMBLY	DASH

LINE NO	MATERIAL CODE	OVERALL EVALUATION: FLAM	TOX	TVS	AGE	[illegible]	[illegible]	CORR	AO	[illegible]	[illegible]	MATERIAL WEIGHT LBS	MATERIAL SURFACE AREA SQ IN	MATERIAL THICKNESS IN	OVERALL CONFIG TEST REPORT	SYSTEM ENVIRONMENT DATA: FLUID TYPE	MAX SYS PRES PSIA	MIN SYS PRES PSIA	MAX MATL TEMP DEG F	MIN MATL TEMP DEG F

LINE NO	T/W	TEST MUA DOCUMENT	MATERIALS SPECS SUPPORT DOCUMENT	MANUFACTURER'S DESIGNATION	CURE CODES FL	TOX	TVS	FSC

LINE NO	PROCESS SPECIFICATION

APPROVALS		
REVISION	INIT	DATE
METALS		
NONMETALS		

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

2. TITLE: PLAN, CONTAMINATION CONTROL AND IMPLEMENTATION	3. OPR:	1. DATA PROCUREMENT DOC. NO. / ISSUE: DR-6
		4. DR NO. PAGE DATE REV.: M&P- 12-13-88

DATA REQUIREMENT DESCRIPTION - CONTINUATION

11. STANDARD DRD TITLE:	12. STD DRD NO. REV PAGE DATE

16. PREPARATION INFORMATION:

control, monitoring, and reporting methodology for all hardware from fabrication through on-orbit operations to return and storage. This plan shall cover as a minimum the following:

(1) Cleaning, Inspection, and Certification Methodology and Frequency.

(2) Environment Definition and Traceability.

(3) Thermal Vacuum Bakeout Criteria, Conditions, and Instrumentation.

(4) Contamination Violation Reporting and Effects Assessment.

(5) Bagging and Packaging, Criteria and Materials.

(6) Transportation Controls and Monitoring.

(7) Clean Room Garments, Controls, and Monitoring.

These plans shall describe activities, as appropriate, from design through receiving inspection at the point of receipt by the mission integrator.

In addition, a plan shall be prepared describing the methods and planning for contamination control for the integration activities. Additional CCIP's shall be prepared defining the contamination controls and method of implementation for the transportation phase and the prelaunch through postflight storage activities as applicable.

B. The effect of the external environment on contaminated Space Station surfaces shall be assessed in terms of optical and other property changes that affect systems life and performance. This assessment should cover the environments of atomic oxygen, UV radiation and particulate radiation. The effects of micrometeoroid/space debris impacts with accompanying debris generation shall be assessed.

MSFC - Form 3461-6 (Rev August 1970)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DATA REQUIREMENT (DR)

1. DATA PROCUREMENT DOC. NO. DR-6 ISSUE		
2. TITLE: PLAN, CONTAMINATION CONTROL AND IMPLEMENTATION	3. OPR:	4. DR NO. PAGE DATE REV. M&P-

SUBMITTAL REQUIREMENTS

5. TYPE: 1	6. FREQUENCY OF SUBMISSION: Three weeks prior to PDR. Three weeks prior to CDR. Revise as required.
7. DISTRIBUTION: EH01 EH02 EH11 EH12 EH32	
9. AS OF DATE:	8. INITIAL SUBMISSION: Three weeks prior to PDR.

10. REMARKS:

DATA REQUIREMENT DESCRIPTION

11. STANDARD DRD TITLE:	12. STD DRD NO. REV PAGE DATE

13. USE:	14. INTERRELATIONSHIP:	15. REFERENCE:
To be used to assess and control the internal and external surfaces and instrumentation, respectively, as it affects systems life and performance.	Materials and Processes Control Plan Space Environmental Effects on Materials and Systems Life and Performance Plan and Analysis Report	MSFC-STD-506

16. PREPARATION INFORMATION:

16. PREPARATION INFORMATION

16.1 SCOPE

This DR establishes content, format, maintenance, and submittal requirements for the Contamination Control and Implementation Plan.

