AEROSPACE REPORT NO.
ATR-2023-01981

Acquisition Considerations to Expand Space Design Options Using Commercial Off-the-Shelf (COTS) Electrical, Electronic, and Electromechanical (EEE) Parts and Units

December 10, 2023

Barbara M. Braun[1], Steven R. Moe[2], and John T. Ranaudo[2]
[1]Corporate Chief Engineer's Office; Office of the Executive Vice President
[2]Parts, Materials, and Processes Department; Electronics Engineering Subdivision

and

Thomas Wunderlich, Ball Aerospace

Prepared for:

General Manager, Corporate Chief Engineer's Office

Authorized by: Corporate Chief Engineer's Office

Acknowledgments

The MSIW team would like to thank Eli Minson (Maxar) and Tom Wunderlich (Ball Aerospace) who led the subteam and produced the initial draft content. We would also like to thank Ron Duphily, Brian Kosinski, Steven Lau, Arthur McClellan, and Allyson Yarbrough of The Aerospace Corporation for providing key technical content and assisting in the document review process.

Abstract

This Aerospace technical report (ATR) is intended for reference when a customer is considering the use of commercial off-the-shelf (COTS) electrical, electronic, and electromechanical (EEE) parts and units in offerors' proposals. It provides examples of contract language that can inadvertently prevent an offeror from bidding a COTS solution and offers suggestions for alternative wording. This ATR was created in conjunction with ATR 2023-01935, *Expanding Space Design Options Using COTS*. These reports, when used in concert, will enable the performance benefits, shorter procurement times, and reduced costs needed to achieve critical mission needs.

Executive Summary

The space industry is being challenged by a heightened focus on its customers' mandate to dramatically shorten the time from contract award to launch to satisfy national needs. A key component of this new approach requires a new mindset regarding the use of leading-edge technology offered by commercially available electronic parts manufacturers, usually intended for non-space or terrestrial applications. This juncture marks a conscious decision to reduce one's traditional exclusive reliance on high-reliability military parts offerings and to implement the use of commercial off-the-shelf (COTS) components and units that better align with these current programs' technical and schedule restraints. This Aerospace technical report (ATR) illuminates the traditional contract language, aka *flowdown*, that constrains a contractor's ability to deliver the best balance of performance and value for the government. It also recommends options and contract language as alternatives that retain focus on mission success.

A holistic approach is provided here that not only focuses on the technical requirements of the military and COTS electrical, electronic, and electromechanical (EEE) parts needed to build the hardware but also identifies the synergy needed from the contracts; design; parts, materials, and processes (PM&P); and mission assurance (MA) organizations that support space hardware acquisitions. The purpose of this ATR is to provide the latitude needed for contracts organizations to flow requirements that are commensurate with the new acquisition approach.

The contract language must embrace and support the mission category, risk tolerance, and design mitigations (at the unit, system, and constellation levels) that are integral parts that contribute to the determination of the EEE parts chosen. When these factors have been made known and incorporated into the contractual language, contractors will be able to determine the program's design and performance baseline, allowing their parts selection organization to determine the quality and reliability level for the EEE parts needed. This ATR identifies traditional contractual flowdown requirements that would hamper the ability to embrace this new direction and provides suggestions for contract language if COTS are being considered.

Table of Contents

Figures

1. Introduction

Contested space requires a change in space architecture acquisition practices as detailed in the Memorandum for Department of Air Force Space Acquisition Workforce, "Three Years or Less from Contract to Launch – A Simple Formula to Go Fast in Space Acquisition," dated April 5, 2023, by Frank Calvelli, Assistant Secretary of the Air Force [2].

The key points of the memorandum relevant to commercial off-the-shelf (COTS) parts and units are:

- Build small satellites.
- Minimize nonrecurring engineering by leveraging existing independent research and development (IRAD), commercial satellite buses, and existing payload technology whenever possible.
- Shorten contract timelines to fewer than three years and use firm-fixed-price (FFP) contracts.

