



Pratt &amp; Whitney Rocketdyne

ROCKET ENGINEERING INSTRUCTION

REI 001

Issued July 1994

Revised December 2005

**MASTER SPECIFICATION INDEX  
FOR THE SSME TURBOPUMP**

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### 1. SUBJECT

This Rocket Engineering Instruction (REI) is a Master Specification Index for the Space Shuttle Main Engine (SSME) Alternate Turbopump program at Pratt & Whitney Rocketdyne (PWR) – West Palm Beach (WPB).

#### 1.1 Purpose

To list documents applicable to the SSME Alternate Turbopump program whose requirements or use are subject to customer or internal change control. The lists include specifications, instructions, test methods and standards, and material controls used under Contracts NAS8-36801 and R20SPA01550585 and are provided in compliance with contract Data Requirements RA-07 and 55-E-708 (respectively).

#### 1.2 Scope

This REI is issued to control changes to Engineering Specifications, Rocket Engineering Instructions, Inspection Methods and Standards, Quality Assurance Specifications, or other controlled documents used by PWR or its suppliers, in accordance with specifications on Engineering Drawings, QADs, or other related documents.

#### 1.3 Ownership and Approval

The SSME Program Chief Engineer or his designee, as specified in the PWR-WPB REI web site, owns and approves this instruction. All changes shall be approved by the owner, with the concurrence of organizations affected by the change.

### 2. APPLICABLE DOCUMENTS

#### 2.1 Applicable documents:

ASQR-01                      Aerospace Supplier Quality Requirements

#### 2.2 Reference documents: The following documents are reference documents and do not form part of this specification.

|                   |   |
|-------------------|---|
| NAS8-36801        | NASA Contract: Data Requirement RA-07   |
| R20SPA01550585    | Rocketdyne Contract: Data Requirement 55-E-708  |
| FR-19678          | SSME AT Configuration Management Plan   |
| SPP 6.8.5.1       | SSME Rocket Engineering Instructions  |
| PP/PR:93-015      | Processing New or Revised SSME Turbopump Specifications Identified in REI 001             |
| NHB 5300.4 (1D-2) | Safety, Reliability, Maintainability and Quality Provisions for the Space Shuttle Program |
| NHB 5300.4 (1E)   | Maintainability Program Requirements For Space Systems                                    |



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### 3. ACRONYMS:

|        |  |
|--------|--|
| AMS    | Aerospace Material Specification               |
| AS     | Aerospace Specification                        |
| CEI    | Component End Item Specification               |
| DCMA   | Defense Contract Management Agency             |
| HPTP   | High Pressure Turbopump                        |
| ICD    | Interface Control Document                     |
| MCL    | Materials Control Laboratory                   |
| MSFC   | Marshall Space Flight Center                   |
| NDT    | Non-Destructive Testing                        |
| NHB    | NASA Handbook                                  |
| PDMS   | Product Data Management System                 |
| PPS    | Purchase Performance Specification             |
| PWA    | Does Not Apply To SSME Hardware                |
| PWA-SP | Pratt & Whitney Space Propulsion Specification |
| PWR    | Pratt & Whitney Rocketdyne                     |
| QA     | Quality Assurance Specification                |
| QAD    | Quality Assurance Data                         |
| REI    | Rocket Engineering Instruction                 |
| SPP    | Space Propulsion Process                       |
| WPB    | West Palm Beach                                |
| SSME   | Space Shuttle Main Engine                      |

### 4. REQUIREMENTS

#### 4.1 General

- a. This Master Specification Index is a list of controlled documents that flow down requirements or instructions for producing SSME High Pressure Turbopump (HPTP) hardware. The change control system for these documents is described in the Configuration Management Plan (FR-19678).
- b. Any specification designated by an asterisk (\*) is considered a "critical process" as defined by NHB 5300.4 (1D-2)<sup>1</sup>. Any revisions to such specifications shall be administered by PWR as Class I engineering changes (ref. FR-19678).

**4.2** This publication will be updated quarterly (see paragraph 6.2 below).

**4.3** When a purchase or sales order is received from PWR-WPB for SSME hardware, suppliers are required to consult the edition of this publication specified in the purchase order to determine the effective revision letter of all the specifications and other controlled documents that apply to that order. They and their subtier suppliers are then required to work to those revisions. Suppliers may, at their option, work to later revisions of REI 001 provided there are no increases to the Purchase Order price. If PWR decides incorporation of a revision of a specification contained herein is mandatory, the Materiel Procurement Department will issue a supplement to the P.O.

<sup>1</sup> A "critical process" is defined as "A material process (i.e., a process which changes the chemical/physical properties of a material) which could have a significant performance effect on hardware identified on the Critical Items List, hardware designated for fracture control and ordnance, and hardware where design conformance cannot be assured by inspection".



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- 4.4** Suppliers are required by Specifications, “Aerospace Supplier Quality Requirements” (ASQR-01) to establish and maintain a system for the control of specifications and other applicable data as stipulated on the PWR Purchase Order, to ensure that articles for P&W are processed in accordance with PWR requirements. As part of that system, first-tier suppliers are required to state applicable specification numbers and revision letters on contract documents to their sub-tier suppliers.
- 4.5** Questions about this REI or requests for documents should be directed to the PWR Material Procurement Department, P.O. Box 109600, West Palm Beach, Florida 33410-9600.

### **5. RESPONSIBILITY**

SSME HPTP Production Requirements Engineering (PRE) group is responsible for revising REI 001 and all specifications contained in appendices B, D, E, I, J and K, & L including those designated as a critical process. Documents listed in other appendices are the responsibility of other PWR groups, the Society of Automotive Engineers, or the U.S. Government. When changes occur to these latter documents, they shall be reviewed by SSME Production Requirements Engineering for applicability to the Alternate Turbopump program.

### **6. PWR DOCUMENT CONTROL PROCEDURES**

#### **6.1 Specification Changes:**

Changes to the SSME HPTP documents stated herein shall be in accordance with Production Program Procedure PP/PR:93-015.

#### **6.2 Index Maintenance:**

- a. This Master Specification Index, REI 001, shall be updated quarterly. The cut-off date for changes shall be the last day of the calendar quarter: March 31, June 30, September 30, and December 31. The updated document shall be published by the end of the month following the end of the quarter: April, July, October, and January. These quarterly updates shall be distributed to NASA/MSFC, DCMA, NASA and PWR Resident Offices, and key PWR-WPB personnel by the Contract Data Manager, and to all SSME HPTP suppliers through the Materiel Procurement Department, via the PWR Worldwide Procurement Internet website ([www2.pratt-whitney.com/procurement/](http://www2.pratt-whitney.com/procurement/) then click on “Rocket Engineering Instruction”)
- b. Revision letters on all documents in REI 001 shall be updated only to changes that are validated and shown in the PWR Product Data Management System (PDMS). If a later revision has been issued to any document, PWR and its suppliers may work to that revision in accordance with paragraph 4.3 above.



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- c. To initiate the quarterly update process, a request shall be issued by SSME HPTP Production Requirements Engineering (PRE). The Information Processing group shall perform the update by incorporating changes requested by PRE, if any, and by matching revision letters in REI 001 as reflected in PDMS. PRE shall submit the revised Index to the Contract Data Manager, using a Contractual Data Signoff Sheet, for customer and internal distribution. When received from the Contract Data Manager, Material Procurement shall automatically update the PWR Internet website.

