Agenda

- Parts, Materials & Processes (PMP)
  - What is PMP
  - Key Players
  - PMP Life Cycle (Macro & Micro)
  - PMP Requirements Flow-down
  - Role of the Parts Manager
  - Tools, Boards, Documentation & Data Review

- Parts Management Process
  - New Parts Request
  - Product Structure & Configuration Control
  - PMP Approval Process
  - PMP - Everything Else
  - Product Structure & Configuration Control (Reprise)

- Space PMP Challenges
  - What’s so Special About Space?
  - Why Does it Cost so Much & Take so Long to Get my Parts!
  - Challenges With Space PMP Selection
What is PMP?

• PMP (Parts, Materials & Processes):
  
  – Parts
    • Electrical, Electronic, Electro-mechanical & Electro-optical (EEEE)
      – Simply: “If you put current through it” it’s EEEE
        » *Exception: Some customers classify connectors & wire as materials
      – Capacitors, Connectors & Contacts*, Crystals, Crystal Oscillators, Fiber Optics, Filters, Fuses, Heaters, Magnetics, Microcircuits (Hybrids, Monolithic, Plastic), Relays, Resistors, Semiconductors (Transistors & Diodes), Switches & Thermostats, Thermistors, Wire & Cable*

  – Materials:
    • Anything that is not EEEE
      – Metals, Composites, Mechanical Piece Parts (nuts, bolts, screws, washers, inserts, cable ties, etc.), Adhesives, Elastomers, Paints, Coatings, Primers, Potting & Staking Compounds, Sleeving & Tubing, Lubricants, Inks, Plastics, Tapes & Films, Fluids, Gas & Liquids
        » Based on customer: wire, cabling & connectors

  – Processes:
    • Fabrication & Installation, Identification & Packaging, Electrical Assembly, Welding & Brazing, Non-destructive Evaluation, Heat Treatment, Surface Finishes, Precision Cleaning & Contamination Control
    • Special Processes (requires extra oversight & approvals)
      – ESD, Soldering, PWBs, Magnesium Alloy Processing, Passivation & Chem. Conversion Coating
Key Players in the PMP Process

- Parts Managers
- Hardware Engineering (Electrical & Mechanical)
- Component Engineering Specialists
- Production Engineering
- Materials & Processes Engineering
- Reliability Engineering
- Radiation Engineering
- Manufacturing Engineering
- Mission & Supplier Mission Assurance
- Other Subject Matter Experts (e.g., Thermal, Structural, etc.)
- The Customer (and consultant team!)
PMP Life Cycle (Macro)

- Planning
- Selecting
- Purchasing/Test
- Maintaining/Manage
- Issues
- Lessons Learned

Click topics for detailed breakout:
- Planning
- Selecting
- Purchasing/Test
- Maintaining/Manage
- Issues
- Lessons Learned

**As-Required:
- Program Driven
- Parts Master
- Status
- YTECOL

**Standardization:
- Source Selection
- Standard parts lists
- Manufacturability
- Operations efficiency
- Cost effectiveness
- Supplier development
- Availability/DMS
PMP Lifecycle (Micro)

Don’t Wait! Start Talking With PMP Team Here!

Preliminary Product Structure & New Parts Requests
- Numeric Release of BOM
- Special Handling Codes
- DMS Assessment

RFQs, PRs, P.O. and/or Inventory Transfers
- Sole Source Justifications
- Identification of MIPs
- Vendor Audits

Load Parts, Materials & Process List Into PAPL Tool
- CCB Process
- Alpha BOM Release

SCD, SID, Assy. Drawing Release
- Incoming Inspection
- Prohibited Materials Analysis
- Vendor Data Review

Receive Parts/Materials
- Update Router (as req.)
- 3rd Party Test House
- DPA, Retin, etc.

Manufacturing, I&T
- Select & Test; PMP Additions
- Review Test Data (as req.)
- Support MRB/FRB (as req.)

Review & Approval Process (Internal PMPCB)
- Tier-1 EEEE Parts
- Tier-2 Materials & Processes
- Tier 3 Radiation Review
- Tier 4 DMS Assessment

Value-Added Parts & Materials Testing
- Update Router (as req.)
- 3rd Party Test House
- DPA, Retin, etc.

