CERN Quality Workshop

Quality Issues in Current and Future Silicon Detectors

Electrical, Electronic, & Electromechanical (EEE) Parts Approval Process

CERN Quality Workshop – November 3-4, 2011
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Introduction

- **NASA has developed and implemented Safety, Reliability and Quality Assurance (SR&QA) policies, processes and requirements; levied on:**
  - NASA centers/institutions
  - NASA programs (e.g., Space Shuttle Program)
  - NASA projects (both crewed and non-crewed)
  - NASA procurements (both Government Furnished Equipment (GFE) and Contractor Furnished Equipment (CFE) providers)

- **These SR&QA policies, processes and requirements are levied throughout development life cycle**
  - NASA standards apply based on utilization and criticality (can be tailored)

- **NASA policy requires independent assurance of compliance through implementation of a quality assurance program**
  - NASA/Johnson Space Center (JSC) has a dedicated Safety and Mission Assurance (S&MA) Directorate

Introduction (continued)

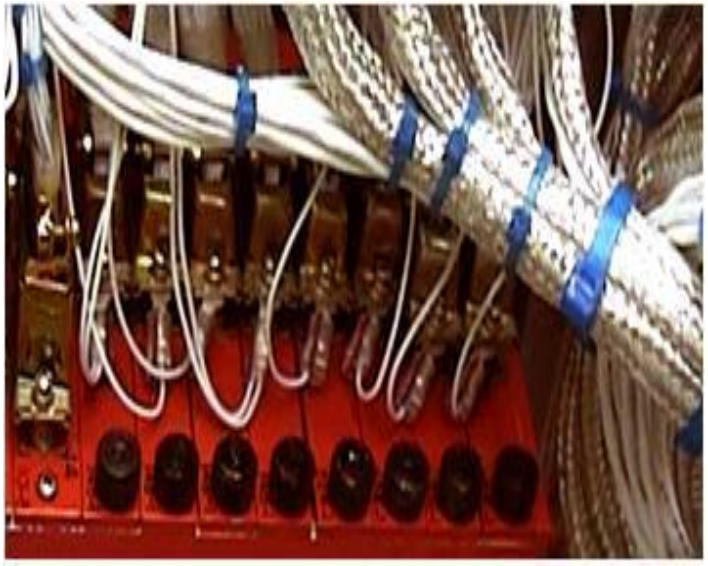
- **JSC SR&QA engineers work directly with Engineering to ensure compliance with NASA standards**
  - SR&QA engineers support concept through final certification
  - Each SR&QA discipline provides a specialized service which is also highly integrated between the other disciplines

- **Electrical, Electronic, & Electromechanical (EEE) parts review and approval process is one of many disciplines provided by SR&QA**
  - Focuses on the design, manufacturing, rework / repair, and inspection of EEE equipment for high-reliability and space flight applications
  - Implemented for NASA's Manned and Unmanned Space-flight Programs.
  - EEE parts experts provide a critical role in ensuring a safe, reliable and quality end-item

- **Focus of this presentation is to provide an overview of the NASA/JSC EEE parts process in order to convey an example of the SR&QA rigor placed on quality screening during hardware development**

Overview

- **Purpose:**
  - Provide insight into the NASA Johnson Space Center Engineering Directorate Certified Parts Approval Process (EDCPAP)
- **Background:**
  - Project Life Cycles
  - Requirements Definition
  - EEE Parts Requirements
- **Process:**
  - Initiate EDCPAP
  - Process Flow
- **Products:**
  - Configuration Management
    - Reports
    - Hardware Certification



Background

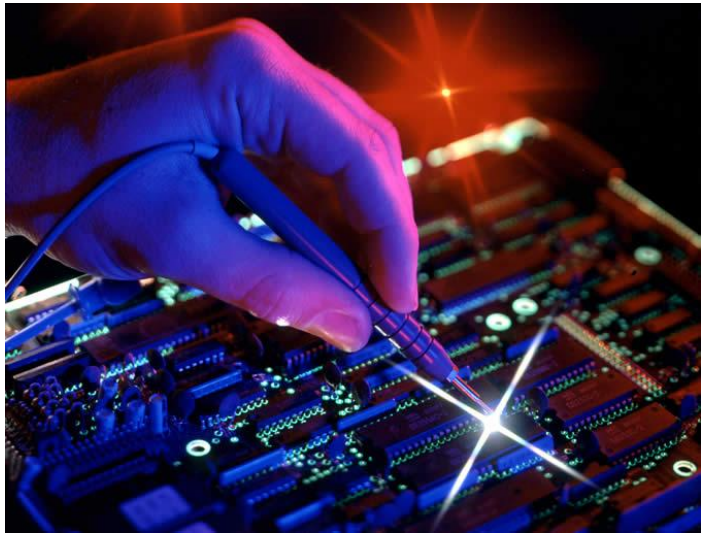
- **Project Life Cycle Phases**
  - Feasibility
  - Definition & Approval
  - Requirements Definition
  - Preliminary Design
  - Detailed Design
  - Flight Production & Certification
  - Deployment
  - Operations