**7. LIST OF APPENDICES:**

APPENDIX A: DELETED, NOT INVOKED ON SSME AT HARDWARE  
 APPENDIX B: PWA-SP SPECIFICATIONS  
 APPENDIX C: AMS/AS SPECIFICATIONS  
 APPENDIX D: ROCKET ENGINEERING INSTRUCTIONS  
 APPENDIX E: NDT METHODS  
 APPENDIX F: NDT STANDARDS  
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 APPENDIX K: PURCHASE PERFORMANCE SPECIFICATIONS  
 APPENDIX L: COMPONENT END ITEM AND INTERFACE CONTROL SPECIFICATION (CEI & ICD)

**Pratt & Whitney**

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(Deleted)**

**For PWA Specification status, see current Pratt & Whitney  
Specification Revision List.**



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| <b>APPENDIX B: PWA-SP SPECIFICATIONS</b> |                      |             |  |
|--|----------------------|-------------|--|
| <b>NOTE</b>                              | <b>SPECIFICATION</b> | <b>REV.</b> | <b>TITLE</b>   |
|  | PWA-SP Glossary      | B           | Glossary-Material and Process Specifications   |
|  | PWA-SP 4             | B           | Hot Isostatic Pressing of Castings   |
|  | PWA-SP 10            | C           | Brazing Honeycomb Abradable Seal Structures  |
| *  | PWA-SP 11            | F           | Heat Treatment of Space Propulsion Materials & Parts   |
| *  | PWA-SP 16            | A           | Welding - Arc, Gas, Electron Beam, Laser Beam, and Inertia-Friction  |
|  | PWA-SP 19            | D           | Gold-Nickel Alloy Brazing  |
|  | PWA-SP 46            |             | Coating, Flame Deposition Tungsten Carbide-Cobalt (LWIN-40)  |
| *  | PWA-SP 80            | F           | Cleanliness Controls for Critical Components   |
|  | PWA-SP 82            | C           | Liquid or Gaseous Oxygen Compatibility   |
|  | PWA-SP 96            | C           | Tierods, Bolts & Screws, Nickel Alloy, Corrosion and Heat Resistant (INCO 718) Consumable Electrode or Vacuum Induction Melted |
|  | PWA-SP 97            | C           | Finishing, by Electrochemical or Electrodischarge Metal Removal  |
|  | PWA-SP 98            | B           | Finishing & Preservation of Carbon Parts   |
|  | PWA-SP 99            | B           | Surface Finishing of Holes   |
|  | PWA-SP 105           | A           | Finishing of Compressor and Turbine Parts, Confined Abrasive Compound  |
|  | PWA-SP 108           | A           | Chemical Milling   |
|  | PWA-SP 109           |             | Control of Low Melting Alloy Contamination   |
|  | PWA-SP 115           | A           | Bolts, Studs, & Screws, Alloy, Heat Resistant Hardened, Roll Threaded 260,000 PSI Tensile Strength                             |
|  | PWA-SP 116           | A           | Cleaning of Titanium and Titanium Alloys   |
|  | PWA-SP 123           | A           | Honeycomb, Ni & Cobalt Alloys  |
|  | PWA-SP 288           | A           | Coating, Flame Deposition Super D-Gun <sup>2</sup> Process   |
|  | PWA-SP 300           | F           | Control of Materials, Processes and Parts  |
|  | PWA-SP 306           | B           | SSME Alternate Turbopump Critical Items List Inspection and Test Requirements  |
|  | PWA-SP 310           | B           | Identification marking, Materials and Items  |
|  | PWA-SP 316           |             | Safety Wire & Cotter Pin Installation  |
|  | PWA-SP 318           |             | Key Washer (Tab Type) Installation   |
|  | PWA-SP 320           |             | Key Washer (Cup Type) Installation High Strength, All Metal  |
|  | PWA-SP 321           | B           | Casting Grade Requirements, Fe-Ni-Co Base alloys   |
|  | PWA-SP 322           |             | Airflow Testing Engine Parts Using a Critical Flow Nozzle  |
|  | PWA-SP 330           | A           | Drawing Interpretation for Airfoils  |
| *Critical Process                        |                      |             |  |

<sup>2</sup> Super D-Gun<sup>™</sup> is a Registered Process Trademark of Praxair Surface Technology, Inc.



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**APPENDIX B: PWA-SP SPECIFICATIONS**

| NOTE              | SPECIFICATION | REV. | TITLE   |
|-------------------|---------------|------|---|
|                   | PWA-SP 331    | A    | Casting Grade Requirements (Al and Mg Alloys)   |
|                   | PWA-SP 332    | A    | Target Dimensions   |
|                   | PWA-SP 334    | H    | Etch Marking  |
|                   | PWA-SP 336    | C    | Sealing Surface Requirements  |
|                   | PWA-SP 345    | A    | Computer File Airfoil Section Coordinate Data and Fairing Procedures                                    |
|                   | PWA-SP 346    | A    | Computer Graphics Files for Product Definition  |
|                   | PWA-SP 355    | B    | Thread Standards, Straight Screw, Buttress, Acme, and Taper Pipe  |
|                   | PWA-SP 357    | A    | Riveting (Solid Hollow, and Blind)  |
|                   | PWA-SP 360    | A    | Drawing Interpretations   |
|                   | PWA-SP 361    |      | Staking   |
|                   | PWA-SP 363    | A    | Thread Standards, Acme-J  |
|                   | PWA-SP 364    |      | Surface Texture Of Critical Ball Bearings   |
|                   | PWA-SP 367    | C    | Engineering Controlled Processes  |
|                   | PWA-SP 371    | D    | Engineering Source Approval for Manufacturing Processes & Materials in Liquid Space Propulsion Programs |
|                   | PWA-SP 373    |      | Interpretation of Computer Graphics Files For Product Definition  |
|                   | PWA-SP 381    | B    | Shipping Closures   |
|                   | PWA-SP 383    |      | Inserts, Self-Locking Nickel Alloy High Strength, All Metal 600°F                                       |
|                   | PWA-SP 384    | A    | Nuts, Self-Locking, Steel, Corrosion and Heat Resist High Strength, All Metal 850°F                     |
|                   | PWA-SP 388    | B    | Surface Texture   |
|                   | PWA-SP 390    | A    | Computer File Airfoil Section Coordinate Data and Fairing Procedures                                    |
|                   | PWA-SP 392    |      | Computer File for Tube Centerline Geometry Data   |
|                   | PWA-SP 395    | A    | Computer File for Three Dimensional General Surface   |
|                   | PWA-SP 444    | B    | Chopped Fibers, Aromatic Polyamide, Kevlar <sup>®3</sup> 29 and Kevlar <sup>®</sup> 49                  |
|                   | PWA-SP 445    |      | Fabric, Aromatic Polyamide Fiber Kevlar <sup>®</sup> 29 and Kevlar <sup>®</sup> 49                      |
|                   | PWA-SP 449    | B    | Polyamide Polymer, Hot-Isostatically Molded Billet  |
|                   | PWA-SP 482    | A    | Plastic Film, Special Quality   |
|                   | PWA-SP 1021   | A    | Alloy Bars, Corrosion and Heat Resistant, Nickel Base (Astroloy)  |
| *Critical Process |               |      |   |

<sup>3</sup> Kevlar<sup>®</sup> is a Registered Trademark of E.I. du Pont de Nemours and Company



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| <b>APPENDIX B: PWA-SP SPECIFICATIONS</b> |                      |             |  |
|--|----------------------|-------------|--|
| <b>NOTE</b>                              | <b>SPECIFICATION</b> | <b>REV.</b> | <b>TITLE</b>   |
|  | PWA-SP 1039          | A           | Alloy Sheet & Plate, Corrosion and Heat Resistant Cobalt Base 2250°F Solution Heat Treat   |
|  | PWA-SP 1042          | A           | Alloy Sheet, Corrosion and Heat Resistant, Cobalt Base (Haynes 188) 2150°F Solution Heat Treat   |
|  | PWA-SP 1052          | A           | Steel Bars & Forgings, Corrosion and Heat Resistant (A-286) Multiple Vacuum Melted, Direct Aged  |
|  | PWA-SP 1074          | B           | Alloy Forgings, Corrosion and Heat Resistant, Nickel Base (IN 100 Mod) Power Metallurgy Product-Solution, Stabilization and Precipitation Heat Treated |
|  | PWA-SP 1103          | A           | Steel Forgings, Corrosion and Heat Resistant (A286) Multiple Melted-Solution and Precipitation Heat Treated  |
|  | PWA-SP 1104          | E           | Alloy Extrusions, Corrosion And Heat Resistant (IN 100 Mod) Extruded Power Metallurgy Product  |
|  | PWA-SP 1105          | A           | Alloy Bars, Forgings and Rings, Corrosion and Heat Resistant Nickel Base (Inconel 718) Multiple Melted-1900°F Solution Heat Treated                    |
|  | PWA-SP 1130          |             | Alloy Bars & Forgings, Corrosion and Heat Resistant Nickel Base (Haynes 214) Multiple Melted-Solution Heat Treated                                     |
|  | PWA-SP 1132          | A           | Alloy Sheet, Strip & Plate, Corrosion and Heat Resistant (INCO 718)  |
|  | PWA-SP 1133          | A           | Nickel Alloy, Corrosion and Heat Resistant, Seamless or Welded Tubing (INCO 625)   |
|  | PWA-SP 1134          | A           | Stainless Steel Bearings, Premium Quality (Cronidur 30)  |
|  | PWA-SP 1135          | C           | Alloy Castings, Investment, Corrosion and Heat Resistant Nickel Base (MAR-M-247)   |
|  | PWA-SP 1136          | B           | Polyurethane Resin, Potting Compound Aremcopot 581   |
|  | PWA-SP 1138          | A           | Epoxy Primer   |
|  | PWA-SP 1139          |             | Primer, Silane Resin (SS4004)  |
|  | PWA-SP 1140          | B           | Sealant, Silicone Rubber   |
|  | PWA-SP 1141          |             | Ceramic Bearing Balls, Premium Quality Hot Isostatically Pressed   |
|  | PWA-SP 1142          | A           | Sputtered Molybdenum Disulfide Coating   |
|  | PWA-SP 1143          | F           | Alloy Bars & Forgings, Low Expansion (Incoloy 909)   |
|  | PWA-SP 1144          | B           | Nitride Surface Treatment (Malcomizing®) <sup>4</sup>  |
|  | PWA-SP 1145          | B           | Ceramic Bearing Balls and Rollers, Premium Quality   |
|  | PWA-SP 1146          | A           | Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant (INCO 718)   |
|  | PWA-SP 1147          | B           | Plastic Film, Special Quality Fluorohalocarbon   |
| *Critical Process                        |                      |             |  |