Kit Parts & Materials w/Traceability Records
- Inspection Characteristics in SAP

Iterative Feedback Process With Design Engineers
- PAPL & Meeting Minutes
- Preliminary SCDs & SIDs
- Low-level Design Reviews

Customer PMPCB
- PMPR Submit & Approval
- Compliance Matrices

Store Parts/Materials in Limited Access Flight Stockroom
- Per Special Handling Code

Manufacturing/Test Readiness Reviews
- Can Occur Earlier in Process

As-Built Data Package
- GIDEP review
- Periodic DMS Assessment

Expedite Purchase Orders & Source Inspections
- SCM (Expedite)
- ATP/QTP Approvals
- SMA (MIPs)
- Value-Added Testing Router

Receive Parts/Materials
- Numeric BOM Release
- Long-lead Assessment
- Periodic DMS Assessment

Update Product Structure
- Numeric BOM Release
- Long-lead Assessment
- Periodic DMS Assessment

Kit Parts & Materials w/Traceability Records
- Inspection Characteristics in SAP

Manufacturing/Test Readiness Reviews
- Can Occur Earlier in Process

Space only
• Space Only

PMP Involved Proposal to Delivery ...and beyond
PMP Requirements Flow-down

PMP Control Plan
Defines the Methods for Flow Down and Compliance

Purchase Department Specification (PDS)
- Mechanical Suppliers
- Material Suppliers

PMP Plan Subset:
- Prohibited Materials
- Traceability/As-built
- PMPCB

Direct Flow Down to Large Subcontractors

Other Methods
- Statement of Work
- Source Control Drawings
- Altered Item Drawings
- Assembly Drawings
- Purchase Order Quality
- Clauses & Notes

Similar-to Analyses
- Sole Source & Price Justifications

Site Visits & Audits
- Approved Supplier & Survey Reports

Design Reviews
- Presentations & Analysis

Source Inspections
- Inspection & Corrective Action Reports

Acceptance Test Plans
- Test Plans, Schematics & Data Sheets

Qualification Test Plans
- Test Plans, Schematics & Data Sheets

Data Review
- CofC, CofA 100% & Sample Test Data

Multiple Methods of Oversight & Verification
Role of the Parts Manager

- Parts Managers are involved in the flow-down and compliance of requirements to ensure specific parts, materials and processes used in manufactured products and systems are reliable and effective. Their work spans all program phases, including: proposal, design & development, manufacturing, integration & test, and post-delivery/launch support for repair and anomaly investigations.

- Parts Managers serve as the interface between internal and external customers and the Program. Parts management oversight and compliance related activities include (but are not limited to):
  - Proposal cost estimations & technical volume support
  - Generation of program parts materials & processes control plan
  - Approval of parts, materials & processes
  - Facilitate and chair parts, materials & processes control boards
  - Generation of parts, materials and processes test & qualification plans
  - Generation of non-standard parts, materials & processes approval requests
  - Generation of source control drawings, selected item drawings, statement of work, etc.
  - Approval of subcontractor/supplier non-standard parts, materials & processes approval requests
  - Approval of subcontractor/supplier acceptance & qualification test procedures
  - Approval of suppliers and test houses
  - Approval of parts, materials and process related test data
  - Support Supply Chain Management Procurement: RFQ, sole source & similar to justifications
  - Approval of assembly and related drawings
  - Support change control board approvals
  - Generation of program selected data requirements list items including preliminary, as-designed and as-built parts, materials and processes lists
  - Approval of subcontractor/supplier selected data requirements list items
  - Generation and/or presenter at program reviews (TIM, PMR, PDR, CDR, EDR, MRR, etc.)
  - Support program IMS, EVMS, Risk & Opportunity, and other tasks.
  - Review of GIDEP, DMSMS, etc. related alerts and advisories
  - Support failure anomaly and material review board investigations
# Tools, Boards, Documentation & Data Review

## Database/Tools
- PMP Related Database Maintenance (PAPL, Spreadsheets, etc.)
- aClass/SPL Maintenance
- Work Requests (SharePoint)
- New Part, Material or Process Development (NPRs)
- Part Maintenance (ISE)
- Coordination of SAP Routings & Coding Flags
- GIDEP & Sentinel (REACT)
- DMS & Obsolescence (Pilot)
- Lessons Learned
- Hardware Design Review Signoff (SharePoint)

