SMC Specifications and Standards Program

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### SMC Specifications and Standards Program

**Abstract**

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**Security Classification**

- **Report**: Unclassified
- **Abstract**: Unclassified
- **This Page**: Unclassified

**Limitation of ABSTRACT**

Same as Report (SAR)

**Number of Pages**

32
Is Development of Space Systems Different?

- Launch is a “one-strike-and-you’re-out” business
- Spacecraft must work by remote control for 15 years
  - Hostile environment
  - "Small" failures can cripple or end mission

No “flight Testing” and No Service Calls in Space Mandates Unique, High-Confidence Mission Assurance Culture

Integrity - Service - Excellence
Space Business is Challenging

- On-Orbit
  - Infant Mortality dramatically increased
  - Secondary rise in failures due to …..
  - Orbital failure trends identifies increased number of early failures

- Factory Anomaly Failure Rates
  - Late build-cycle failures post-1995 have shown a dramatic increase
  - System test failures are up 39%
  - 57% increase in orbital failures

<table>
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<tr>
<th>Late Build-Cycle Failures</th>
<th>System Test Failure Cause</th>
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An Unforgiving Business; One Strike and You’re Out

- Acquisition agents relegated to a “trust and see” role
- Specs and standards loosely applied
- MA largely decoupled from design process
- Quality and review processes dramatically curtailed
- Test discipline greatly relaxed
Design issues are the dominant cause of on-orbit anomalies
  - Suggests flaws and potential improvements associated with design assurance activities

Parts are not the dominant cause of total anomalies
  - Parts issues are most apparent during infant mortality—a proto-qual and testing issue

Workmanship issues have decreased
  - More attention to testing and QA/MA practices

The number of unknown anomalies has increased
  - Lack of solid understanding of “as built” configuration

Software is emerging as a leading source of anomalies
Space System Development Cycle

**Develop**
- Requirements/ConOps Definition
- System Concepts
- Technology Demonstration
- Design/Engineering

**Acquire**
- Contract
- Manufacture/Produce/Code
- Assemble, Integration/Test
- Space-Ground-User Segment/Integration

**Sustain**
- On-Orbit Constellation Mgmt
- Ground Systems
- Satellite Anomaly

**Evolve**
- Space/Ground Segments
- User Equipment

Typical DoD Life Cycle Cost Curve
- System Development & LRIP: 28%
- Production, Operations & Support: 72%

Notional Space Life Cycle Cost Curve
- System Acquisition: 70%
- Operations & Support: 30%

Majority of SMC Investment Dollars Spent in DT&E Phase


MS "A" MS "B" MS "C"
SMC Specs & Standards (S&S) Initiative

- Apply specs & standards as element of acquisition practices and toolset
- “Select” list of Space systems standards
- Issue Organizational Policy
- Specify critical standards in RFP
- Specs & Standards program is to ensure sound technical practices applied across NSS programs
- There is a cost to doing our business, but we were already doing to some extent, regardless of this initiative

- SMC Instruction 63-106, issued 2009
- S&S integral to SMC acquisition process
- Applies to all new development, acquisition and sustainment contracts, including new large ECPs or contracts for legacy programs
- Contractual compliance through the supplier chain, as appropriate
- SMC/EN (Chief Engineer) is OPR
SMC Specifications and Standards Functional Areas

**MANAGEMENT**

- Program Management
- Systems Engineering
- Product Assurance
- Subcontract Management
- Design Reviews
- Configuration Management
- Manufacturing and Production Management
- Parts Management
- Risk Management
- System Safety
- Occupational Safety and Health

**TECHNICAL**

- Electrical Power, (Batteries & Solar)
- Electromagnetic Interference & Control
- Environmental Engineering; Cleanliness
- Human Systems Integration
- Interoperability
- Logistics
- Maintainability
- Mass Properties
- Moving Mechanical Assemblies
- Ordnance
- Pressurized Systems & Components
- Parts, Materials & Processes
- Reliability/Availability
- Information Assurance/Program Protection
- Software Development
- Structures
- Survivability
- Test, Space & Ground
SMC Compliance Standards List

- SMC Technical Baseline
  - 68 documents
  - Includes all four space system segments
  - Approved by SMC/EA

- Comprises Formal, Stable, & Accessible Standards
  - Military (Mil-Std)
  - International (ISO)
  - Industry (AIAA)
  - SMC Standards

- Reflects current best practices
- Updated periodically

Our Assessment: It’s Working
## Compliance Documents for SMC Acquisitions  
(July 2010)

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Characteristics of SMC Standards

- Requirements based- compliance in RFP and Contract
  - “Shall” based
  - Not tutorial / Guidance
  - “What” and not “How To”
    - Some exceptions
- Product requirements based on sound processes and key process attributes
  - Process attributes/criteria included in Standard
    - Alternative for “How To”
- Offeror may propose listed standard or another government
  - Industry technical society (IEEE, AIAA, etc.), international or corporate version
  - Provided it is comparable in rigor and effectiveness
  - will be placed on contract as a compliance document

Regardless of the documentation form, the compliance documents provide a clear technical baseline for government program to manage
Re-establishing Best Practices

Standards – Specifications

- SV/LV Environmental Design & Test Requirements
- Hardware Development Tests & Environments; MIL-STD-810G
- Software Development & Verification; Mil-Std 498
- Ground Equipment Test Requirements; MIL-STD-1833
- Range Safety Requirements; EWR 127-1, AFSPCMAN 91-710
- Mass Properties Controls for Space Systems; MIL-STD-1833
- EMC Requirements; Mil-Std-1541A
- EMI/EMC Requirements; Mil-Std-461E
- Wiring Harness Design & Testing; SMC Standard
- Battery Requirements; SMC Standard
- Solar Cell Development & Test; Aerospace TOR AIAA S111-2005
- Solar Panels Development & Test; Aerospace TOR AIAA S112-2005
- Moving Mech. Assemblies; Aerospace TOR AIAA S114-2005
- Structural Design & Test Rqts; Aerospace TOR AIAA S110-2005
- Metallic Pressure Vessels-Pressurized Structures; AIAA S-080-1998
- Composite Overwrapped Pressure Vessels; AIAA S-081-2000
- Solid Motor Case Design & Test Requirements; SMC Standard
- Explosive Ordnance; (Aerospace TOR) AIAA S113-2005
- Flight Pressurized Systems; SMC Standard
- Technical Requirements for PMP; MIL-STD-1547B
- Systems Engineering; SMC Standard
Background

Dr. Ashton B. Carter
Under Secretary of Defense for Acquisition, Technology & Logistics

Memo: September 14, 2010*

Guidance Roadmap*

Memo: November 3, 2010*

KEY THEMES

- Target affordability and Cost Control
  - Restore Affordability – Mandate as a requirement
  - Drive productivity growth through Will/Cost Should Cost management
  - Set shorter program timelines and manage them

- Incentivize Productivity and Innovation in Industry
  - Reward contractors for successful supply chain and indirect cost management
  - Increase the use of Fixed-Price Incentive Firm Target contracts

- Reduce Non-productive processes and bureaucracy

- Improve tradecraft in service acquisition
  - Prevent requirements creep
Industry Partnership

• Highly desirable
  • ……perhaps politically mandatory!!
  • Collaboration based product/process technical practices
  • Facilitates detailed technical discussions about success, philosophy, etc of our technical practices

• Benefits
  • Common understanding/expectations
  • Common technical language
  • Common RFP/Contract Tools

• Increased visibility and understanding of industry practices
  • Including span of industry customer base

• However, selection of Industry partners critical
  • Willingness to publish standard consistent with government needs
  • Could/would be basis for military standard if no cooperative agreement with an industry organization established
Summary

• Use of standards as “normal” part of Govt toolbox recommended
  • States expectations/requirements of govt customer
    • Let’s industry know what’s important to customer
    • Helps level playing field
  • There is a cost to doing our business, but we should already be doing, regardless of this initiative
• IMHO - Teaming with industry essential!!
  • For both technical and political reasons
  • Selection of Industry partners critical
    • Willingness to publish standard consistent with government needs
    • Basis for military standard if no cooperative agreement with an industry organization established
Summary