Current space missions demand faster development cycles, enhanced performance, and lower price points than legacy space systems. Traditionally, COTS parts and units have been available with greatly reduced lead times and cost over their military standard counterparts, which has reduced the development cycle times. To achieve the performance, cost, and schedule goals of these new space systems, satellites will require use of COTS buses, systems, units, and parts. This is becoming increasingly relevant for constellation architectures where large numbers of satellites are required. Many satellite acquirers acknowledge this and indicate that the use of COTS parts is acceptable in their systems, but the typical language of current requests for proposal (RFPs) and statements of work (SOWs) may inadvertently prohibit or create barriers to the use of COTS items.

Consider the semiconductor industry as an example of the diminishing manufacturing sources and material shortages (DMSMS) within the military and aerospace supply chains. Global demand for semiconductors has experienced a significant shift in its end markets and resulting user demands, as shown in Figure 1. Simply put, suppliers are not building semiconductors primarily for the space or military industry anymore. The availability of space-rated parts has diminished, and the biggest advances in semiconductor performance are being driven by terrestrial usage. This change in suppliers' demand profiles has resulted in the need for space systems to consider using COTS parts.

For the purposes of this ATR, we define a *COTS part* as a catalogued EEE part or unit for which the U.S. government (USG) or its contractors does not control the specification. The part or unit manufacturer, or nongovernment bodies (such as the Automotive Electronics Council [AEC]), solely establishes and controls the specifications for performance, configuration, and reliability (including design, materials, processes, and testing) without additional requirements imposed by users.

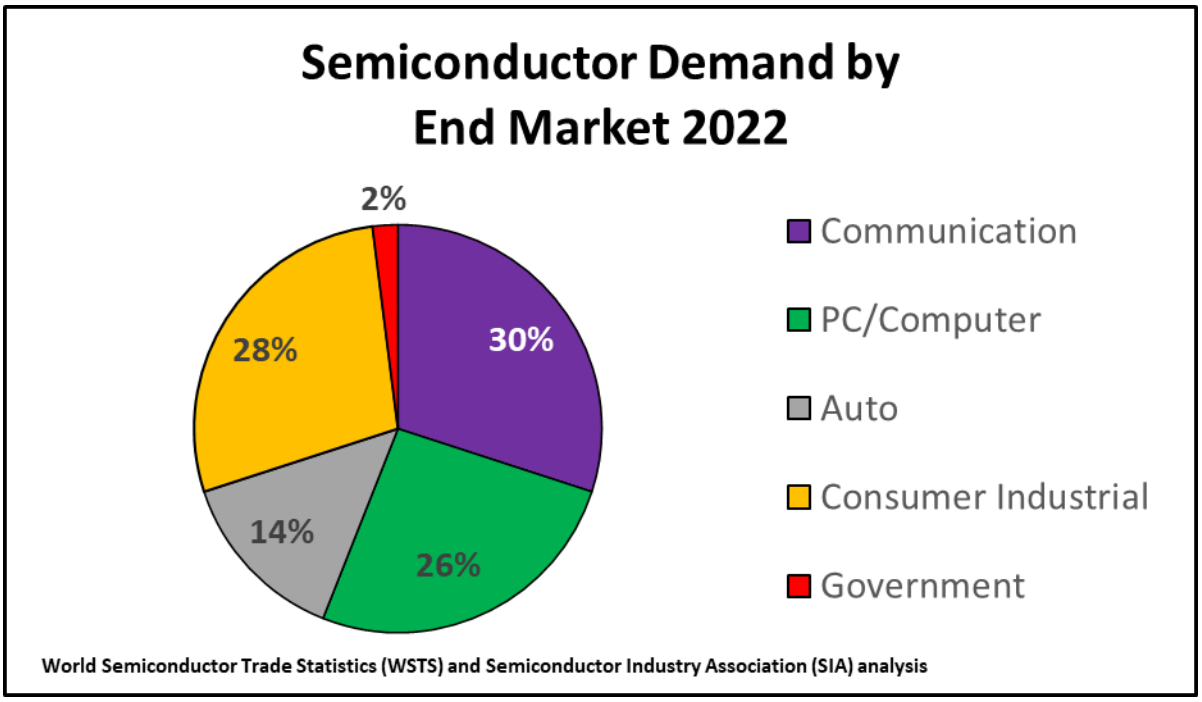

Figure 1. Semiconductor demand by end market 2022 [21].