## Documentation
- PMP Proposal Generation
- Review Program PMP Plan/SOW
- Create/Maintain Program PMP Schedule
- Requirements flow-down (PMP Plan, PDS documents, etc.)
- Develop Screening & Qualification Plans
- PMPR/NSPAR Generation
- Generate Subcontractor Statement of Work (SOW)
- Drawing Reviews & Signoff
- CDRLs/SDRLs Generation & Support
- Sole Source Justifications

## Boards & Oversight
- Risk & Opportunity Assessments
- PMPCB Lead/Chair
- PMP Selection
- Supplier & Test House Selection (ASL)
- Technology Insertion Board
- Supplier Audits
- CCB
- Subcontractor Oversight
- Support Manufacturer Source Inspections
- Support VMDA
- Support FRB & MRB Activities

## Data Reviews
- ATP/QTP
- Vendor & Manufacturing Test Data & DPA
- Engineering Analyses Support (Thermal, Mechanical, Reliability, Survivability)

## Program/Customer Interface
- Program Meetings
- Program Status Reporting (IMS, EVMS, PMRs, etc.)
- Design Reviews (TEMs, PDR, CDR, MRR, TRR, etc.)
Parts Management Processes
New Part Request Process (NPR)

- All parts must be assessed for suitability for their intended application
- Parts classified into 10 applications per table below:

<table>
<thead>
<tr>
<th>Code</th>
<th>Application</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF</td>
<td>Space Flight</td>
<td>Used only for parts qualified to military, space-level requirements, Note 2.</td>
</tr>
<tr>
<td>MXT</td>
<td>Military Extended Temperature Range</td>
<td>Complies with Table E241-MSO-A1-8 requirements Operation and storage temperatures of -55°C to +150°C</td>
</tr>
<tr>
<td>MIL</td>
<td>Military Temperature Range</td>
<td>Complies with Table E241-MSO-A1-8 requirements Operation and storage temperatures of -55°C to +125°C</td>
</tr>
<tr>
<td>AUF</td>
<td>Airborne Uninhabited Fighter</td>
<td>Complies with Table E241-MSO-A1-8 requirements Operation and storage temperatures of -40°C to +85°C</td>
</tr>
<tr>
<td>AIF</td>
<td>Airborne Inhabited Fighter</td>
<td></td>
</tr>
<tr>
<td>GM</td>
<td>Ground/Surface Mobile</td>
<td></td>
</tr>
<tr>
<td>NS</td>
<td>Naval Sheltered</td>
<td>Complies with Table E241-MSO-A1-8 except HAST and 85/85 are not required Operation and storage temperatures of -0°C to +70°C</td>
</tr>
<tr>
<td>GSH</td>
<td>Ground Sheltered</td>
<td></td>
</tr>
<tr>
<td>FTE</td>
<td>Factory Test Equipment or Commercial</td>
<td>Support equipment and engineering models not subject to reliability data Operation and storage temperatures of -0°C to +70°C</td>
</tr>
<tr>
<td>NP</td>
<td>Non-Production (RAPID) / Prototype</td>
<td>Parts approved for RAPID programs only. NP is for development programs and are not subject to reliability data analysis or temperature limits.</td>
</tr>
</tbody>
</table>

**Note 1:** Temperature limits are for ambient air unless noted otherwise.
**Note 2:** Qualification requirements for Space Parts are dependent on contractual requirements based on mission type and duration.
New Part Request Process (NPR) Cont’d

- SPL = Standard Parts List
  - By Sector & App.Class
  - 5 SPL’s Used at NGMS:
    - BWI-SF-SPL
    - BWI-AUF-SPL
    - BWI-AIF-SPL
    - BWI-FTE-SPL
    - BWI-NP-SPL

- PPSL = Pgm. Parts Selection List
  - Parts Approved for a Given Program
  - Can be an SPL Items
  - Includes SCD/SID items

- Alternate Approach to Rejection:
  - Approve at Lower App. Class
  - Generate SCD/SID for Screen/Qual
  - SCD/SID Added to PPSL
  - Space: PMPCB ➔ PPSL

*Standardization: Performance, Availability, Reliability
Product Structure & Configuration Control

- ISE Database (Information System for Engineers)
  