16.2 APPLICABLE DOCUMENTS

JSC-20149, Revision A
JSC-SP-R-0022A
MSFC-50M02442
NHB 8050.1C
MIL-STD-1246A
FED-STD-209B

16.3 CONTENTS

A. The Contamination Control and Implementation Plan for complying with the program's contamination requirements shall be prepared to provide uniform

MSFC - Form 3461-5 (Rev August 1970)

PACKAGE NO. 10443R

DOCUMENTATION RELEASE LIST
GEORGE C. MARSHALL SPACE FLIGHT CENTER

MSFC CODE IDENT 14981/339B2
ISSUE DATE FEB 22 2007

CH	DOCUMENT NUMBER	DRL DSH	DRL REV	TITLE	CCBD NO.	PCN	PC	EFFECTIVITY
*	MSFC-STD-506	203	-	STANDARD MATERIALS AND PROCESSING CONTROL	000-00-0000	0000000	M	NONE

	CHG NO.	CHG REV	CHG NOTICE	RESPONSIBLE ENGINEER	RESPONSIBLE ORGANIZATION	ACTION DATE	DESCRIPTION
		C	SCN000	D. GRIFFIN	EH02	02/03/94	REVISION 'C' RELEASED 01/03/89.
	1	C	SCN001	D. GRIFFIN	EH02	02/03/94	RELEASES CHANGE PAGES TO REVISION 'C' RELEASED 03/15/91.
	2	C	SCN002	TERRIE RICE	EH43	06/18/97	THREADED FASTENER PARAGRAPH UPDATE
*	3	C	SCN000	EUGENA GOGGANS	EO03	02/22/07	DOCUMENT RELEASED THRU PDS. NO LONGER TRACKED IN ICMS.

CHECKER

N/A
02/15/07

(FINAL)

PACKAGE NO: 10443R

PROGRAM/PROJECT: MULTI

LAST UPDATED: 02/22/07

NOMENCLATURE: MSFC-STD- GOING TO NONE EFFECTIVITY

ECR NO:	PCN:	CCBD NO:	DATE PREPARED:
E003-0000	0000000	000-00-0000 SB3-00-0000	02/22/07

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-HDBK-1453		202	-			
			MSFC-HDBK-1674		202	-			
			MSFC-HDBK-2221		203	-			
			MSFC-HDBK-505		202	-			
			MSFC-HDBK-670		202	-			
			MSFC-MNL-1951		209	-			
			MSFC-PROC-1301		202	-			
			MSFC-PROC-1721		202	-			
			MSFC-PROC-1831		202	-			
			MSFC-PROC-1832		202	-			
			MSFC-PROC-404		202	-			
			MSFC-PROC-547		202	-			
			MSFC-QPL-1918		204	-			
			MSFC-RQMT-1282		202	-			
			MSFC-SPEC-1198		202	-			
			MSFC-SPEC-1238		202	-			
			MSFC-SPEC-1443		202	-			
			MSFC-SPEC-164		202	-			
			MSFC-SPEC-1870		202	-			
			MSFC-SPEC-1918		203	-			
			MSFC-SPEC-1919		206	-			
			MSFC-SPEC-2083		202	-			
			MSFC-SPEC-2223		202	-			
			MSFC-SPEC-2489		206	-			
			MSFC-SPEC-2490		205	-			
			MSFC-SPEC-2491		203	-			
			MSFC-SPEC-2492		203	-			
			MSFC-SPEC-2497		211	-			
			MSFC-SPEC-250		202	-			
			MSFC-SPEC-445		202	-			
			MSFC-SPEC-504		202	-			
			MSFC-SPEC-521		202	-			
			MSFC-SPEC-548		202	-			
			MSFC-SPEC-560		202	-			
			MSFC-SPEC-626		202	-			
			MSFC-SPEC-684		202	-			
			MSFC-SPEC-708		202	-			
			MSFC-SPEC-766		202	-			
			MSFC-STD-1249		202	-			
			MSFC-STD-1800		202	-			
			MSFC-STD-246		202	-			
			MSFC-STD-2594		203	-			