2. Acquisition Considerations and Recommendations for Using COTS Parts and Units

In this section, we address some specific contract language flowed from RFPs and SOWs that are barriers to using COTS parts and units. These barriers will obligate offerors to respond with approaches that require the use of space-rated parts, eliminating their ability to embrace the advantage that COTS parts may offer. Examples of these barriers and mitigation suggestions are provided.

Customer agency subject matter experts (SMEs) are assigned to evaluate the contractor's approach to the current contract flowdown. Government SMEs who evaluate the contract flowdown require the latitude to approve this new approach.

2.1 PM&P and EEE Requirements

Constraint: Parts, materials, and process requirements include those meant to govern the selection and usage of parts and materials and represent some of the most significant inadvertent barriers to the usage of COTS parts. Specific references, such as those listed below, contain requirements that often cannot be met by COTS parts:

- Aerospace technical report number TOR-2006(8583)-5235 REV B, titled *Parts, Materials, and Processes Control Program for Space Vehicles*, and TOR-2006(8583)-5236 REV B, titled *Technical Requirements for Electronic Parts, Materials, and Processes Used in Space Vehicles*

- NASA-STD-8739.11, *EEE Parts Selection, Screening, Qualification & Derating*

- SMC-S-009, *Parts, Materials, and Processes Control Program for Space and Launch Vehicles*, and SMC-S-010, *Technical Requirements for Electronic Parts, Materials, and Processes used in Space Vehicles*

- NASA Document 300-STM-1013, *SMA Technical Memorandum – Code 300 Policy on EEE Parts Assurance*

Option: In lieu of flowing down these standards, we suggest that the acquirer allow offerors to propose their own parts management approach with data and rationale. The target audience would include those involved in the design, selection, procurement, or use of COTS parts for short-duration, risk-tolerant, and resilient missions. The acquirer can assess the adequacy of the parts management approach offered as part of the evaluation. The following documents can be included as "reference only," intended to provide a framework for communicating best practices, not to be used as compliance documents for the flow down of requirements.

- SD-19, *DOD Parts Management Guide*

- ISO14621-1:2019, *Space Systems – Electrical, Electronic, and Electromechanical (EEE) Parts – Part 1: Parts Management*

- ISO14621-2-2019, *Space Systems – Electrical, Electronic, and Electromechanical (EEE) Parts – Part 2: Control Programme Requirements*

The SD-19 guide was developed to address rapidly changing designs and provides guidance on how to evaluate the risk posture of using commercial part types, offshore manufacturers, and prohibited materials. It enables contractors to develop a parts management plan that addresses the use of these higher-risk profile parts and processes with identified risk and reliability analysis considerations. Rather than providing a prescriptive guide, the contractors can now develop systems that meet the technical mission objectives with known risk analysis.

The International Organization for Standardization (ISO) developed ISO 14621-1 and ISO 14621-2 jointly to assist the user and supplier communities in developing and executing an effective process for the design, selection, and application of EEE space parts throughout the lifecycle of the program. This ISO document addresses the key elements for an EEE parts management program for space systems and is written in general terms as a baseline for developing, implementing, validating, and evaluating a space parts management program.

These documents are meant to assist a contractor in delivering a parts management plan that is acceptable to the customer. It is not intended that these documents should be identified as compliance documents. Through the application of a parts management guide and practices, each program is now able to develop an individual plan that provides appropriate latitude for innovative approaches and design solutions meeting mission needs.