<sup>4</sup> Malcomizing® is the Registered Trademark of MDC Corporation



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**APPENDIX B: PWA-SP SPECIFICATIONS**

| NOTE              | SPECIFICATION | REV. | TITLE  |
|-------------------|---------------|------|--|
|                   | PWA-SP 1148   | E    | Carbon-Graphite Molded Shapes  |
|                   | PWA-SP 1149   | A    | Tierods, Bolts & Screws, Nickel Alloy, Corrosion and Heat Resistant, Heat Treated-Roll Threaded (Astroloy) |
|                   | PWA-SP 1150   | A    | Lubricant, Molybdenum Disulfide Powder Dow Corning <sup>5</sup> Z Moly-Power                               |
|                   | PWA-SP 1151   | B    | Anti-Gallant Compound Dow Corning <sup>6</sup> 321 Dry Film Lubricant Spray                                |
|                   | PWA-SP 1152   | A    | Anti-Gallant Compound Braycote <sup>6</sup> 640 ACMS   |
|                   | PWA-SP 1153   |      | Anti-Gallant Compound & Treatment  |
|                   | PWA-SP 1154   | B    | Steel Bearings, Premium Quality (440C)   |
|                   | PWA-SP 1155   | B    | Carburized Steel Bearings, Premium Quality (AISI 9310)   |
|                   | PWA-SP 1156   | C    | Laminated Glass Fabric, Polytetrafluoroethylene (PTFE) Tubular Bearing Cage Material                       |
|                   | PWA-SP 1157   | A    | Bronze Powder Filled Polytetrafluoroethylene (BFPTFE) Matrix Bearing Cage Material (SALOX-M)               |
|                   | PWA-SP 1158   | A    | Aluminum Alloy Bars & Rods, Rolled Drawn or Cold Finished  |
|                   | PWA-SP 1159   | A    | Anti-Gallant Compound - Halocarbon 25-5S   |
|                   | PWA-SP 1160   | E    | Contamination Control Requirements for Final Assembly and Test Areas                                       |
|                   | PWA-SP 1161   | B    | Alloy Sheet, Low Expansion Iron Base (Incoloy 909)   |
|                   | PWA-SP 1163   | A    | Alloy Sheet, Strip & Plate, Corrosion and Heat Resistant Nickel Base (Haynes 230)                          |
|                   | PWA-SP 1171   | B    | ALLOY PLATE Cobalt Base-35Ni-20Cr-10Mo   |
|                   | PWA-SP 1196   |      | Alloy Bar & Billet, Corrosion and Heat Resistant Cobalt Base   |
|                   | PWA-SP 1201   | B    | Titanium Sponge  |
|                   | PWA-SP 1240   | A    | Titanium Alloy Forgings 5Al-2.5 Sn, Extra Low Interstitial Annealed  |
|                   | PWA-SP 1489   | D    | Alloy Castings, Investment, Corrosion and Heat Resistant Nickel Base (MAR-M-247)                           |
|                   | PWA-SP 1490   | C    | Alloy Castings, Investment, Corrosion and Heat Resistant Nickel Base (INCO 718)                            |
|                   | PWA-SP 1493   | A    | Alloy Castings, Investment, Corrosion and Heat Resistant Nickel Base (Alloy 454)                           |
|                   | PWA-SP 1494   | A    | Alloy Castings, Investment, Corrosion and Heat Resistant Nickel (IN100)                                    |
| *                 | PWA-SP 6000   | A    | Bars & Forgings, Commercially Pure Nickel  |
|                   | PWA-SP 36122  |      | Aluminum Foil Tape (3M <sup>7</sup> Type 425) <sup>7</sup>   |
| *Critical Process |               |      |  |

<sup>5</sup> Dow Corning<sup>®</sup> is the Registered Trademark of the Dow Corning Corporation

<sup>6</sup> Braycote<sup>®</sup> is the Registered Trademark of Castrol, Inc.

<sup>7</sup> 3M<sup>®</sup> is the Registered Trademark of the 3M Company



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| <b>NOTE</b>                              | <b>SPECIFICATION</b> | <b>REV.</b> | <b>TITLE</b>   |
|  | PWA-SP 36158         | B           | Weld Fabrication Controls for Rocket Engine Nickel Alloy Castings  |
|  | PWA-SP 36180         | J           | Contamination Control  |
|  | PWA-SP 36181         | D<br>SCN004 | SSME-AT High Pressure Oxidizer Turbopump (HPOTP) Standard Repair/Acceptance Limit Specification                                  |
|  | PWA-SP 36182         | D           | Space Shuttle Main Engine Alternate High Pressure Oxidizer Turbopump Field Inspection Criteria Specification                     |
|  | PWA-SP 36183         | C<br>SCN002 | Space Shuttle Main Engine Alternate High Pressure Oxidizer Turbopump Standard Field Repair Procedures Specification              |
|  | PWA-SP 36184         | C           | Standard Flight Life Limit Deviation Approval Request (DAR) for the Space Shuttle Main Engine (SSME) Alternate Turbopump Program |
|  | PWA-SP 36185         | B<br>SCN004 | Space Shuttle Main Engine Alternate High Pressure Fuel Turbopump Field Inspection Criteria Specification                         |
|  | PWA-SP36186          | D           | SSME-AT HPFTP Standard Field Repair Procedures Specification   |
|  | PWA-SP 36187         | SCN001      | SSME-AT High Pressure Fuel Turbopump (HPFTP) Standard Repair/Acceptance Limit Specification                                      |
|  | PWA-SP 36470         | A           | Polyurethane Foam Insulation (Stathane G-502 SE)   |
|  | PWA-SP 36471         | B           | SP-36471 Semi-Rigid Foam Insulation (Foamex® XR13-2) <sup>8</sup>  |
|  | PWA-SP 36472         | B           | Adhesive, Polyurethane (PR-1578®) <sup>9</sup>   |
|  | PWA-SP 36473         | B           | Elastomeric Cover, Fabric Reinforced   |
|  | PWA-SP 36512         | B           | Coating (Hypalon®) <sup>10</sup>   |
|  | PWA-SP 36683         | B           | Cleaning of SSME-AT Plumbing   |
|  | PWA-SP 36731         | C           | Putty, Insulating, RTV   |
|  | PWA-SP 36951         |             | Tack Welding   |
|  | PWA-SP 36961         | A           | Chromium Coating of Roller contact Bearing   |
|  | PWA-SP 36964         | B           | Coating, Copper Vapor Deposition   |
|  | PWA-SP 36966         | C           | Electroplated Gold   |
|  | PWA-SP 79303         |             | Inserts, Self-Locking, Steel, Corrosion & Heat Resist. High Strength, All Metal  |
|  | PWA-SP 79329         | A           | Nuts, Self-Locking, Corrosion and Heat Resistant Alloy Ultra High Strength   |
| *Critical Process                        |                      |             |  |

<sup>8</sup> Foamex® is the Registered Trademark of Foamex International, Inc.