- S&S Synchronization a high priority within National Security Space
  - Achieve MA Objectives
    - Ensure sound technical practices applied across NSS programs
    - Ensure adequate resources baselined
  - Commonality/consistency of practices "across our community"
    - Govt NSS; Primes; subs; sub-tier supply base
    - “Right Size” our Standards
    - Consistent with contractor practices

- Institutionalization practices
  - Disciplined implementation
    - Consistent implementation on both sides

Continue dialogue to achieve above objectives

Healthy tension must be embraced and not discarded
Back-up
PMP Issue

Impact of PMP Failures

- Cost impacts magnified if not discovered until late in build cycle

Costly PMP Problems
  - Heterojunction Bipolar Transistor (HBT)
  - Inadequately Qualified
    - Field Programmable Gate Array (FPGA)
      - Inadequate Test
    - Ceramic capacitors
      - Defective
    - Stacked ceramic capacitors
      - Inadequate Process Control
  - Tin Whiskers
    - Poor Prohibited Materials Control

Large Cost Savings When Failures Caught Early

Increased PMP Failure Risk → Importance of PMP Programs

2. A. Saari, RADC Report TR-82-87, 1982
3. Chart provided by Bruce Arnheim, Aerospace Corp.
SMC Systems Engineering Process Overview

**Baseline Technical Command Media**
- Policies, specs/standards
- Best practices
- Handbooks and guides
- Data deliverables

**Program Planning, Tailoring, and Management**
- Spec and std tailoring
- Program management planning
- Technical planning
- Technical data sharing
- Government/contractor working group relation
- Critical process tailoring
- KPP/TPM criteria
- Definitive pedigree and sell-off criteria

**Program Execution Assessment and Metrics**
- Gated technical reviews
- MA verification assessment
- Verification management process
- Independent V & V
- Configuration status
- KPP/TPM mgmt
- Test effectiveness
- TLYF deviations and risk assessment
- Critical process escape assessment
- Schedule slip

**Mission Readiness Certification**

**Feedback and Improvement**
- Lessons
- Best practices
- Process improvement
- Education and training

**Integrity - Service - Excellence**
Example: Unit Thermal Test Erosion

- Data shows reducing thermal cycles has an effect on problems during system thermal testing.
- Note: with increasing complexity comes increasing harness and thermal equipment problems. *Unit level testing will not solve this system TV problem*

\[
\text{Equiv Cycles} = \text{Test cycles} \times (\Delta °C/85)^2
\]

Reducing unit thermal cycles results in increased system test defects
Contract Implementation

3. Initial Applicable Documents
(Compliance & Reference)
for
A Typical Satellite Vehicle Acquisition Program
For Prescribed Development

ANNEX A TO ATTACHMENT 1
RFP NO. 000000-00-0-0000
Prepared by SMC/AXEM
00 Month 0000
Revised 00 Month 0000

The Offeror may propose the listed specification or standard contained herein or another government, industry technical society (IEEE, AIAA, etc.), international or corporate version, provided it is comparable in rigor and effectiveness. If alternative standards are proposed, the Offeror must provide information that shows that the recommended alternative provides the same level of efficacy as does the listed specification/standard. In all cases the acceptable responses will be placed on contract as a compliance document.

SMC/EA team engages directly with SPO and ACE during RFP development to identify applicable standards.
DoD “Better Buyer” and Efficiency Initiatives and Potential Impacts
Compliance Documents for SMC Acquisitions
19 July 2010

This list establishes the specifications and standards
to be used on all new SMC contracts
in accordance with
SMC Instruction 63-106
dated 1 October 2009

David E. Swanson
Colonel, USAF
SMC/EA

Date
Contentious Technical Issues

- Heritage/Legacy Hardware
  - Design Practices
  - Qualification Practices
  - “We’ve flown this box on xx missions successfully”
    - Traceability back to design and test practices critical – on both government and industry sides

- PM&P
  - Derating
  - Part Quality
    - Screens
    - QCI (Quality Conformance testing)

- EMI/EMC
  - Design Margins
  - Testing

- Space Systems Environmental Test
  - Qual/Proto-qual
  - Design levels
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<td>Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing</td>
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| 10    | Program Execution; Program Protection | DoDI 8500.2 | Information Assurance Implementation | 2003 | SMC/PIP | - Coordinate tailoring to generate requirements language with SMC/PIP  
|       |                             |                 |       |          |        | - Contract-specific specification shall be configuration controlled by SMC/PIP and levied on contract |
| 11    | Program Execution; Program Protection | DCID 6/3 Manual | Protecting Sensitive Compartmented Information Within Information Systems | 2003 | SMC/PIP | - Tailored to generate contractor requirements for portions of the system processing SCI  
<p>|       |                             | Intelligence Community Directive Number 503 | Intelligence Community Information Technology System Security Risk Management, Certification, &amp; Accreditation | 2005 | SMC/PIP | - Coordinate with POC and SMC/PIP |</p>
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| 12    | 1.4 Program Execution; Program Protection | DOD 5220-22M    | National Industrial Security Program                                 | 2006     | SMC/PIP | - Coordinate tailoring/CDRLs with SMC/PIP.  
- Shall be levied on contract as part of DD 254                                            |
| 13    | 1.4 Program Execution; Program Protection | DODI 8510.01    | DoD Information Assurance Certification and Accreditation Process (DIACAP) | 2007     | SMC/PIP | - Tailoring required to generate requirements language  
- Coordinate with POC and SMC/PIP                                                            |
| 14    | 1.4 Program Execution; Program Protection | DoDM 5200.39-M  | Procedures for Critical Program Information (CPI) Protection Within the Department of Defense | 2008     | SMC/PIP | - Coordinate tailoring/CDRLs with SMC/PIP.  
- Levy on contract as part of DD 254                                                          |
| 15    | 1.4 Program Execution; Program Protection | AFPAM 63-1701   | Program Protection Planning                                          | 2003     | SMC/PIP | - Coordinate tailoring/CDRLs with SMC/PIP.  
- Levy on contract as part of DD 254                                                          |
| 16    | 1.4 Program Execution; Program Protection | AFPD 63-17     | Technology and Acquisition Systems Safety Program Protection        | 2001     | SMC/PIP | - Coordinate tailoring/CDRLs with SMC/PIP.  
- Levy on contract as part of DD 254                                                          |
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<td>Engineering Specialties; Integrated Logistics Support</td>
<td>MIL-STD-1545</td>
<td>Optional Spare Parts, Maintenance and Inventory Support of Space and Missile System.</td>
<td>1977</td>
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<td>MIL-STD-1538</td>
<td>Spare Parts and Maintenance Support of Space and Missile Systems Undergoing RDT&amp;E</td>
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<td>1992 (Validation)</td>
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- Coordinate tailoring with SMC/PIL |
| 58    | 4.5 Engineering Specialties; Integrated Logistics Support | MIL-PRF-29612B | Training Data Products | 2001 | SMC/PIL | Coordinate tailoring with POC and SMC/PIL |
| 60    | 4.7 Engineering Specialties; System Safety | EWR 127-1 | Eastern and Western Range Range Safety Requirements | 1997.0 | SMC/SES | Use on legacy systems initially acquired before 2004 |
|       | 4.7 Engineering Specialties; System Safety | AFSPCMAN 91-710 | Range Safety User Requirements Manual | 2004.0 | SMC/SES | Use on launch systems acquired after 2004 |
| 61    | 4.7 Engineering Specialties; System Safety | MIL-STD-882C | System Safety Program Requirements | 1993 | SMC/SES | The current version D is acquisition reform version;  
SMC/SE requires Version C without Notice 1. |
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<th>Additional Usage Requirements</th>
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<td>SMC Standard SMC-S-022</td>
<td>Requirements for End-of-Life Disposal of Satellites in Low Earth Orbits</td>
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<td><strong>Engineering Specialties; Environmental</strong></td>
<td>NASA STD 8719.14, Rev. 4</td>
<td>Process For Limiting Orbital Debris</td>
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<td>Required SMC tailoring in SMC-T-003 (2010)</td>
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<td>Test Requirements For Launch, Upper-Stage, &amp; Space Vehicles</td>
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<td>Test Requirements for Gnd Equipt &amp; Assoc Computer S/W Sptng Space Vehicles</td>
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