2.2 Reliability Requirements

Constraint: Contracts and solicitations often present reliability requirements in terms of a single probability of success number (Ps) for an individual satellite (or sometimes separately for the satellite bus and the payload). Customers often flow down MIL-HDBK-217F Notice 2, updated February of 1995, as a compliance standard for the calculation of such Ps numbers. Both these approaches can prevent an offeror from bidding optimized system solutions that use COTS parts.

Option: MIL-HDBK-217FN2 should be a reference document with contractors defining their process for estimating EEE part failure rates. The following order of preference for estimating EEE part failure rates are currently being used by contractors:

- Part supplier estimates from qualification testing
- Contractor testing and on-orbit experience estimates
- Updating MIL-HDBK-217FN2 failure rates with Reliability Analysis Center (RAC) report A06830 and ANSI-VITA-51.1

COTS produced today, by reputable manufacturers, built on automated, statistically controlled production lines may have equal or better quality than MIL-SPEC parts. Parts manufacturer data and newer prediction models are not perfect, but they can be used to calculate more realistic COTS failure rates. Additional guidance on the use of COTS parts is available in TOR-2020-01447, E.P.I.C. (Enterprise, Partnerships, Innovation, Culture) Speed Electronics: A Pre-RFP Application Guide for Alternate-Grade Electronics in Small Satellites and Resilient Systems [20].

With current resilient and proliferated systems, it is recommended that acquirers specify a functional availability requirement for the constellation. When more than one space vehicle is launched and a set of requirements for “m out of n” operational vehicles is specified, functional availability analysis calculates the probability that a constellation of satellites will be operational at time “t” in the future. The analysis

depends on the reliability prediction of individual satellites, which quantifies the functional availability over the system lifecycle. Specifying a functional availability requirement allows offerors to make system trades between the reliability of an individual satellite and the number of satellites in a constellation. Constellation and internal satellite redundancy design trades open the use of COTS parts and units.

The operational availability requirement for a satellite is also specified since it encompasses recoverable satellite, ground, line of sight, single-event effect (SEE), and maintenance outages.

Constellation functional availability predictions and assessment methods provide quantitative performance measures that can be used in assessing a given satellite reliability design at the constellation level. They are also used to compare constellation and satellite alternatives to reduce lifecycle costs. These techniques help assess design options and increase the probability of mission success of the constellation level.

2.3 Supply Chain Risk Management (SCRM)

2.3.1 Counterfeit Parts

Constraint: Requirements for counterfeit parts are the same for space-rated parts, military and NASA standard parts identified in section 2.1, and COTS parts.

Option: When a counterfeit avoidance requirement needs to be flowed, the RFP should simply refer to adherence to SAE AS5553, *Counterfeit Electrical, Electronic, and Electromechanical (EEE) Parts; Avoidance, Detection, Mitigation, and Disposition* and AS6171, *Test Methods Standard; General Requirements, Suspect/Counterfeit, Electrical, Electronic, and Electromechanical Parts*. Requiring the contractor to buy only from original component manufacturers or their licensed distributors is also a solution.

2.3.2 Prohibited Materials

Constraint: Space EEE standards routinely prohibit materials such as tin, zinc, and cadmium. The risk these requirements are designed to mitigate are shorts due to sublimation and whisker growth. In contrast, pure tin is used extensively in the commercial (non-space) industry primarily because of the safety and legal requirements to eliminate lead from the workplace.

Option: When using COTS parts, instead of specifying prohibited materials, a viable alternative for the acquirer is to ask offerors to assess the effects of outgassing, sublimation, and tin, zinc, and cadmium whisker growth for test and mission applications. Contractors' parts management approach should address how they will mitigate the risk of materials that need special handling in the space environment.

2.3.3 Traceability

Constraint: Traditional USG programs flow down supply chain, assembly, and part traceability requirements. Part traceability requirements for single lot date code, wafer lot traceability, or other similar requirements may not align with the common practices of COTS EEE parts manufacturers and constrains opportunities to leverage their benefits using items. Traceability for COTS unit suppliers will likely be limited to the part or model number of the unit provided, without a bill of materials.