PACKAGE NO: 10443R

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-STD-2903		202	-			
			MSFC-STD-2904		202	-			
			MSFC-STD-2905		202	-			
			MSFC-STD-2906		202	-			
			MSFC-STD-2907		202	-			
			MSFC-STD-366		202	-			
			MSFC-STD-383		202	-			
			MSFC-STD-486		202	-			
			MSFC-STD-506		203	-			
			MSFC-STD-531		202	-			
			MSFC-STD-557		202	-			
			MSFC-STD-561		203	-			
			MSFC-STD-781		202	-			

SUBMITTED BY ENGINEERING AREA:	BASIC	CHANGE	PARTIAL	COMPLETE	CLOSES ACTION
EO03		X		X	EO03

PREPARED BY:
EUGENA GOGGANS
12/19/06

SUBMITTED BY:

CONCURRENCE:

TRANSMITTAL DATES
TO RELEASE DESK 02/22/07 10:00
TO MSFC DOC REP 02/22/07 00:00

REMARKS:

2007 FEB 22 AM 11:22

MSFC DOCUMENTATION REPOSITORY - DOCUMENT INPUT RECORD

I. GENERAL INFORMATION

1. APPROVED PROJECT:	2. DOCUMENT/ DRAWING NUMBER:	3. CONTROL NUMBER:	4. RELEASE DATE:	5. SUBMITTAL DATE:
Multi Program/Project Document	MSFC-STD-506 Rev. C		06/11/1997	08/11/2003

6. DOCUMENT/DRAWING TITLE:	7. REPORT TYPE:
Standard Material and Processes Control	MSFC Standard

8. CONTRACT NUMBER / PERFORMING ACTIVITY:	9. DRD NUMBER:	10. DPD / DRL / IDRD NUMBER:
N/A	N/A	N/A

11. DISPOSITION AUTHORITY (Check One):	12. SUBMITTAL AUTHORITY:	13. RELEASING AUTHORITY:
[X] Official Record - NRRS 8/12/A ~~[X]~~ Reference Copy - NRRS 8/5/A/3 (destroy when no longer needed)	Steven J. Gentz	Gail H Gordon 8/11/03

14. SPECIAL INSTRUCTIONS:
This procedure is a multiprogram/project support document used to defineMaterials and Processes Control standards.

15. CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER:	16. ORIGINATING NASA CENTER: / 17. OFFICE OF PRIMARY RESPONSIBILITY:
Steven J. Gentz ED35/Materials Processes & Manufacturing Dept. Building 4612 544-2570	16. MSFC 17. ED35

18. PROGRAMMATIC CODE (5 DIGITS):	19. NUMBER OF PAGES:
336-33-60	44

II. ENGINEERING DRAWINGS

20. REVISION:	21. ENGINEERING ORDER:	22. PARTS LIST:	23. CCBD:
N/A			

III. REPORTS, SPECIFICATIONS, ETC.

24. REVISION:	25. CHANGE:	26. VOLUME:	27. BOOK:	28. PART:	29. SECTION:
~~N/A~~ C					

30. ISSUE:	31. ANNEX:	32. SCN:	33. DCN:	34. AMENDMENT:

35. APPENDIX:	36. ADDENDUM:	37. CCBD:	38. CODE ID:	39. IRN:

IV. EXPORT AND DISTRIBUTION RESTRICTIONS

- [ ] Privacy Act (see MWI 1382.1)
- [ ] Proprietary (see MPD 2210.1)
- [ ] Patent (see MPG 2220.1)
- [ ] ITAR (see MPG 2220.1)
- [ ] EAR (see MPG 2220.1)
- [ ] Other ACI (see NPG 1620.1 and MPG 1600.1) ______
- [X] No statutory or institutional restrictions applicable -- material may be electronically distributed to user in the NASA domain

V. ORIGINATING ORGANIZATION APPROVAL

40. ORG. CODE:	41. PHONE NUMBER:	42. NAME:	43. SIGNATURE/DATE:
ED35	(256) 544-2570	Steven J. Gentz	for Richard Wright 8/11/03

VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

44. RECEIVED BY:	45. DATE RECEIVED:	46. WORK ORDER:
Tammy Wise	10-15-03	