



# NASA Engineering & Safety Center (NESC) Assessment – Recommendations on Use of Commercial-Off-The-Shelf (COTS) Parts for NASA Missions

## UPDATE

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# Outline

- NASA Engineering and Safety Center (NESC) assessment
  - Phase I: completed in Dec 2020; final report released for public
  - Phase II: on-going; expected to be completed soon
- Phase I
  - Scope of the assessment
  - New terminologies
  - Recommendations on COTS parts selection, procurement, circuit application, RHA and part-, board- and system-level verification
  - NESC Findings, Observations and Recommendations
- Phase II
  - Scope of the assessment
- Summary



# Phase I: Scope of the Assessment

- Capture current practices on use of COTS EEE parts across NASA centers.
  - Parts selection, evaluation, screening, and qualification process
- Provide NESC recommendations that could lead to future agency guidance.
- Participation from eight centers: ARC, GRC, GSFC, JPL, JSC, KSC, LaRC, MSFC.
- Available at <https://ntrs.nasa.gov/citations/20205011579>



# Phase I Report: Table of Contents

4.0 Executive Summary; 5.0 Assessment Plan ; 6.0 Problem Description

7.0 Center Practices on Use of COTS

- 7.1 Scope of the assessment and Center summaries on use of COTS

- 7.2-7.9 Eight center reports

- Center programs and projects and use of COTS
- Center strategy of use of COTS
- Center governing parts documents
- Current practices on COTS selection, evaluation screening and qualification
- Center best practices
- Center proposed recommendations

- 7.10 Current and best practices on use of COTS

- Summary of current practices on use of COTS
- Risk context in use of COTS
- Best practices on COTS selection
- Current practices on part-, board- and system-level verification
- Best practices on COTS parts application
- RHA consideration for COTS parts

- Common concerns on use of COTS

- 7.11 Phase II

8.0 NESC Findings, Observations, and Recommendations

11.0 Lessons learned; Appendix A (Example projects with use of COTS), B (COTS parts) and C (Summary of previous NESC COTS related assessments)



# Agency Baseline Parts Requirements

- **COTS part:** A Commercial-Off-The-Shelf part designed for commercial applications for which the part manufacturer solely establishes and controls the specifications for performance, configuration and reliability, including design, materials, processes, and testing without additional requirements imposed by users and external organizations.
- NASA-STD-8739.10 recommend MIL-SPEC parts as the first choice or best practice, specifying different levels of MIL-SPEC parts as baseline parts, and detailed MIL-SPEC/NASA screening and qualification requirements on non-MIL-SPEC parts.

Table 3. EEE Part Classes for Each Grade

Item	Grade 1	Grade 2	Grade 3	Grade 4
Typical Minimum Quality Class	Microcircuit: <b>Class S, V (hermetic) and Y (nonhermetic)</b> Hybrid Microcircuit: <b>Class K</b> Discrete Semiconductor: <b>JANS (Joint Army-Navy, Class S)</b> Capacitor or Resistor: <b>Failure Rate Level (FRL) T, S, R and tantalum caps: C &amp; D</b> Other: Various	Microcircuit: <b>Class B or Q</b> Hybrid Microcircuit: <b>Class H</b> Discrete Semiconductor: <b>JANTXV</b> Capacitor or Resistor: <b>FRL R, P, or B-tantalum caps</b> Other: Various	Microcircuit: <b>Class M, N, T, or /883</b> Hybrid: <b>Class G, D, or E</b> Discrete Semiconductor: <b>JANTX</b> Capacitor or Resistor: <b>P or B, and Other</b> Other: Various, Vendor Hi-Rel Automotive Grade	Commercial (Often is PEM)

MIL-SPEC parts

Most current practices

NASA screened COTS, A COTS part, after procurement, qualified and screened per NASA Agency, Center or Program parts requirements documents