Option: In lieu of having full traceability, it is recommended that supply chain traceability requirements be retained for counterfeit mitigation and assembly level installation records.

COTS EEE parts and unit reference numbers (for example, EEE part numbers, unit catalog part numbers, or location designators) are important features for assembly-level traceability (i.e., to address industry alerts such as the Government Industry Data Exchange Program [GIDEP] or NASA EEE parts bulletins.) Assembly-level traceability also facilitates adjudicating on orbit anomalies using the contractor's configuration controlled as-built parts list (ABPL) (see section 2.4.1).

2.3.4 Component-Level Mandatory Inspection Points (MIPs)

Constraint: Military EEE parts standards require mandatory inspection points (MIPs). COTS component manufacturers may not allow MIPS as part of the normal assembly flow, as it would interrupt their manufacturing flow for their primary commercial customer.

Option: As an alternative, it is recommended that a construction analysis could be offered to validate and inform mitigation of critical areas of concern.

2.4 The Contract Data Requirements List (CDRL)

Many items on the contract data requirements list (CDRL) can create barriers to the use of COTS parts. Several examples are outlined below. These are provided for context; therefore, this is not an exhaustive list for each subparagraph.

2.4.1 As-Designed Parts List (ADPL), As-Designed Materials and Processes List (ADMPL), As-Built Parts List (ABPL), and As-Built Materials and Processes List (ABMPL)

Constraint: COTS item manufacturers typically do not provide parts lists or material lists as deliverables. They may allow on-site review of their databases. A requirement to provide these CDRLs may add a constraint to the system design by precluding the use of COTS components from suppliers who will not bid on RFPs with this language or who take exception to the requirements.

Option: We recommend adding "as available" to the data item description, with the understanding the customer/government may not receive the ADPL, ADMPL, ABPL, or ASMPL from COTS parts and unit manufacturers. We recommend that, where applicable and when of value, acquirers may pursue viewing them at the manufacturer's site.

2.4.2 Government Contract Quality Assurance Audit

Constraint: As indicated in section 2.3.4, the flowdown of requirements to audit COTS suppliers will be a barrier to the use of COTS parts. This often takes the form of a requirement for independent verification and validation of the COTS original component manufacturers (OCMs) and original equipment manufacturers (OEMs) quality management systems.

Option: It is standard practice for the acquirer to perform QA Audits of the Offerors seeking contract awards. It is incumbent on these Offerors to have a Quality Management System (QMS) in place that defines how their processes are controlled, monitored, and improved, as required. It is reasonable for the Acquirer to expect that the Offeror shall have processes in place that identify how they will control their sub-tier suppliers for all mission categories and genres of parts (see section 2.6).

2.4.3 Unit-Level Mandatory Inspection Points (MIPs)

Constraint: As indicated in section 2.3.4, the flowdown of requirements to audit or inspect product at COTS suppliers will be a barrier to the use of COTS units. This often takes the form of a requirement for independent verification and validation of the COTS OCM and OEM quality management systems and manufacturing lines. These audits and inspections are used for validation and verification that the product, service, or system meets requirements and specifications and that it fulfills its intended purpose.

Option: It is reasonable for the acquirer to expect that offerors shall have processes in place that identify how they will control their subtier suppliers for all mission categories and genres of units. It is recommended that MIPs are not flowed down for COTS units.

2.4.4 Field Programmable Gate Array (FPGA), Hybrid and Application-Specific Integrated Circuit (ASIC) Design Data Packages

Constraint: A CDRL is often flowed down with the requirement for data design packages. The provenance of the parts within these components and the typical traceability requirements flowed down for military standard devices are often not possible to obtain from OCMs because they may contain intellectual property and do not provide information required to operate the device.

Option: For parts that are programmable and coded, the risks need to be addressed and adjudicated to the satisfaction of the program with data and rationale.