  **Part Master**
  - Special Handling Codes
  - Shelf Life & YTEOL Information
  - Maintains Supplier Test Data

  **Configuration Control**
  - Product Structure
  - Bill of Materials (BOMs)
  - Traceability Data (Receiving)
  - New Parts Requests

  **CADSTAR**
  - Drawings & RNs
  - Electronic Sign-off

  **Other (use ISE data)**
  - DMS/Obsolescence
  - GIDEP

  **Approvable parts are based on Mission Class**

  **Inactive parts are blocked automatically**

  **Estimate Years To End Of Life Shown Here**

---

**ISE Database (Information System for Engineers)**

- Part Master
  - Special Handling Codes
  - Shelf Life & YTEOL Information
  - Maintains Supplier Test Data

- Configuration Control
  - Product Structure
  - Bill of Materials (BOMs)
  - Traceability Data (Receiving)
  - New Parts Requests

- CADSTAR
  - Drawings & RNs
  - Electronic Sign-off

- Other (use ISE data)
  - DMS/Obsolescence
  - GIDEP
Product Structure & Configuration Control Cont’d

• BOM Creation & Revision (TeamCenter, ISE, NX & Mentor)
  - Mechanical Drawings & Parts Lists
    - Fully Dimensioned (stand-alone)
    - Database Drawings (assoc. CAD model)

Configuration Control Board (CCB)
  - Document Master
  - Drawing Release
  - Revision Notice (RN) Generation

---

**Table: Document Types and Graphic Types**

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Graphic?</th>
<th>Graphic Type</th>
<th>Graphic Size</th>
<th>PL?</th>
<th>PL Type</th>
<th>PL size</th>
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</thead>
<tbody>
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<td>Yes</td>
<td>Unigraphics</td>
<td>D</td>
<td>Yes</td>
<td>SQL TABLE</td>
<td>A</td>
</tr>
<tr>
<td>HDD- Electrical</td>
<td>Yes</td>
<td>Mentor</td>
<td>D</td>
<td>Yes</td>
<td>SQL TABLE</td>
<td>A</td>
</tr>
<tr>
<td>TSPEC</td>
<td>Yes</td>
<td>MS Word</td>
<td>A</td>
<td>No</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SCHEMATIC</td>
<td>Yes</td>
<td>Mentor</td>
<td>D</td>
<td>No</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ICD</td>
<td>Yes</td>
<td>Varies- usually Unigraphics</td>
<td>D</td>
<td>No</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
PMP Approval Process

- Program Approved Parts List (PAPL Tool)
  - Exclusive to Space Programs
    - Airborne/Other NPR Approval ➞ PPSL
  - Separate PAPLs for EM, Qual, Flight Structures
    - Imports Data from ISE Database

“Fills Gap” Between NPR/SPL & Program PMP Control Plan Requirements
PMP Approval Process

- Program Approved Parts List (PAPL Tool)
  - Captures SME Reviews & Parts Information

![Image of PAPL Tool interface](image-url)
PMP Approval Process

- PAPL PMPCB DVU “Reject” Example:

**Eng Part Number**
- JANS2N2222AUB

**GAGE Code**
- 81349

**Notes**
- SPL

**Radiation Review Summary**
- Not recommended
- DPA Requirements

**Material Review Summary**
- 

**PMPCB Recommendation**
- 

**PMPCB_Comments**
- Part rejected. Use "R" part as non-R has had recent low rad test results. FM part will need NHA for Gold removal. Use non-R TXV for DVU. Will need new SID as 594R278H01 is for JANS, not JANSR.

**Replacement Part Number**
- JANSR2N2222AUB

**Replacement Document**
- 

**Internal PMPCB Review**
- Approve
- 

**Meets Apvd PL Reqtd**
- Yes
- 

**PAR Number**
- 

**Part Approval**
- Yes on PMPSL
- 

**PMPCB Comments**
- 

**Mission Assurance**
- 

**Source Inspection?**
- 

**Preop Inspection?**
- 

**Qualification testing?**
- 

**Other tests/comments**
- 

**Engineer Part Number**
- JANS2N2222AUB

**Internal PMPCB Review**
- No
- 

**Meets PL Reqtd**
- 

**PAR Number**
- 

**Part Approval**
- 

**PMPCB Comments**
- 

**Replacement Part Number**
- JANSR2N2222AUB

**Record:** 1 of 1

**No Filter**

**Search**

**[Image of a PMPCB approval form]**
PMP Approval Process

- PMP “Typical” Documentation
  - Non-Standard Part Approval Requests (NSPARS)
    - Non-SPL or Non-1st Order Selection per PMP Control Plan
  - SCDs, SI Ds, & Al Ds
    - Flow-down: Screening, Qualification, Traceability, Data, etc.
  - SDRLS (Internal or Customer)
    - PMP Control Plan
    - As-Designed & As-Built PMP Lists
    - Other SDRLs (per Contract)