# MIL-SPEC parts vs. COTS parts

- Government control or insight
  - Government has control and insight in MIL-SPEC parts, results in parts with high (but not perfect) quality and reliability and full access to part-level verification.
  - Government does not have control or insight into COTS parts, resulting in a major challenge of part-level verification or guaranteed knowledge of COTS parts.
- Does it mean COTS parts are low in quality and reliability? Not necessarily.
  - Government control is not prerequisite anymore for high quality and reliability parts, especially when, in recent years, some manufacturers in commercial industry have developed rigorous process controls driven by advanced technologies and commercial market, often equivalent to or exceeding government controls on MIL-SPEC parts.
  - Equally important to note that this is not universally the case and may vary from manufacturer to manufacturer.



# New Terminologies Defined

- Phase I defined an *Industry Leading Parts Manufacturer (ILPM)*
  - A parts manufacturer with high volume automated production facilities and which can provide documented proof of the technology, process and product qualification, and its implementation of the best practices for “zero defects” for parts quality, reliability and workmanship.
  - Take advantage of what commercial industry does the best - high volume automatic production manufacturer and best practices for “zero defects”
- Phase II
  - Provide characteristics and criteria of an ILPM and part-level verification criteria for NASA missions.
  - Define additional terminology “Established COTS parts”
  - Phase II recommendation is to select Established COTS parts category from ILPMs; updated from Phase I recommendation of “select parts from ILPMs”.



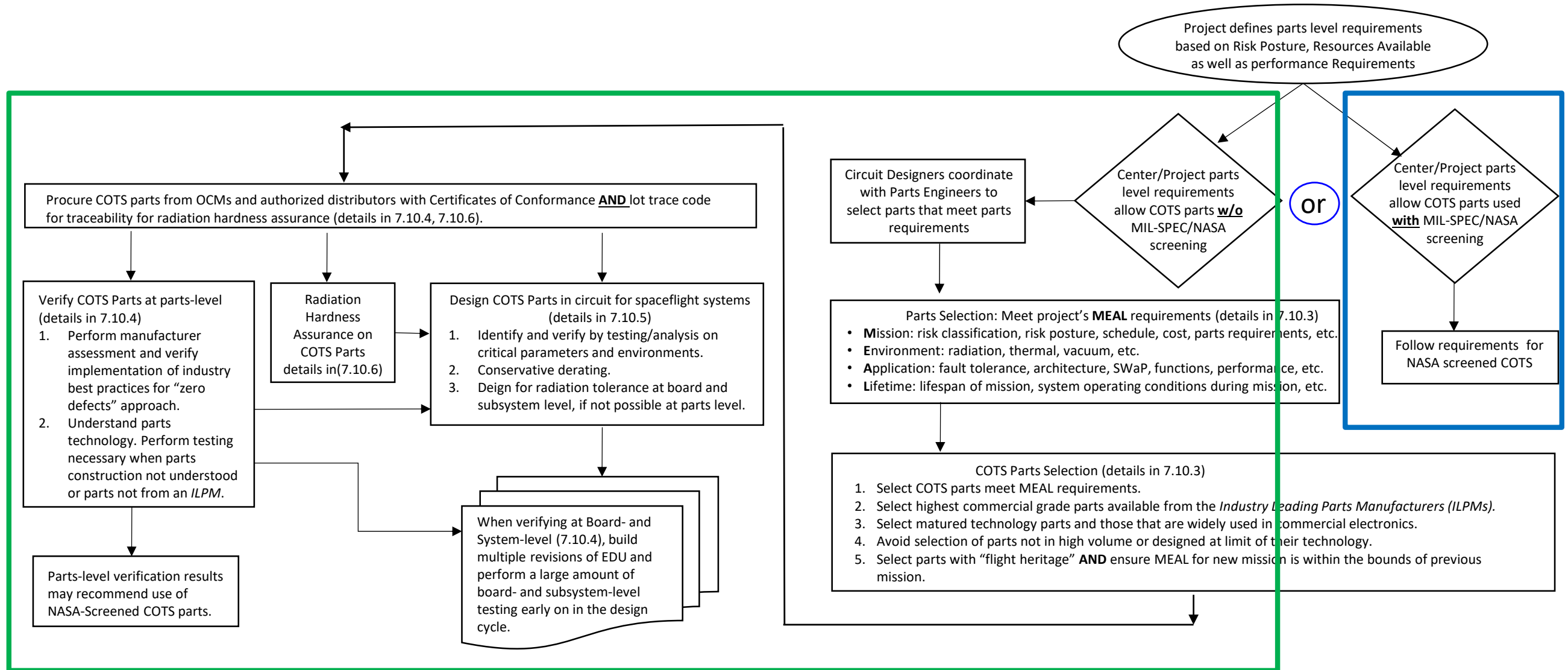
# Phase I: Center Reports – Current Practices