2.4.5 Malicious Vulnerabilities to Hardware, Software, and Firmware

Constraint: Most contracting approaches require the use of trusted sources to ensure that satellite electronics, including embedded software, function as intended and are free of malicious vulnerabilities (viruses, worms, Trojan Horses, etc.). COTS EEE parts and unit providers do not typically offer an accreditation of trust, apply rigorous assurance mitigations, or provide insight into source code or design data that provide confidence in the integrity of their part.

Option: It is recommended that the offeror specify a risk-based assurance approach that enables the offeror to identify, mitigate, and manage satellite electronics risks. Offerors should evaluate the risks that could alter expected behavior, including viruses, worms, Trojan Horses, etc. Information on program-specific, risk-based management of hardware assurance is available in DoDI 5200.44, “Protection of Mission Critical Functions to Achieve Trusted Systems and Networks (TSN).”

Another available resource is the Space Attack Research and Tactic Analysis (SPARTA) matrix provided by The Aerospace Corporation. [22] SPARTA is intended to provide unclassified information to space professionals about how spacecraft may be compromised via cyber and traditional counterspace means.

2.5 Radiation Hardness Requirements

Constraint: Defining radiation hardness requirements, single-event upset (SEU) rates, and SEE rates may lead to design constraints that may exclude some COTS items that would have met mission needs. Given the reduced traceability of COTS components, residual risk of lot-to-lot variation (as well as variability within each lot) in radiation susceptibility will exist. Requirements for single lot date code, wafer lot traceability, or other similar requirements may eliminate the opportunity to use COTS items along with their benefits.

Option: In lieu of a specific radiation hardness requirement, Aerospace report ATR-2023-01935, *Expanding Space Design Options Using COTS*, may be used as a reference. The report provides guidelines on how to assess and mitigate the risk of COTS items with the understanding that residual risk may remain. The key is that the residual risk will be assessed, documented, negotiated, and accepted by all stakeholders during all phases of the program.

2.6 General Mission Assurance Requirements

Constraint: In general, space-level military standards are flowed down by default. (See section 2.1 for reference.)

Option: It is recommended that a general mission assurance requirement be adopted that allows for program trades between risk, cost, and schedule for programs that wish to enable the use of COTS parts and units.

It is also recommended that acquirers allow offerors (that is, contractors responding to RFPs) to describe their mission assurance approach and quality management system that will be employed to mitigate mission assurance risks. Offerors should include a discussion of relevant standards and certifications to support their approach. Offerors' plans must define the risk mitigation required to meet the performance and availability requirements within the cost and schedule constraints described in the RFPs. Offerors shall provide detail and rationale as to how they will address these processes in accordance with the risk profile of the mission, in the context of the mission's availability and performance requirements.

Aerospace report ATR-2023-01889, *Mission Assurance Guidelines for Mission Risk Classes and Do No Harm (DNH) for Space Vehicles*, can be used as a guide for defining the mission assurance topics customers wish to see in offerors' responses. In lieu of flowing down these topics as a list of requirements, it is recommended that acquirers evaluate the contractors' mission assurance plans against the needs of the mission.

3. Conclusion

To meet national priorities and in response to the U.S. space industry challenge to dramatically shorten the time from contract award to launch, a new approach to contracts and subsequent development is necessary. To address this challenge, it is necessary to widen the tradespace to allow considerations for leading-edge technology offered by commercially available electronic parts developed for non-space or terrestrial applications. The intent of this report is to identify and eliminate the traditional barriers that would limit the use of COTS parts and, thus, limiting their ability to dramatically shorten the time from contract award to launch. It was created in conjunction with Aerospace report ATR 2023-01935, *Expanding Space Design Options Using COTS*. These documents, when used in concert, allow acquirers to embrace this new direction and provide suggestions for how contracts should be structured to enable the use of COTS parts and units and deliver warfighter capabilities more quickly and cost effectively.

4. Acronyms and Definitions

Acquirer	The government agency or office issuing the request for proposal (RFP)
ADPL	As designed parts list
ADMPL	As designed materials and processes list
ABPL	As-built parts list
ABMPL	As-built materials and processes list
AEC	Automotive Electronics Council
aka	Also known as
ATR	Aerospace technical report
CDRL	Contract data requirements list
COTS	Commercial off-the-shelf. A catalogued EEE part or unit for which the U.S. government or its contractors does not control the specification. The item manufacturer, or nongovernment bodies (such as AEC for automotive), solely establishes and controls the specifications for performance, configuration, and reliability (including design, materials, processes, and testing) without additional requirements imposed by users.
DMSMS	Diminishing manufacturing sources and material shortages (DMSMS) is the loss, or impending loss, of manufacturers or suppliers of items, raw materials, or software.
DOD	Department of Defense
EEE	Electrical, electronic, and electromechanical
FFP	Firm fixed price
FPGA	Field programmable gate array
Genre	This refers to the variety of operating platforms and uses for which parts or units were designed, including, but not limited to, the military, NASA, automotive and commercial off-the-shelf grade parts and units.
GIDEP	Government Industry Data Exchange Program
IP	Intellectual property
IRAD	Independent research and development
ISO	International Organization for Standardization
MA	Mission assurance
MIP	Mandatory inspection point
OCM	Original component manufacturer
OEM	Original equipment manufacturer
Offeror	The contractor responding to the request for Proposal (RFP)
PDR	Preliminary design review
Ps	Part reliability prediction standard
QA	Quality assurance
QMS	Quality management system
RFP	Request for proposal

SAE	Society of Automotive Engineers
SCRM	Supply chain risk management
SEE	Single-event effect
SEU	Single-event upset
SME	Subject matter expert
SOW	Statement of work
SPARTA	The Aerospace Corporation created the Space Attack Research and Tactic Analysis (SPARTA) matrix to address the information and communication barriers that hinder the identification and sharing of space-system tactic, techniques, and procedures (TTPs). SPARTA is intended to provide unclassified information to space professionals about how spacecraft may be compromised via cyber and traditional counterspace means. The matrix defines and categorizes commonly identified activities that contribute to spacecraft compromises. Where applicable, SPARTA TTPs are cross-referenced to other Aerospace-related work like TOR-2021-01333-REV A, which is available in the Related Work menu of the SPARTA website.
SRR	System requirements review
TOR	Technical operating report
USG	United States government

5. References

[1] Hogan, S. L., ATR-2023-01935, *Expanding Space Design Options Using COTS*, The Aerospace Corporation.

[2] Calvelli, F., Assistant Secretary of the Air Force, Memorandum for the Department of Air Force Space Acquisition Workforce, "Three Years or Less from Contract to Launch – A Simple Formula to Go Fast in Space Acquisition," dated April 5, 2023.

[3] SD-19, *Parts Management Guide*, Defense Standardization Program Office, December 2013.

[4] MIL-STD-3018, *Department of Defense Standard Practice, Parts Management*, June 2015.

[5] SMC Standard SMC-S-009 (2013), *Parts, Materials, and Processes Control Program for Space Vehicles*.

[6] SMC Standard SMC-S-010 (2013), *Technical Requirements for Electronic Parts, Materials, and Processes Used in Space Vehicles*.

[7] Robertson, S. R., et al., TOR-2006(8583)-5235 REV B, *Parts, Materials, and Processes Control Program for Space Vehicles*, The Aerospace Corporation.

[8] Robertson, S. R., et al., TOR-2006(8583)-5236 REV B, *Technical Requirements for Electronic Parts, Materials, and Processes Used in Space Vehicles*, The Aerospace Corporation.

[9] Johnson-Roth, G., TOR-2011(8591)-21, *Mission Assurance Guidelines for A-D Mission Risk Classes* for definitions of MA processes, The Aerospace Corporation.

[10] SAE AS5553, *Counterfeit Electrical, Electronic, and Electromechanical (EEE) Parts; Avoidance, Detection, Mitigation, and Disposition*, SAE International.