- Other Documentation
  - Review & Approval of Assembly Drawings, Test Specs, etc.
  - Generation of Technology Readiness Assessment (New Technology)
  - Program Monthlies, Technical Exchange, & Design Reviews
    - PMR, TEMs, iPDR/PDR, iCDR/CDR, MRR, TRR, etc.
    - Page & Line, Earned Value & Other Status Reports
PMP Approval Process

• The Customer and the Consultant Team
  • The “Small Box”
    • Approval of 1st Order Parts During PMPCB
    • Approval of NSPARS, SCDs, SDRLs, TRA, etc.
      • 2-3 Week Minimum for Initial Documentation Approval/Comments
        • Longer Based on # of Consultant Assessments Required
        • Iterative Process – Ensure Time Allocated in Program Schedule (IMS)
        • Include Time for Updates & Resubmittals
  • The “Big Box”
    • Attendance at Design Reviews (Pre & Formal)
      • Want to be Part of the “Sausage Making”
      • Drawback: Often Results in Reluctance on Asking “The Hard” Questions
    • On & Off-site Technical Exchange Meetings (TEMS)
    • Onsite Representation
      • Can be Good Thing: “Quick Access” For Inspections & Consultation

The “Big Box” – Customer has Privy Into Every Aspect of Design & Build
PMP - Everything Else

- Procurement, Receiving, 3rd Party Testing, Kitting, & Manufacturing:
  - Purchase Requisitions & Purchase Orders (Supply Chain & Buyers)
    - Sole Source Justifications
    - Traceability & Data Requirements
    - T’s & C’s for Counterfeit Avoidance, FARs & DARs, etc.
  - Supplier & Program Mission Assurance
    - Approved Supplier List (ASL)
    - Supplier Audits & Oversight
    - Inspection Requirements (pre-cap & final source, MIPs, photos, etc.)
  - Receiving Inspection & Kitting Traceability & Testing
    - Capture & “Push” of Traceability Data
      - Support GI DEP / Customer Alert
      - As-Built Configuration
    - Prohibited Materials Analysis
      - Tin / Other Prohibitions
    - Data Review (performed by component specialists)
      - Supplier & 3rd Party Test House
      - Store Data in ISE (Part Master)
  - Manufacturing
    - Build & Test
    - Process & Equipment Qualifications
    - As-Built Configuration Records

PMP Flow-down & Oversight Spans Many Functional Areas
Product Structure & Configuration Control (Reprise)

- **ISE handoff to SAP Database**
  - SAP = Enterprise Resource Planning (ERP) Database

### Manufacturing
- Manufacturing Readiness Reviews (MRRs)
- Test Readiness Reviews (TRRs)
- Work order Generation
- Job-on & Operation Sign-off
  - Link to LX Training Database
  - As-built Configuration

### Other ERP Functions
- Kitting Inventory Management
  - ISE Push Traceability Data
- Purchasing & Quality Records
- LX Training Database
- Time Card & Payroll, etc.
Space PMP Challenges
What’s so Special About Space?