<sup>9</sup> Polyurethane (PR-1578®) is the Registered Trademark of PRC-DeSoto International, Inc.

<sup>10</sup> Hypalon® is the Registered Trademark of Clifton Adhesive, Inc.



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| NOTE | SPECIFICATION | REV. | TITLE  |
|------|---------------|------|--|
|      | AMS 2249      | F    | Chemical Check Analysis Limits – Titanium and Ti Alloys  |
|      | AMS 2269      | E    | Chemical Checks Analysis Limits – Nickel, Nickel Alloys and Cobalt Alloys  |
|      | AMS 2403      | L    | Plating–Nickel, General Purpose  |
|      | AMS 2406      | K    | Plating–Chromium, Hard Deposit   |
|      | AMS 2410      | J    | Plating–Silver, Nickel Strike, High Bake   |
|      | AMS 2422      | E    | Plating Gold   |
|      | AMS 2424      | E    | Plating, Nickel, Low Stressed Deposit  |
|      | AMS 2430      | M    | Shot Peening, Automatic  |
|      | AMS 2431      | A    | Peening Media–General Requirements   |
|      | AMS 2470      | L    | Anodic Chrome Acid Process Treatment of Aluminum Alloys  |
|      | AMS 2471      | F    | Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process, Undyed Coating   |
|      | AMS 2473      | G    | Chemical Film Treatment for Aluminum Alloys, General Purpose Coating   |
|      | AMS 2482      | C    | Hard Coat Treatment of Aluminum Alloys, Teflon–Impregnated or Codeposited  |
|      | AMS 2515      | E    | Polytetrafluoroethylene (PTFE) Resin Coating Low build, 370 to 400°C (698 to 752°F) Fusion   |
|      | AMS 3159      | F    | Leak Test Solution Liquid Oxygen Compatible  |
|      | AMS 3417      | B    | Flux, Brazing High Temperature   |
|      | AMS 3650      | C    | Rods, Sheets, and Molded Shapes, Polychlorotrifluoroethylene (PCTFE) Unplasticized   |
|      | AMS 3690      | B    | Adhesive Compound – Epoxy Room Temperature Curing  |
|      | AMS 4008      | J    | Aluminum Alloy Sheet & Plate 1.25 Mn – 0.12 Cu Strain Hardened (3003–H140)   |
|      | AMS 4027      | M    | Aluminum Alloy Sheet & Plate (6061–T6 Sheet,–T651 Plate)   |
|      | AMS 4120      | R    | Aluminum Alloy, Rolled or Cold Finished Bars, Rods and Wire 4.4 Cu – 1.5mg – 0.60 Mn (2024). Solution Heat Treated and Naturally aged (T4) Solution Heat Treated, Cold Worked, and Naturally Aged (T351) |
|      | AMS 4127      | J    | Aluminum Alloy Forgings and Rolled or Forged Rings (6061–T6)   |
|      | AMS 4219      | E    | Aluminum Alloy Casting 7.0SI–0.55Mg – 0.12 TI–0.06 Be (A357.0 T61P) Solution and Precipitation Heat Treated  |
|      | AMS 4530      | G    | Cu–Be Alloy Sheet, Strip & Plate   |
|      | AMS 4532      | F    | Cu–Be Alloy Sheet & Strip Half Hard  |
|      | AMS 4650      | L    | Cu–Be Alloy Bars, Rods, Shapes, TBoo (A) & Forgings Solution Heat Treated  |
|      | AMS 4676      | E    | Nickel–Copper Alloy, Corrosion–Resistant, Bars and Forgings 66.5 Ni – 3.0 Al – 0.62 Ti – 28 Cu Hot–finished, Precipitation Hardenable  |
|      | AMS 4786      | F    | Gold–Palladium–Nickel Alloy Brazing Filler Metal, High Temperature 70Au–8Pd–22Ni   |



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|------|---------------|------|---|
|      | AMS 4787      | F    | Gold Nickel Alloy Brazing, Filler Metal, High Temperature   |
|      | AMS 4966      | M    | Titanium Alloy, Forgings (5Al 2.5 Sn, Annealed)   |
|      | AMS 5040      | L    | Steel, Sheet and Strip 0.15 Carbon, Maximum Deep Forming Grade  |
|      | AMS 5042      | L    | Steel, Sheet and Strip 0.15 Carbon, Maximum Forming Grade   |
|      | AMS 5362      | K    | Steel Castings, Invest, Corr & Ht Resistant (AISI 347) Solution Heat Treated  |
|      | AMS 5510      | R    | Steel Sheet, Strip & Plate, Corr & Ht Resistant (AISI 321) Solution Heat Treated  |
|      | AMS 5512      | K    | Steel Sheet, Strip & Plate, Corr & Ht Resistant (AISI 347) Solution Heat Treated  |
|      | AMS 5513      | H    | Sheet, Strip & Plate, Corr Resistant (AISI 304) Solution Heat Treated   |
|      | AMS 5525      | H    | Steel Sheet, Strip & Plate, Corr & Ht Resistant (A286) Solution Heat Treated  |
|      | AMS 5529      | G    | Steel, Corrosion Resistant Sheet & Strip (17CR-7Ni) Solution Heat Treated and Cold Rolled, Precipitation Hardenable   |
|      | AMS 5536      | L    | Nickel Alloy, Sheet, Strip & Plate, Corr & Ht Resistant (Hastelloy-X) Solution Heat Treated   |
|      | AMS 5540      | L    | Nickel Alloy, Sheet, Strip & Plate, Corr & Ht Resistant (INCO 600) Annealed   |
|      | AMS 5542      | L    | Nickel Alloy, Sheet, Strip & Plate, Corr & Ht Resistant Annealed  |
|      | AMS 5544      | H    | Nickel Alloy, Sheet, Strip & Plate, Corr & Ht Resistant (Waspaloy) Consumable Electrode or Vacuum Induction Melted, Annealed  |
|      | AMS 5571      | G    | Steel, Corr and Ht Resistant Solution Heat Treated Tubing, Seamless (AISI 347)  |
|      | AMS 5581      | D    | Nickel Alloy, Corrosion and Heat Resistant, Seamless or Welded Tubing (INCO 625) Annealed   |
|      | AMS 5586      | F    | Nickel Alloy Tubing, Weld, Corr & Ht Resistant (Waspaloy) Consumable Electrode or Vacuum Induction Melted, Annealed   |
|      | AMS 5587      | E    | Nickel Alloy, Corrosion and Heat Resistant, Seamless Tubing (Hastelloy X) Solution Heat Treated   |
|      | AMS 5596      | J    | Nickel Alloy, Corrosion and Heat Resistant, Sheet, Strip, Foil and Plate (INCO 718) Consumable Electrode or Vacuum Induction Melted 1775°F (968°C) Solution Heat Treated  |
|      | AMS 5597      | E    | Nickel Alloy, Corrosion and Heat Resistant, Sheet, Strip, Foil and Plate (INCO 718) Consumable Electrode or Vacuum Induction Melted 1950°F (1066°C) Solution Heat Treated |
|      | AMS 5599      | F    | Nickel Alloy, Corr & Ht Resistant, Sheet, Strip, and Plate Annealed   |
|      | AMS 5608      | E    | Cobalt Alloy, Corr & Ht Resistant, Sheet, Strip & Plate (Haynes 188) Solution Heat Treated  |
|      | AMS 5618      | F    | Steel, Corr Resistant Bars, Wire & Forgings (AISI 440 C)  |