[11] AS6171, *Test Methods Standard; General Requirements, Suspect/Counterfeit, Electrical, Electronic, and Electromechanical Parts*, SAE International.

[12] NASA-STD-8739.10, *Electrical, Electronic and Electromechanical (EEE) Parts Assurance Standard*, National Aeronautics and Space Administration.

[13] MIL-STD-11991A, Department of Defense Standard Practice, *General Standard for Parts, Materials, and Processes*, August 26, 2015.

[14] ISO14621-1:2019, *Space systems – Electrical, electronic and electromechanical (EEE) parts – Part 1: Parts management*, International Organization for Standardization.

[15] ISO14621-2-2019, *Space systems – Electrical, electronic and electromechanical (EEE) parts – Part 2: Control programme requirements*, International Organization for Standardization.

[16] DoD Instruction 5000.02, *Operation of the Adaptive Acquisition Framework*.

[17] MIL-HDBK-217FN2, Military Handbook, *Reliability Prediction of Electronic Equipment*, 1991.

[18] *New System Reliability Assessment Method*, IITRI Project No. A06830, Reliability Analysis Center (RAC), June 1, 1998.

[19] *Reliability Prediction MIL-HDBK-217 Subsidiary Specification*, ANSI/VITA 51.1– 2008 (R2013), VITA.

[20] Yarbrough, A. D., et al., TOR-2020-01447, *E.P.I.C. (Enterprise, Partnerships, Innovation, Culture) Speed Electronics: A Pre-RFP Application Guide for Alternate-Grade Electronics in Small Satellites and Resilient Systems*, The Aerospace Corporation.

[21] Casanova, R., Chip Sales Rise in 2022, Especially to Auto, Industrial, Consumer Markets - Semiconductor Industry Association (semiconductors.org) (ref. WSTS and SIA Analysis table).

[22] SPARTA: Space Attack Research and Tactic Analysis. The Aerospace Corporation. https://aerospace.org/sparta.

AEROSPACE REPORT NO.
ATR-2023-01981

Acquisition Considerations to Expand Space Design Options Using Commercial Off-the-Shelf (COTS) Electrical, Electronic, and Electromechanical (EEE) Parts and Units

Cognizant Program Manager Approval:

Lori W. Gordon, SYSTEMS DIRECTOR
ENTERPRISE SYSTEMS ENGINEERING
CORPORATE CHIEF ENGINEERS OFFICE

Aerospace Corporate Officer Approval:

Mark J. Silverman, CHIEF ENGINEER/GENERAL MANAGER
OFFICE OF EVP

Content Concurrence Provided Electronically by:

Brian P. Kosinski, MTS LEVEL 5 - CASUAL
CORPORATE CHIEF ENGINEERS OFFICE
OFFICE OF EVP

ST0416

AEROSPACE REPORT NO.
ATR-2023-01981

Acquisition Considerations to Expand Space Design Options Using Commercial Off-the-Shelf (COTS) Electrical, Electronic, and Electromechanical (EEE) Parts and Units

Technical Peer Review Performed by:

Barbara M. Braun,
PRINCIPAL DIRECTOR
CORPORATE CHIEF
ENGINEERS OFFICE
OFFICE OF EVP

Felton E. Knighton,
PRINCIPAL DIRECTOR
ELECTRONICS &
SENSORS DIVISION
ENGINEERING &
TECHNOLOGY GROUP

Mark J. Silverman, CHIEF
ENGINEER/GENERAL
MANAGER
OFFICE OF EVP

Office of General Counsel Approval Granted Electronically by:

Kien T. Le, ASSISTANT GENERAL COUNSEL
OFFICE OF THE GENERAL COUNSEL
OFFICE OF GENERAL COUNSEL & SECRETARY

Export Control Office Approval Granted Electronically by:

Angela M. Farmer, SECURITY SUPERVISOR
GOVERNMENT SECURITY
SECURITY OPERATIONS
OFFICE OF THE CHIEF INFORMATION OFFICER

ST0416