- **Requirements Definition**
  - Preliminary Design Life Cycle
    - Project Technical Requirements
    - Detailed Specifications
    - Project Requirements and Verification Document

EEE Part Requirements

- **EEE Parts Requirements**
  - Military Standards & Specifications
  - NASA Standard Electrical, Electronic, Electromechanical Parts List MIL-STD-975, (now obsolete)
  - Orbiter Approved Parts List
  - Space Station Approved Parts List
  - NASA Parts Selection List
  - EEE Parts Requirements Documentation

- **EDCPAP**
  - Definition of Application Environment
  - Part Identification and selection
  - Manufacturers Identification and Qualification
  - Validation of the Line and Part Capability
  - Qualified Manufacturers On-going Relationship

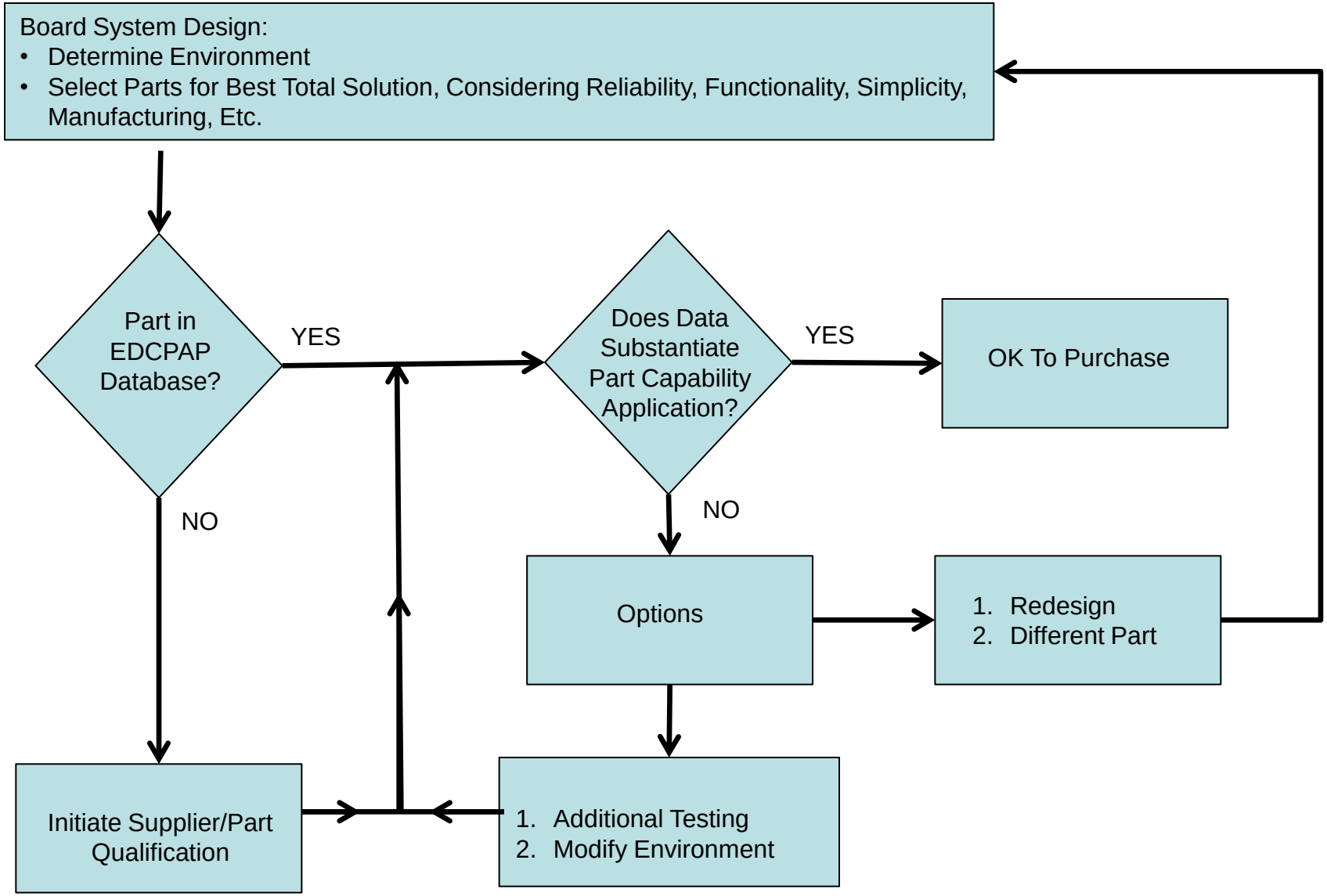


Application Environment

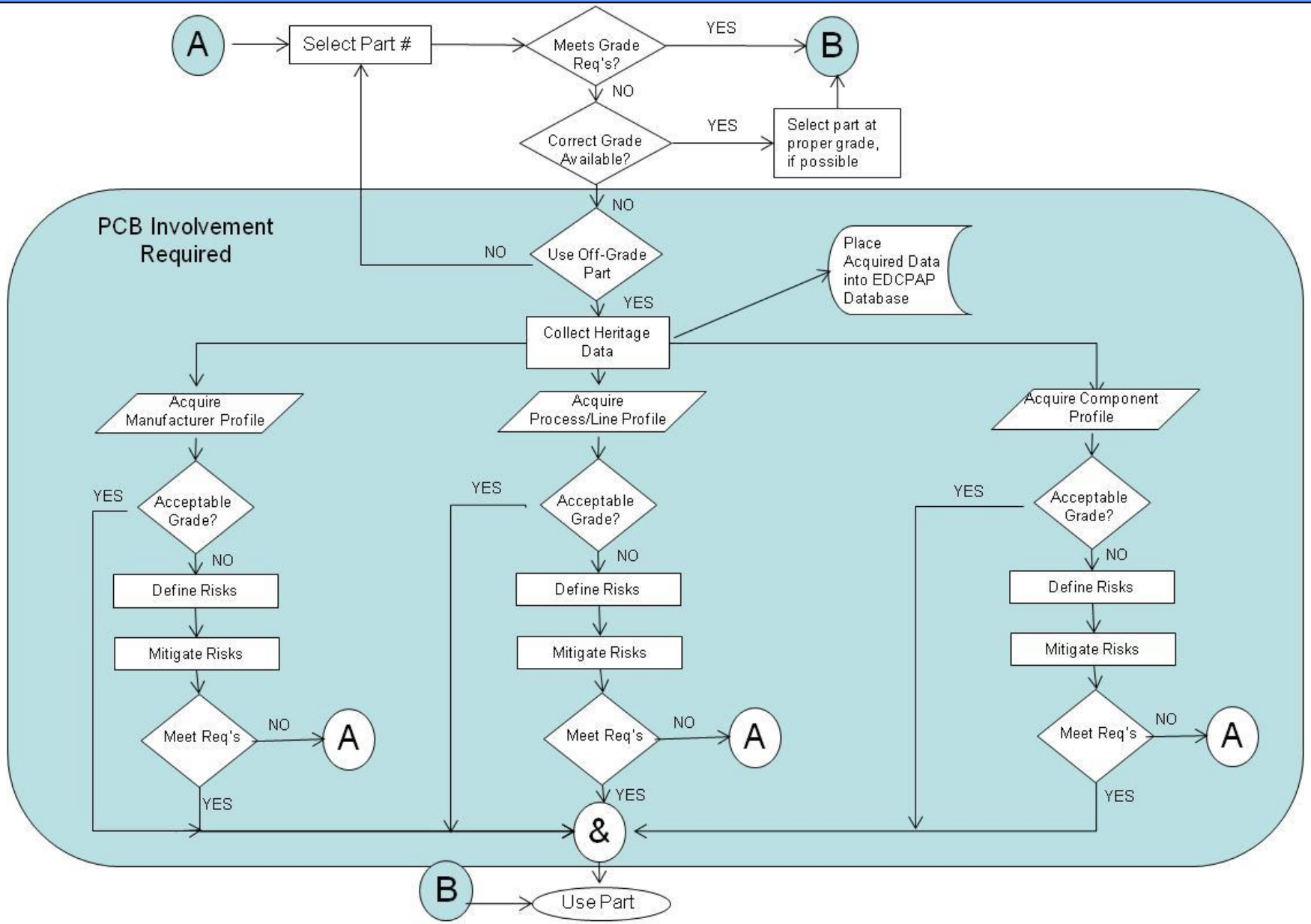
- **Expected Environment and System Operational**
  - Temperature (operating, storage, and manufacturing)
  - Thermal Extremes
  - Shock (thermal, mechanical, pneumatic)
  - Vibration
  - Humidity (operating, transport, storage)
  - Temperature Cycles*
  - Radiation*
  - Destructive Physical Analysis*
  - Particle Impact Noise Detection* (PIND)
  - Other Unique Environmental Tests as necessary based on application