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|------|---------------|------|---|
|      | AMS 5645      | P    | Steel Bars, Wire, Forgings, Tubing & Rings, Corr & Ht Resistant (AISI 321) Solution Heat Treated  |
|      | AMS 5646      | M    | Steel Bars, Wire, Forgings, Tubing & Rings Corr & Ht Resistant (AISI 347) Solution Heat Treated   |
|      | AMS 5662      | M    | Nickel Alloy, Corrosion and Heat Resistant, Bars, Forgings and Rings (INCO 718) Consumable Electrode or Vacuum Induction Melted 1775°F (968°C) Solution Heat Treated Precipitation Hardenable   |
|      | AMS 5663      | M    | Nickel Alloy, Corrosion & Heat Resistant, Bars, Forgings & Rings Consumable Electrode or Vacuum Induction Melted, Solution and Precipitation Heat Treated   |
|      | AMS 5664      | E    | Nickel Alloy, Corrosion and Heat Resistant, Bars, Forgings and Rings Consumable Electrode or Vacuum Induction Melted 1950°F (1066°C) Solution Heat Treated Precipitation Hardenable (INCO 718)  |
|      | AMS 5665      | M    | Nickel Alloy, Corrosion and Heat Resistant, Bars, Forgings, and Rings 74Ni - 15.5 Cr - 8.0 Fe - UNS N06600  |
|      | AMS 5666      | E    | Nickel Alloy, Corr & Ht Res, Bars, Forgings, & Rings 62 Ni - 21.5 Cr - 9.0 Mo - 3.65 Extr (Cb + Ta) Annealed  |
|      | AMS 5689      | F    | Steel, Corrosion and Heat Resistant, Wire 18 Cr - 10.5 Ni - 0.40 Ti (SAE 30321) Solution Heat Treated   |
|      | AMS 5707      | J    | Nickel Alloy, Corrosion and Heat Resistant Bars, Forgings, and Rings 58 Ni - 19.5 Cr - 13.5 Co - 4.3 Mo - 3.0 Ti - 1.4 Al - 0.05 Zr - 0.006B Consumable Electrode or Vacuum Induction Melted Stabilization and Precipitation Heat Treated |
|      | AMS 5708      | H    | Nickel Alloy, Corrosion and Heat Resistant Bars, Forgings, and Rings 58 Ni - 19.5 Cr - 13.5 Co - 4.3 Mo - 3.0 Ti - 1.4 Al Consumable Electrode or Vacuum Induction Melted 1975°F (1079°C) Solution Heat Treated                           |
|      | AMS 5731      | K    | Steel, Corrosion and Heat Resistant Bars, Wire, Forgings, Tubing and Rings 15 Cr - 25.5 Ni - 1.2 Mo - 2.1 Ti - 0.006B - 0.30V Consumable Electrode Melted 1800°F (982°C) Solution Heat Treated  |
|      | AMS 5732      | H    | Steel, Corrosion and Heat Resistant Bars, Wire, Forgings, and Rings 15 Cr - 25.5 Ni - 1.2 Mo - 2.1 Ti - 0.006B - 0.30V Consumable Electrode Melted 1800°F (982°C) Solution and Precipitation Heat Treated                                 |
|      | AMS 5737      | N    | Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, and Tubing 15 Cr - 25.5 Ni - 1.2 Mo - 2.1 Ti - 0.006B - 0.30V Consumable Electrode Melted 1650°F (899°C) Solution and Precipitation Heat Treated                               |
|      | AMS 5772      | D    | Cobalt Alloy, Corrosion and Heat Resistant Bars, Forgings, and Rings 40 Co - 22 Cr - 22 Ni - 14.5 W - 0.07 Solution Heat Treated  |
|      | AMS 5832      | F    | Nickel Alloy, Corrosion & Heat Resistant Welding Wire 52.5 Ni - 19 Cr - 3.0 Mo - 5.1 Cb - 0.9 Ti - 0.50 Al - 18 Fe  |



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|------|---------------|------|---|
|      | AMS 5842      | D    | Cobalt-Nickel Alloy, Corrosion and Heat Resistant Bars 19 Cr - 36 Co - 25 Ni - 7.0 Mo - 0.50 Cb - 2.9 Ti - 0.20 Al - 9.0 Fe Vacuum Induction Plus Vacuum Consumable Electrode Melted Solution Heat Treated and Work Strengthened          |
|      | AMS 5843      | D    | Cobalt-Nickel Alloy, Corrosion and Heat Resistant Bars 19 Cr - 36 Co - 25 Ni - 7.0 Mo - 0.50 Cb - 2.9 Ti - 0.20 Al - 9.0 Fe Vacuum Induction Plus Vacuum Consumable Electrode Melted Solution Heat Treated and Work Strengthened and Aged |
|      | AMS 5844      | F    | Alloy, Corrosion Resistant, Round Bars 20 Cr - 35 Ni - 35 Co - 10 Mo Vacuum Induction Consumable Electrode Vacuum Melted Solution Heat Treated and Work Strengthened  |
|      | AMS 5845      | G    | Alloy, Corrosion Resistant, Round Bars 20 Cr - 35 Ni - 35 Co - 10 Mo Vacuum Induction Consumable Electrode Vacuum Melted Solution Heat Treated and Work Strengthened and Aged   |
|      | AMS 5858      | C    | Steel, Corrosion and Heat Resistant, Sheet, Strip, and Plate 15 Cr - 25.5 Ni - 1.2 Mo - 2.1 Ti - 0.006B - 0.30 V Multiple Melted 1800°F (982°C) Solution Heat Treated, Welding Grade Precipitation Hardenable                             |
|      | AMS 5876      | C    | Cobalt Alloy, Corrosion and Heat Resistant, Strip 20 Cr - 15 Ni - 40 Co - 7.0 Mo - 16 Fe Vacuum Induction Plus Consumable Electrode Melted Solution Heat Treated and Cold Rolled  |
|      | AMS 5895      | C    | Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing, and Rings 15 Cr - 25.5 Ni - 1.2 Mo - 2.1 Ti - 0.006B - 0.30 V Consumable Electrode Melted, 1750°F (954°C) Solution Heat Treated, Welding Grade Precipitation Hardened  |
|      | AMS 6265      | K    | Steel, Bars, Forgings, and Tubing 1.2 Cr - 3.25 Ni - 0.12 Mo (0.07 - 0.13C) SAE 9310 Vacuum Consumable Electrode Remelted   |
|      | AMS 6322      | M    | Steel Bars, Forgings, and Rings 0.50 Cr - 0.55 Ni - 0.25 Mo (SAE 8740)  |
|      | AMS 7228      | J    | HAS BEEN SUPERCEDED BY AS7228   |
|      | AMS 7233      | D    | HAS BEEN SUPERCEDED BY AS7233   |
|      | AMS 7290      | F    | Decalcomania  |
|      | AMS 7310      | J    | Rings, Pistons, Cast Iron As Cast UNS A96061  |
|      | AMS 7320      | E    | Sealing Rings, Cast Leaded-Tin Bronze 80 Cu - 16 Sn - 5Pb as Cast   |
|      | AMS 7467      | C    | HAS BEEN SUPERCEDED BY AS7467   |
|      | AMS 7475      | B    | HAS BEEN SUPERSEDED BY AS7475   |
|      | AMS 7490      | P    | Rings, Flash Welded Corrosion and Heat-Resistant Austenitic Steels, Austenitic-Type iron, Nickel or Cobalt Alloys, or Precipitation-Hardenable Alloys   |
|      | AS870         | D    | (R) Wrenching Configuration, B. Hexagonal (12 Point) Drive, Design Standard For   |
|      | AS1310        | B    | Fasteners Torque for Threaded Applications, Definition of   |
|      | AS3062        | C    | Bolts, Screws, & Studs, Screw Thread Requirements   |
|      | AS7228        |      | Rivets, Steel, Corrosion Resistant 18 Cr - 9 Solution Heat Treated, Procurement Specification For   |



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|------|---------------|------|---|
|      | AS7233        |      | Rivets, Solid, UNS N04400, Corrosion Resistant 67 Ni – 31 Cu Procurement Specification For  |
|      | AS7251        | B    | Nuts, Self-Locking, Steel, Corr & Ht Resistant High Strength, All Metal   |
|      | AS7452        |      | Bolts & Screws, Steel, Low-Alloy Heat Treated, 1200°F USN, Rolled Threaded, UNJ Thread Form   |
|      | AS7461        | A    | Bolts & Screws, Titanium Alloy 6 Al – 4 V Fatigue Rated, Procurement Specification For  |
|      | AS7466        | B    | Bolt and Screw, Nickel Alloy, UNS N07718 Tensile Strength 185 KSI Fatigue Rated Procurement Specification   |
|      | AS7467        | A    | Bolt and Screw, Nickel Alloy, UNS N07718 Tensile Strength 185 KSI Stress Rated Procurement Specification  |
|      | AS7468        | B    | Bolts, Cobalt – Chromium–Nickel Alloy UNS R30035, Tensile Strength 260 KSI, Procurement Specification   |
|      | AS7475        | C    | Bolts, Cobalt – Chromium–Nickel Alloy UNS R30159, Tensile Strength 260 KSI Procurement Specification  |
|      | AS7477        | D    | Bolt and Screws, Steel, UNS S66286 Tensile Strength 130 KSI, Procurement Specification  |
|      | AS7478        | B    | Bolt and Screws, Steel, UNS S66286 Classification: 130 KSI/1200°F 1800°F Solution Heat Treated, aged After Roll Threaded Procurement Specification for            |
|      | AS7482        | A    | Studs, Corrosion and Heat Resistant Steel, UNS S66286 Tensile Strength 130 KSI 1800°F Solution Heat Treated, Aged Before Roll Threading Procurement Specification |

**APPENDIX D: ROCKET ENGINEERING INSTRUCTIONS**

| REI     | REV. | TITLE   |
|---------|------|---|
| REI 001 | 75   | Master Specification Index for the SSME Turbopump                       |
| REI 004 | R    | Parts Handling, Packaging and Transportation                            |
| REI 005 | J    | Proof Pressure Acceptance Test Procedure for SSME HPOTP Hardware        |
| REI 007 | E    | Bearing Handling, Inspection, & Preservation, SSME                      |
| REI 008 | D    | SSME HPTP Prebroaching and Installation Procedure for Inserts and Studs |
| REI 011 | B    | SSME HPTP Lubrication and Sealing Compounds And Application             |
| REI 012 | K    | SSME High Pressure Fuel Turbopump (HPFTP) Assembly Specification        |
| REI 013 | T    | SSME High Pressure Oxidizer Turbopump (HPOTP) Assembly Specification    |
| REI 014 | H    | Packaging of Parts Susceptible to Corrosion                             |
| REI 016 | F    | Fastener Assembly Requirements For The SSME HPOTP and HPFTP             |
| REI 017 | F    | Proof Pressure Acceptance Test Procedure for SSME HPFTP Hardware        |
| REI 018 | E    | Proof Spin Test for SSME HPFTP  |
| REI 020 | F    | SSME High Pressure Oxidizer Turbopump (HPOTP) Disassembly Specification |
| REI 022 | B    | Carbon Seal Handling, Cleaning, Packaging, SSME HPTP                    |
| REI 025 | J    | In Process Cleaning Procedure for SSME Hardware                         |
| REI 026 | D    | SSME High Pressure Fuel Turbopump (HPFTP) Disassembly Specification     |



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| REI     | REV. | TITLE  |
|---------|------|--|
| REI 028 | D    | Precision Cleaning Procedure for SSME Hardware                       |
| REI 029 | B    | Frequency Check Procedure for SSME HPFTP Blades                      |
| REI 030 | A    | SSME HPFTP Liquid Air Insulation Repair/Rework Procedure             |
| REI 031 | A    | Analytical Balancing procedure for SSME HPFTP/HPOTP Turbine Hardware |

**APPENDIX E: NDT METHODS**

| NOTE | METHODS        | REV. | TITLE   |
|------|----------------|------|---|
|      | ATTM-MASTER    | C    | Alloy Type Test Method (ATTM)   |
|      | BSQ            | 3    | Balance System Qualification  |
|      | BTM-13         | F    | Bond Test Method (BTM), Gravity Leak Test Optical System                                    |
|      | CDM-2          | E    | Contamination Detection Method (CDM)  |
|      | HIM-1          | Q    | Hardness Inspection Method (HIM)  |
|      | PTM-MASTER     | G    | Pressure Test Method (PTM)  |
|      | PTM-CODE-A     | A    | Pressure Test Method (PTM), Leak Test   |
|      | PTM-CODE-B     | A    | Pressure Test Method (PTM), Proof Test  |
|      | PTM-CODE-C     | C    | Pressure Test Method (PTM), Leak Test   |
|      | PTM-CODE-D     | A    | Pressure Test Method (PTM), Leak Test   |
|      | PTM-CODE-E     | A    | Pressure Test Method (PTM), Leak Test   |
|      | PTM-CODE-F     |      | Pressure Test Method (PTM), Code F, Leak Tests of Carbon Seals                              |
| *    | SP-BTM 2       | A    | Bond Test Method, Ultrasonic  |
|      | SP-CTM 1       |      | Space Propulsion Computerized Tomographic Inspection Method - Airfoil Thickness Measurement |
| *    | SP-CVM1 CODE 1 |      | Crystal Verification Method (CVM) Lau'e Back Reflection Analysis                            |
| *    | SP-CVM1 MASTER |      | Crystal Verification Master (CVM)   |
| *    | SP-CVM 2       | B    | Space Propulsion Crystal Verification Method (SP-CVM) - Chemical And Anodic Etch            |
| *    | SP-CVM 2H      | C    | Space Propulsion Crystal Verification Method (SP-CVM) - Chemical and Anodic Etch            |
| *    | SP-ECM MASTER  | C    | Space Propulsion Eddy Current Method (SP-ECM)   |
| *    | SP-ECM CODE 1  |      | Space Propulsion Eddy Current Method (SP-ECM) - Bearing Races                               |
| *    | SP-ECM CODE 1F | A    | Space Propulsion Eddy Current Inspection of Bearing Rings                                   |
| *    | SP-ECM CODE 2F | A    | Space Propulsion Eddy Current Inspection of Bearing Balls                                   |
| *    | SP-ECM CODE 4  |      | Space Propulsion Eddy Current Method (SP-ECM) - Phase Sensitive Flaw Detection              |
| *    | SP-ECM CODE 5  | B    | Space Propulsion Eddy Current Method (SP-ECM) - Rotating Eddy Current Flaw Detection        |
| *    | SP-EIM MASTER  | C    | Space Propulsion Etch Inspection Method (SP-EIM)  |

\*Critical Process



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| NOTE | METHODS        | REV. | TITLE   |
|------|----------------|------|---|
| *    | SP-EIM CODE 2  | B    | Space Propulsion Etch Inspection Method (SP-EIM) – Chemical                                       |
| *    | SP-EIM CODE 3  |      | Space Propulsion Etch Inspection Method (SP-EIM) – Etch Anodize                                   |
| *    | SP-EIM CODE 5  | A    | Space Propulsion Etch Inspection Method (SP-EIM) Surface Temper                                   |
| *    | SP-EIM CODE 7  | B    | Space Propulsion Etch Inspection Method (SP-EIM) – Chemical                                       |
| *    | SP-EIM CODE 7L | B    | Space Propulsion Etch Inspection Method (SP-EIM) – Chemical                                       |
| *    | SP-EIM CODE 7W |      | Space Propulsion Etch Inspection Method (SP-EIM)–Chemical   |
| *    | SP-FPM MASTER  | H    | Space Propulsion Fluorescent Penetrant Method (SP-FPM) Master                                     |
| *    | SP-FPM CODE 2  |      | Space Propulsion Fluorescent Penetrant Method (SP-FPM) – High Sensitivity                         |
| *    | SP-FPM CODE 4  | B    | Space Propulsion Fluorescent Penetrant Method (SP-FPM)  |
| *    | SP-FPM CODE 5  |      | Space Propulsion Fluorescent Penetrant Method (SP-FPM) High Sensitivity After Thermal Cycle (T/C) |
| *    | SP-FPM CODE 7  |      | Space Propulsion Fluorescent Penetrant Method (SP-FPM)–Ultra High Sensitivity                     |
| *    | SP-MPM         |      | Space Propulsion Magnetic Particle Method (SP-MPM)  |
|      | SP-NDTQ        | C    | Space Propulsion Non-Destructive Test Qualification and Certification Specification (SP-NDTQ)     |
| *    | SP-SIM 1       | A    | Space Propulsion Ultrasonic Inspection Method, Immersion  |
| *    | SP-SIM 4       |      | Space Propulsion Ultrasonic Inspection Method   |
| *    | SP-SIM 11      | A    | Space Propulsion Ultrasonic Inspection Method – Immersion   |
| *    | SP-SIM 12      | B    | Space Propulsion Ultrasonic Inspection Method – Immersion   |
| *    | SP-SIM 13      | B    | Space Propulsion Ultrasonic Inspection Method – Immersion   |
| *    | SP-SIM14       | A    | Space Propulsion Ultrasonic Inspection Method – Immersion   |
| *    | SP-SIM 309     |      | Space Propulsion Ultrasonic Inspection – Bond Joints, C-Scan Method                               |
| *    | SP-SIM 314     |      | Space Propulsion Ultrasonic Inspection – Bar Stock  |
| *    | SP-SIM 315     | A    | Space Propulsion Ultrasonic Inspection Method For Silicon Nitride Bearing Rolling Elements        |
| *    | SP-XRM MASTER  | D    | Space Propulsion X-RAY Method (SP-XRM) – Radiographic Inspection                                  |
| *    | SP-XRM CODE 1  |      | Space Propulsion Radiographic Inspection  |
| *    | SP-XRM CODE 3  |      | Space Propulsion Radiographic Inspection  |
| *    | SP-XRM CODE 4  |      | Space Propulsion Radiographic Inspection  |
|      | TDM-7          | G    | Thickness Determination Method (TDM) Ultrasonic   |

\*Critical Process



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**APPENDIX F: NDT STANDARDS**

| NOTE | STANDARD     | REV. | TITLE   |
|------|--------------|------|---|
|      | CDS-3        | C    | Contamination Detection Standard, Low-Melt Alloy Contamination of Part Surfaces   |
|      | CVS-10       |      | Crystallographic Verification Standard, SSME Single Crystal Nickel Base Alloy Investment Casting  |
|      | DCS-1-MASTER | N    | Dimensional Control Standard, Inspection Of Compressor And Turbine Blades And Vanes   |
|      | DCS-23       | P    | Dimensional Control Standard, Inspection of 37 Degree Conical Seat Sealing Surfaces and Double Angle Sealing Surface  |
|      | DCS-35       | B    | Dimensional Control Standard, Spline Measurement  |
|      | DCS-48       | E    | Dimensional Control Standard, Inspection of Die-Stampings   |
|      | DCS-72       | C    | Dimensional Control Standard, Identification Marking On Tube Assemblies   |
|      | DCS-131      | B    | Dimensional Control Standard, Oil, Air, And Fuel Passages   |
|      | DCS-152      | B    | Dimensional Control Standard, Inspection of Turbine Airfoils - Raw Material   |
|      | ECS-MASTER   | A    | Eddy Current Standard Master  |
|      | ECS-45       | D    | Eddy Current Standard, General Application Eddy Current Standard Military & LSP Engines   |
|      | ECS-50       | E    | Eddy Current Standard, Inner & Outer Bearing Rings (Ball and Roller) P&W Rocket Engine Programs   |
|      | ECS-51       |      | Eddy Current Standard, Bearing Ball Elements (Rocket Engines Programs)  |
|      | EIS-13       | V    | Etch Inspection Standard, Blue Etch Anodize Disks, Hubs, Couplings, Blade Retainers, Rotating Airseals, and Rotating Spacers  |
|      | EIS-17       | E    | Etch Inspection Standard, Powder Metal Parts  |
|      | EISMASTER    | K    | Etch Inspection Standard - Master   |
|      | FCPS-2       | G    | Fracture Critical Part Standard   |
|      | FPS-25       | B    | Fluorescent Penetrant Standard, Roll Threaded Bolts, Screws, Studs, And TieRods   |
|      | FPS-38       | L    | Fluorescent Penetrant Standard, Fusion Wells  |
|      | FPS-89       | A    | Fluorescent Penetrant Standard, Tube Details  |
|      | FPSMASTER    | U    | Fluorescent Penetrant Standard - Master (FPS-M)   |
|      | FPVS-6       | D    | Equiax Or Single Crystal Turbine Blades Rocket Engine Programs. Fluorescent Penetrant/Visual Inspection Standard, 1st, 2nd and 3rd Stage Equiax and/or Single Crystal Cast Turbine Blades SP-WPB Rocket Engine Programs |
|      | FPVS-9       | C    | Cast Turbine Vanes/Stators Rocket Engine Programs   |
|      | FPVS-24      |      | Silver Plated Labyrinth Seal Lands  |
|      | SIS-MASTER   | D    | Sonic Inspection Standard Master  |
|      | SIS-42       | C    | Sonic Inspection Standard, Titanium Alloy Forging Stock and PWA 1232 Plate Stock  |
|      | SIS-43       | D    | Sonic Inspection Standard, Steel & Nickel Alloy Rotor Forging Stock   |



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| NOTE | STANDARD     | REV. | TITLE   |
|------|--------------|------|---|
|      | SIS-44       | E    | Sonic Inspection Standard, Nickel Alloy Billet Powder Metallurgy Product  |
|      | SIS-45       | C    | Sonic Inspection Standard, Stock For Bearing Details  |
|      | SIS-315      | A    | Sonic Inspection Standard, Bar Stock  |
|      | SIS-322      | F    | Sonic Inspection Standard, Sonic Inspection of Sonic Configuration  |
|      | SIS-328      | A    | Ceramic Ball Bearing Balls Rocket Engines   |
|      | SIS-330      | A    | Sonic Inspection Standard Ceramic Roller Bearing Rollers Rocket Engines   |
|      | STS-MASTER   | B    | Surface Temper Standard - Master  |
| +    | STS-A-VENDOR | C    | Surface Temper Standard, Ball And Roller Bearings   |
|      | VIM-MASTER   | B    | Visual Inspection Method (VIM) Master   |
|      | VIS-4        | AB   | Brazed Joints   |
|      | VIS-7        | P    | Aircraft Engine, Gearbox And Accessory Anti-Friction Bearing  |
|      | VIS-14       | J    | Carbon Ring And Face Seals  |
|      | VIS-22       | H    | Imperfections on Hardfaced or Chromium Plated Surfaces Mating with Carbon Seals                                 |
|      | VIS-23       | Y    | Imperfections on Raw Material Tubing, Detail Tubes & Assemblies and Tube Assembly Conical Seat Sealing Surfaces |
|      | VIS-45       | G    | All Chromium Plated Parts Except Those Contacting Carbon Seals  |
|      | VIS-46       | K    | Imperfections on Die-Formed Sheet Metal Parts   |
|      | VIS-104      | D    | Surface Condition of Shaped or Broached ANSI B92.1-1970 Spline Teeth  |
|      | VIS-114      | T    | Honeycomb Details & Brazed Assemblies Used For Abradable Rubstrips  |
|      | VIS-219      |      | Die Shear On Double-Hex Wrenching Configuration of Bolts and Nuts   |
|      | VIS-226      | G    | Fusion Welds  |
|      | VIS-454      | J    | Surface Imperfections on Major Rotating Parts   |
|      | VIS-459      | A    | Blends In Cast Turbine Vanes/Stators, Ducts and Housings (GEB Rocket Engine Programs)                           |
|      | VIS-460      | A    | Obsolete  |
|      | VIS-479      |      | PTFE Segmented Bearing Caged With Metallic Shrouds (GEB Rocket Engine Programs)                                 |
|      | VIS-480      |      | Glass Cloth Filled PTFE Bearing Cages (GEB Rocket Engine Programs)  |
|      | VIS-530      | A    | Rocket Engines, Ball and Roller Bearings After Engine Run at Rig Test   |
|      | VIS-531      | B    | Rub Deposition of Bronze Power Filled PTFE (SALOX-M) onto Rocket Bearing Raceways                               |
|      | VIS-536      | A    | Ball and Roller Bearings, Rocket Engine   |
|      | VIS-553      | A    | SSME Cryogenic Insulation Kevlar® Filled Urethane Insulation (KFUI) System                                      |



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| NOTE                            | STANDARD   | REV. | TITLE   |
|---------------------------------|------------|------|---|
|                                 | VIS-559    | B    | SSME Rotating Hardware Upset Edges Due To Peening   |
| *                               | VIS-578    | A    | Visual Imperfections on SSME Turbopump Hardware   |
|                                 | VIS-MASTER | U    | Visual Inspection Standard Master   |
|                                 | XRS-33     | M    | X-Ray Standard, PWA 16 Fusion Welds   |
|                                 | XRS-71     | D    | X-Ray Standard, Drum Rotor Electron Beam Welds  |
|                                 | XRS-90     | A    | X-Ray Standard, Cast Turbine Blades (GEB Rocket Engine Programs)                          |
|                                 | XRS-92     |      | X-Ray Standard, PWA 1489 Equiaxed Cast Turbine Vanes/Stators (GEB Rocket Engine Programs) |
|                                 | XRS-94     | A    | X-Ray Standard, Molded Bronze Filled PTFE Cage Material (GEB Rocket Engine Programs)      |
|                                 | XRS-99     |      | X-Ray Standard, Brazed Tube and Manifold Assemblies                                       |
|                                 | XRS-107    |      | X-Ray Standard, Chip or Foreign Material Entrapment in Liquid Space Propulsion Hardware   |
|                                 | XRS-302    | A    | X-Ray Standard, Chip Or Foreign Material Entrapment                                       |
|                                 | XRSMaster  | M    | X-Ray Inspection Master   |
| * Critical Process              |            |      |   |
| + Cancelled-Refer to STS-Master |            |      |   |

**APPENDIX G: QUALITY ASSURANCE SPECIFICATIONS**

| NOTE | QA-SPEC                 | REV. | TITLE  |
|------|-------------------------|------|--|
|      | PW-QA6071               | P    | Control Of Hidden Requirements And Special Identification  |
|      | PW-QA6076               | AD   | Cancelled, Replaced by ASQR-01   |
|      | PW-QA6077               | K    | Cancelled, Replaced by ASQR-01   |
|      | PW-QA6078               | AB   | Quality Control Requirements For Bar Stock, Castings, Forgings, Extrusions, Rolled Or Welded Rings, And Sonic Configured Parts Produced By Suppliers |
|      | PW-QA6084               | AA   | Cancelled, Replaced by ASQR-20.1   |
|      | PW-QA6088               | Y    | Control Of Non Conforming Articles By Vendor   |
|      | PW-QA6088<br>Appendix A | 2    | Nonconformance, Cause, and Corrective Action Data Codes  |
|      | PW-QA6091               | D    | THIS SPECIFICATION INCORPORATED INTO PW-QA6076   |
|      | PW-QA6096               | 5    | Requirements And General Information For Suppliers Of Non-Complex Support Equipment  |
|      | PW-QA6099               | A    | Process Certification Requirements<br>Cancelled-Ref UTCQR09.1  |
|      | ASQR-01                 | 5    | Aerospace Supplier Quality Requirements  |
|      | PW-QA6097               |      | General Information and Requirements for suppliers of Tools  |



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**APPENDIX H: GOVERNMENT SPECIFICATIONS**

| NOTE | SPECIFICATION     | REV. | TITLE  |
|------|-------------------|------|--|
| %    | QQ-P-35<br>Cancel | C    | Passivation Treatments for Corrosion Resistant Steel<br>Refer to ASTM A967, SAE AMS QQ-P-35                  |
|      | QQ-N-281          | D    | Nickel, Copper Alloy, Bar, Rod Plate, Sheet, Strip, Wire<br>Forgings and Structural /Special Shaped Sections |

%See ASTM-A967

**APPENDIX I: MCL MANUAL, F-54 ADDENDA**

| NOTE | ADDENDUM NO.  | REV. | TITLE   |
|------|---------------|------|---|
|      | MCLMF-54ADD1  | C    | Aluminum Alloy Castings   |
|      | MCLMF-54ADD2  | C    | Aluminum and Copper Alloy Forgings And Rolled Rings   |
|      | MCLMF-54ADD3  | E    | Steel, Heat & Corrosion Resistant Alloy Forgings And<br>Rolled Rings - Non-Airfoil Rotor Applications   |
|      | MCLMF-54ADD4  | D    | Steel, Heat & Corrosion Resistant Alloy Forgings, Rolled<br>Contour Stock, And Rings - Non-Rotor  |
|      | MCLMF-54ADD10 | C    | Control Of Ceramic Cores  |
|      | MCLMF-54ADD11 | G    | Ferrous And Heat Resistant Alloy Castings   |
|      | MCLMF-54ADD12 | C    | Titanium Alloy Forgings And Rolled Rings For Rotor<br>Applications  |
|      | MCLMF-54ADD14 | D    | Wrought Or Extruded Bar, Rod, Tube, Plate, Sheet, Strip,<br>And Wire For Non-Rotor Applications   |
|      | MCLMF-54ADD15 | C    | Supplier Designed Assemblies, Sub-Assemblies Or Details<br>For Which P&W Drawings May Specify Only Shipping<br>Closure Or Decalcomania Specifications |
|      | MCLMF-54ADD16 | D    | Metallic Purchased Parts Not Subject To Laboratory Control<br>At Source (LCS)   |
|      | MCLMF-54ADD17 | E    | Materials, Parts, And Assemblies Subject To Laboratory<br>Control At Source - LCS   |
|      | MCLMF-54ADD18 | C    | Non-Metallic Purchased Parts Not Subject To Laboratory<br>Control At Source   |
|      | MCLMF-54ADD22 | C    | Chemical And Metallurgical Processing   |
|      | MCLMF-54ADD23 | C    | Test And Calibration Requirements For Commercial And<br>In-House Laboratories   |
|      | MCLMF-54ADD24 | C    | Alloy Data Control Procedure For Major Rotor Parts (MRP)  |
|      | MCLMF-54ADD25 | B    | Industrial X-Ray Film   |
|      | MCLMF-54ADD26 | D    | Direct Procurement Of Rotor Part Forgings And Rolled<br>Rings By Machining Suppliers  |
|      | MCLMF-54ADD28 | C    | Titanium Alloy Forgings And Roller Rings For Non-Rotor<br>Parts   |
|      | MCLMF-54ADD29 | C    | Vapor Deposition Coatings   |
|      | MCLMF-54ADD32 | D    | GATORIZED™ Forgings Produced From Extruded<br>Billet-Rotor Applications   |
|      | MCLMF-54ADD35 | B    | Thermal Spray Coatings  |
|      | MCLMF-54ADD36 | C    | Supplier Control Procedures For Source Qualification  |
|      | MCLMF-54ADD38 | C    | Control Of Bearings   |



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**APPENDIX I: MCL MANUAL, F-54 ADDENDA**

| NOTE | ADDENDUM NO.  | REV. | TITLE   |
|------|---------------|------|---|
|      | MCLMF-54ADD40 | E    | Heat Treatment and Case Hardening                         |
|      | MCLMF-54ADD42 | B    | Adhesive Bonded Assemblies                                |
|      | MCLMF-54ADD43 | C    | Finishing By Electrochemical And Electrodischarge         |
|      | MCLMF-54ADD44 | G    | Chemical And Electro-Chemical Metal Finishing             |
|      | MCLMF-54ADD45 | C    | Supplier Controls For Threaded Fasteners And Tie Rod Nuts |
|      | MCLMF-54ADD52 | C    | Non-Metallic Raw Materials                                |
|      | MCLMF-54ADD56 | B    | Cleaning of SSME-AT Plumbing                              |
|      | MCLMF-54ADD58 | A    | Laboratory Control Plus (LC+)                             |

**APPENDIX J: SUBCONTRACTOR RESPONSIBILITIES**

| NOTE | SR NO.  | REV. | TITLE   |
|------|---------|------|---|
|      | SR-010  |      | Rights in Technical Data and Computer Software ATD/ATP (SSME)                       |
|      | SR-031  | B    | Flowdown of Unique SSME AT Program Requirements                                     |
|      | SR-034  | B    | SSME Configuration Management   |
|      | SR-036  | G    | Requirements for Space Shuttle Main Engine Turbopump Program Supplier Documentation |
|      | SR-043  | C    | SSME Alternate Turbopump First Article Inspection                                   |
|      | SR-044  | C    | SSME Alternate Turbopump Airfoil Manufacturer First Article Inspection              |
|      | SR-045  | A    | Production Readiness Reviews  |
|      | SR-046  | A    | Process-Product Integrity Audits  |
|      | SR-049  |      | SSME Alternate Turbopump Engineering Data   |
|      | SR-050  | B    | Focused Process-Product Integrity Audit   |
|      | SR-1001 | J    | Subcontractor Responsibilities Reference Programs                                   |

**APPENDIX K: PURCHASE PERFORMANCE SPECIFICATIONS**

| NOTE | PPS NO.   | REV. | TITLE   |
|------|-----------|------|---|
|      | PPS F-768 | D    | Transducer, Speed Sensing, Multi-Element, Magnetic High Pressure Fuel Turbopump for Space Shuttle Main Engine |


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**APPENDIX L: CEI & ICD SPECIFICATIONS**

| NOTE | SPECIFICATION | REV.                | DESCRIPTION                                       |
|------|---------------|---------------------|---|
|      | CP11369       | D SCN002            | End Item Spec for Oxidizer Turbopump              |
|      | CP11370       | B SCN002            | End Item Spec for Fuel Turbopump                  |
|      | CP11371       | G<br>IRN<br>PW 0066 | Interface Control Document for Oxidizer Turbopump |
|      | CP11372       | D<br>IRN<br>PW 0067 | Interface Control Document for Fuel Turbopump     |