- Eight Centers (ARC, GRC, GSFC, JPL, JSC, KSC, LaRC, MSFC) documented their center practices on the use of COTS and presented to the team.
  - ARC, GRC, GSFC, JPL, JSC, LaRC, MSFC use COTS in spaceflight systems, largely Class D or sub-Class D missions
  - KSC uses COTS in critical GSE
- Practices varied from Center-to-Center but consensus was reached on the following COTS selection, application and verification flow.





# Flow Chart for COTS parts selection, procurement, circuit application, RHA and part-, board- and system-level verification



# Phase I: NESC Findings, Observations and Recommendations (I)



- The team had 11 Findings, 7 Observations, and 13 Recommendations.
- 11 Findings:
  - COTS parts for spaceflight: F1-9
  - COTS parts and assemblies for critical GSE: F10-11
- 13 recommendations were identified and directed towards the spaceflight program or project managers, project avionics systems leads, circuit design engineers, EEE parts engineers, procurement office, etc.
  - COTS risk identification and mitigation: R-1, -2, -3
  - Verification when using COTS parts: R-4, -5
  - COTS parts selection, procurement and verification at part-level: R-6, -7, -8, -9
  - COTS application and environment: R-10
  - COTS for critical ground support systems: R-11
  - Class D and Sub-Class D missions: R-12, 13
- Phase II report will have updated recommendations.



## Phase II: Scope of the Assessment

- Capture current practices on use of COTS EEE parts from DoD and FAA.
  - Participation from eight centers: ARC, GRC, GSFC, JPL, JSC, KSC, LaRC, MSFC, plus DoD (Army, MDA, Navy) and FAA.
- Understand COTS manufacturers' processes.
  - Generated a list of questions for COTS manufacturers
  - Talked to some COTS parts manufacturers to understand their processes
- Provide NESC recommendations that could lead to future agency guidance.



# Phase II: Final Report

- Final report will be publicly available
  - FAA/DoD current practices provided by the agencies
  - Recommend different approaches for Class A/B/C/D and human-rated missions
  - Recommend to select Established COTS parts from ILPMs when using COTS parts
    - Characteristics of an ILPM
    - Criteria of an ILPM
    - Definition of Established COTS parts
    - MIL-SPEC/NASA “screening”
  - Guidelines on part-level verification and criteria for Class A/B/C/D and human-rated missions
  - Parts manufacturer's questionnaire
  - Update NESC findings, observations and recommendations on use of COTS parts for NASA missions



# Summary

- NASA Engineering and Safety Center (NESC) assessment
  - Phase I: completed December 2020
    - Capture current practices on use of COTS EEE parts across NASA centers regarding parts selection, evaluation, screening, and qual processes.
    - Phase I report available at <https://ntrs.nasa.gov/citations/20205011579>
  - Phase II: on-going; expected to be completed in March and April 2022
    - Final report will be publicly available
      - ILPM and Established Parts
      - Recommend different approaches for Class A/B/C/D and human-rated missions
      - Recommend to select Established COTS parts from ILPMs when using COTS parts
      - Establish and maintain a strong customer-manufacturer relationship
        - Contact NASA Electronics and Packaging Program (NEPP)