- * **Performed at part level**

Part Identification and Selection Flow



Part Identification and Selection Flow



Manufacturer Identification

- **General Assessment**
  - Statistical Process control
  - Total Quality Management
  - Low Failure in Time (FIT) Rate
  - ISO 9001 Certified
  - Continuous Improvement Plan
  - Problem Notification and Resolution Procedures
  - Qualified Products List/Qualified Manufacturer List
  - Government-Industry Data Exchange Program (GIDEP) Search

Manufacturer Qualification

- **Line Qualification**
  - How Line Qualified
  - Line Operation Time & Utilization
  - Line Products
  - In-line Process Monitors and Validation
  - Customer Base

- **Part Qualification**
  - Generic Part Number
  - Part Description
  - Failure Rate
  - GIDEP, NASA Advisory, Product Change Notices/Recalls
  - NASA Usage History
  - Screening
  - Temperature Assessment (storage, operating)
  - RoHS Compliance
  - Obsolescence Assessment
  - Radiation

Manufacturer Validation

- **Test Methods**
  - Military Standards/Specifications/Handbooks (i.e. 883, 19500, 38535, 38535, HDBK 217, etc.,)
  - American National Standards Institute (ANSI) (i.e. J-STD-004, -005, -006)
  - International Organization for Standardization (ISO) Standards
  - Electronics Industries Alliance
  - American Society for Testing and Materials (ASTM)

Industry Qualification Tests

MICROCIRCUIT INDUSTRY QUALIFICATION TESTS

DESCRIPTION OF TEST	MILITARY HERMETIC (Mil. Std. 883)			AUTOMOTIVE PLASTIC (Typical)		
	LTPD	# LOTS	DURATION	LTPD	# LOTS	DURATION
Burn-In 100%	(PDA = 5%)	All	168 Hours	(PDA = 0.5% to 2.0%*)	All	46 - 168 Hours
Operating Life Qualification	5	1	1K Hours	2-3	1 or 3	1K - 2K Hours
Biased Humidity Qualification	Not Specified	Not Specified	Not Specified	2 - 3	1 or 3	1K - 2K Hours
Temp Cycle Qualification	15	1	100 cycles	1.5 - 3	1 or 3	1K Cycles
Mechanical Qualification	15	1	NA	Not Specified	Not Specified	Not Specified
Group A Cycling	2	All	NA	1	All	NA

*Values are for when PDA is specified. 100% burn in is seldom specified, but may be performed at the manufacturers' option. Burn-in and/or sample burn-in procedures vary significantly between manufacturers and are product dependent.

Source: Harris Semiconductor

Products

- **Configuration Management**
  - EDCPAP Report
    - Manufacturer's Evaluation
    - Part/Line Evaluation
    - Traceability
    - As-built versus As-designed Parts List
    - Drawings
    - Risk Assessment
  - Hardware Certification
  - Hardware Example
    - Laptop Computer w/Modifications
      - Computers are used for many varied applications in NASA programs
      - These computers require special power supplies to use DC power busses
      - The power supply builder found that several parts were identified as a specific manufacturer but in fact were not and were non-functional when tested
      - Parts were purchased through a broker instead of through the OEM or its authorized distributor

Hardware Example

Summary

- **NASA utilizes many standards to ensure safe, reliable and quality space-flight hardware**
- **Lesson's learned over the past several decades have been continuously incorporated into these standards**
- **This EEE parts review and approval process is just one example of the benefits of a quality process in hardware development**