- Majority of “Space” Unique Requirements are Technical in Nature (graphic below)
- Higher Administrative Burdens Include:
  - Significant Customer Interaction & Oversight; Including On-site Representative(s)
  - Numerous Contract Standard Data Requirements List (SDRL) items
  - Maintenance of As-Designed, As-Built, and Long-Lead PMP Lists
  - PMPCB & Non-standard Part Approvals
  - Various Checklists, Status Reports & Meetings
  - Customer Participation in Supplier & Internal Manufacturing Design Reviews & Audits

- Vacuum (things evaporate & grow whiskers; no thermal convection)
- Zero Gravity (loose things float around)
- Wide Thermal Excursions (hot & cold mitigations required)
- Radiation (Total Ionizing Dose, Single Event Effects, Displacement Damage, etc.)
- Surface Charging (Zap!)
- Coronal Cosmology (Partial Discharge)
- Atomic Oxygen (scours & abrades material surfaces)
- Micrometeoroids (punch holes in materials)
- Residual Magnetism (can affect instrumentation)
- Die Foundry Approval & Testing (high dollar, long-lead)
- Launch Related (rapid depressurization, acoustic, vibration, pyro-shock)

You Only Get one Chance – Must be Right the First Time!
Why Does it Cost so Much & Take so Long to get my Parts?

Higher Parts Quality Level (Class-V, K, S)
More Restrictive Failure Rates (T & S)
PMP Plan
All PMP & Alternates Require Approval
Parts, Materials & Processes Control Board
Prohibited/Restricted PMP (Esp. Pure Tin)
Assy. Drawings/SCDs/Travelers PMP Sign-off
Processes Require Qualification
Non-Standard PMP Approvals
Customer Oversight / Approvals
Radiation Effects (TID, SEE, DD, etc.)
Vacuum Outgassing
Vacuum Thermal Constraints (No Convection)
EMI/EMC
Component Durability Index
Micrometeoroids
Contamination Control / Atomic Oxygen / Surface Charging / Corona (Partial Discharge)
Worst Case Analysis (e.g., margin at end of life)
FEMA/FEMCA
PWB Design Rules / Restrictions
Technology Insertion Board / Heritage
iPDRs/iCDRs
Manufacturing Readiness Reviews
Test Readiness Reviews
Page & Line Meetings
Monthly Program Reviews
Failure & Material Review Boards
Pedigree/Traceability
OEMs & Authorized Suppliers
Foundry Approvals
100% Screening
Lot Specific Qual Testing & QCI
Pre-Cap & Final Source Inspections
Certified materials

Serialized Read & Record Test Data
Certificate of Analysis (Materials)
Data Review/Retention
Incoming Inspections (XRF, etc.)
Limited DMS/Obsolescence
As-Designed PMP/As-Built PMP Lists
Various Other SDRLs
End-Item-Data-Package
No repair (except limited software)
Long/Tiered Procurements (36-52 Wks)
High Cost $$$

Common
NPR Process, GIDEP,
EVMS (Pgm. Specific), IMS (Pgm. Specific),
Counterfeit Control, Limited Life, ITAR,
Temperature (Operational / Survival), Vibration, Power,
Mission Duration, # Temp. Cycles, Moisture Rating, Derating*,
Parts Age Control*, ESD, Supplier Audits / Oversight,
Sole Source / Similar To Justifications, ATP/QTP Reviews
VECR Process, SRR/PDR/CDR (Pgm. Specific), Reliability Analyses
Software QA*

*More Restrictive for Space

All PMP w/i Application Class
All PMP on Standard Replacement List
Open Market Procurement
No XRF Testing
No DPA or QCI Testing
Repair/Maintenance
First Article Inspection (FAI)
1st Lot Qual (or after process change)
Certificate of Conformance Sufficient
Design Try-outs (Standard Practice)
Limited Program Reviews
Funded DMS/Obsolescence
Majority Hardware Ext. Manufactured
No Traceability
Challenges With Space PMP Selection

• “Google” is not Your Design Tool!
  – Use Space Quality Baseline (1st Order) & Heritage Program Parts

• Just Because you Used it on Your Last Program….  
  – Heritage & Qualification Processes More Rigorous for Space (refer to “seesaw”)  
  – #1 Thing you can do: Limit use of Plastic Parts & COTS  
    • Ask Yourself: Is Part Mission-enabling, or is There an Alternate Solution?  
    • Average Lead-time 36-52 Weeks; $30K to $150K+ per lot to Qualify

• Lots of Application Notes & Restrictions on Space PMP
  – Ex. Ceramic Capacitors  
    • Use M123 & G311P829; Avoid Base Metal Electrode  
    • COTS: Avoid top 3 in tier; Choose Automotive Grade (if necessary)
  – Ex. Resistors:  
    • Ask Yourself: Do I Really Need a 0.1% Resistor? It’s O.K. – Just Long-lead & High $
THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN