





# Introduction



- **Mission:** Langley Research Center NEPP/NEPAG FY22 task to Identify "New Space" emerging COTS technology selection/usage analysis for high-risk community usage. Important focus will be on the qualification/screening differences when compared to Mil-Spec counterparts. This task analysis will result in accomplishing the foundation for a designer reference that allows for better technology application choices where reliability and risk assessments are required when unique COTS functionality is required by projects..
  
- **Deliverables:** Generate Cross Reference tool depicting what technologies & commodities are available by vendor and what features and reliability testing is being performed for those vendor offerings. The tool would also attempt to capture form fit and functions that make that product appeal to project need. When Size Weight and Power becomes increasingly important versus reliability, we will try to capture that for comparison.
  
- **Format**
  - Database of Vendor/Parts related information, Task Outline
  - Final Report



# Background



- **Background:** There is an increasing interest in using alternate reliability grade parts in aerospace electronics assemblies. What are alternate reliability grade parts, who makes them & why consider using them ?
  - Various Reputable Commercial/Military Electronic Vendors
  - Unique functions/performance
  - Typically manufactured on high volume commercial production lines
  
- **Task Goal:** Designers Guide to functionality and reliability assessment.
  - Datasheet or Military SCD documentation(VID drawings) (“Web-Based Links”)
  - Vendor Reliability Grade Nomenclature (Lean Rel, Enhanced Product..... )
  - Understanding of Vendor Radiation Performance claims (“Space Enhanced”)
  - Temperature performance range (Industrial, “Military-Like”, and Military)
  
- **Commodity Perspective**
  - Research provided better understanding for reliability in contrast to Mil parts
  - Select Topics – discussed in final report



# Motivation



## ➤ Advantages of alternative reliability grade electronic parts

- Newer technology, (attractive to new & unique missions (w/ higher risk tolerance)
- Lower procurement costs
- Readily Available (COVID & Supply Chain Chaos excluded)
  - More functional selection options
  - Better project schedule mitigation
  - Better suited for shorter mission duration needs

## ➤ Key Requirements, Environment & Part Application Match

- Mission, Environment, Application and Lifetime Assessment
- Penalties for Mis-Match range from catastrophic failure to limited performance
- Beware [Budget, Time] ramifications
- Safe Operating Range – additional Derating – Design analysis
  - Ensure part series pedigree is clearly understood
- Radiation Performance – Datasheet – Heritage/Vendor Testing
  - Customer Testing needed when data or similarity analysis is not feasible





# Key Points (& more)



- **Alternate Reliability Grade Part Testing**
  - Not always tested for tolerance to natural space radiation
  - No Destructive Physical Analysis performed
  - Manufacturer facilities typically not DLA Certified (commercial parts)
  - Vendor may be QML – but parts are not likely to be manufactured on those production lines



# Key Points (& more)

## ➤ Alternate Reliability Grade Part Qual/Screening Tests/Features

### ➤ Review of Test Specifications (Product Example #1)

- Wafer lot uniformity and traceability
- Lower cost
- Single wafer fab location
- Wafer lot traceability
- Radiation monitors
- Outgassing characterization
- High reliability lead finishes and no Cu wire bonds
- Extended temperature
- No matte tin
- TID testing per lot and benchmark SEL at product release
- Outgassing Testing



# Key Points (& more)



## ➤ **Alternate Reliability Grade Part Qual/Screening Tests/Features**

- Review of Test Specifications (Vendor/Product Example #2)
  - Wafer lot uniformity and traceability
  - Radiation monitors
  - Smaller packages than traditional ceramic/hermetic
  - Outgassing characterization
  - High reliability lead finishes and no Cu wire bonds
  - Extended temperature
  - High reliability screening
  - Serialized devices
  - Single Event Latchup (SEL) testing
  - High reliability Quality Conformance Inspection
  - 100% processing attributes data
  - Electrical test variable data, if applicable
  - Radiographic inspection report, if applicable
  - Failure analysis report, if applicable
  - Certificate of Conformance







# Key Points (& more)

## ➤ Alternate Reliability Grade Part Qual/Screening Tests/Features

- Review of Test Specifications (Vendor/Product Example #3) cont'd
  - Enhanced mold compound for low outgassing.
  - Extended qualification of each assembly lot including HAST and temperature cycling.
  - 100% temperature cycling.  
Every unit receives temperature cycling or equivalent.
  - Single production flow.  
One wafer fab and assembly site to minimize lot-to-lot variation.
  - Long product life cycles.
  - Each product has its own Vendor Item Drawing (VID) on DLA website



# Final Key Point

## ➤ Alternate Reliability Grade Part Qual/Screening Tests/Features

### ➤ Review of Test Specifications (Vendor/Product Example #4)

- Radiation tolerant (RT) plastic
- AEC-Q100 Based Specification

Test	Class V	PEMs Plastic	RT Plastic
Wafer Lot Acceptance	YES	YES	YES
Nondestructive Bond Pull	YES	NO	NO
Visual Inspection and Serialization	YES	YES	NO
Radiography(pre- and post-stress)	YES	YES	NO
Acoustic Microscopy (C-SAM, pre- and post-stress)	NO	YES	NO
Temperature Cycle	YES	YES	NO
PIND	YES	NO	NO
Constant Acceleration	YES	NO	NO
Interim Electrical Test (Pre- and Post-Burn in)	YES	YES	NO
Burn-in (Static and Dynamic)	YES	YES	NO
Final Electrical Test (Tri-temp, -55C, +25C, +125C)	YES	YES	NO
Percent Defective Allowable (PDA) Calculation	YES	YES	NO
External Visual	YES	YES	NO



# Quality Assurance



## ➤ General Testing Summary

- Manufacturer Typically screening based on the AEC Q100 standard for automotive grade parts or similar.
- Can vary though – base line tests comparable to below:
  - Thermal cycle
  - Electrical test
  - Baseline C-SAM
  - Solderability
  - Wafer Lot Acceptance
  - Single Event Latchup (SEL) testing (for radiation die qualified/tested parts)
  - 100% temperature cycling
  - Outgassing characterization
  - Certificate of Conformance



# Selection Challenges



## ➤ Terminology

- Vendor Marketing Terms are not standard – and unique and market specific
- Numerous vendors – web search difficulties – information location random

## ➤ Technical Criteria Matching

- Vendor Testing not standard in some cases –
- AEC Q100 helps standardize – thus some comparisons can be manageable
- Selection Tool intended to aid in analysis and differentiation
- Without a tool – comparison process is more laborious





# Future Actions



## ➤ Selection Tool Update

- Increased Number of Vendors
- Expand Tool to include other commodities – passives, semiconductors, etc..
- More electronic parameter selection database fields
  - Functional specific (for better application analysis)
  - Better search and organizing features by commodity
  - Add lead time and cost info for better supply chain awareness....

## ➤ Further Research on Qualification Specifics

- AEC-Q100 related parts – typical annual production volume estimates
- What parts were PPAP qualified – general details captured
- Gather Part/Factory POC information for Designer/EEE Engineer factory inquiries and pre-selection information update, follow up and confirmation



# Thoughts Moving Forward



- **Where do we need to be 5 years from now.**
  - Better Vendor Product Usage/Analysis and Selection Prioritization
  - Ensure better understanding of alternate reliability grade specifications for microcircuits, passive parts and other emerging technology components
  - Better Selection tool options to aid in reducing obsolescence risk
  
  - We need to ensure continued involvement from all NASA Centers!
  - User Community Feedback & part usage information needed for awareness/metrics
  - Incorporate datamined commercial information from other databases as aid for expanding the part selection tool scope (i.e. Small Sat, E-Parts etc...)





# QUESTIONS / FEEDBACK

