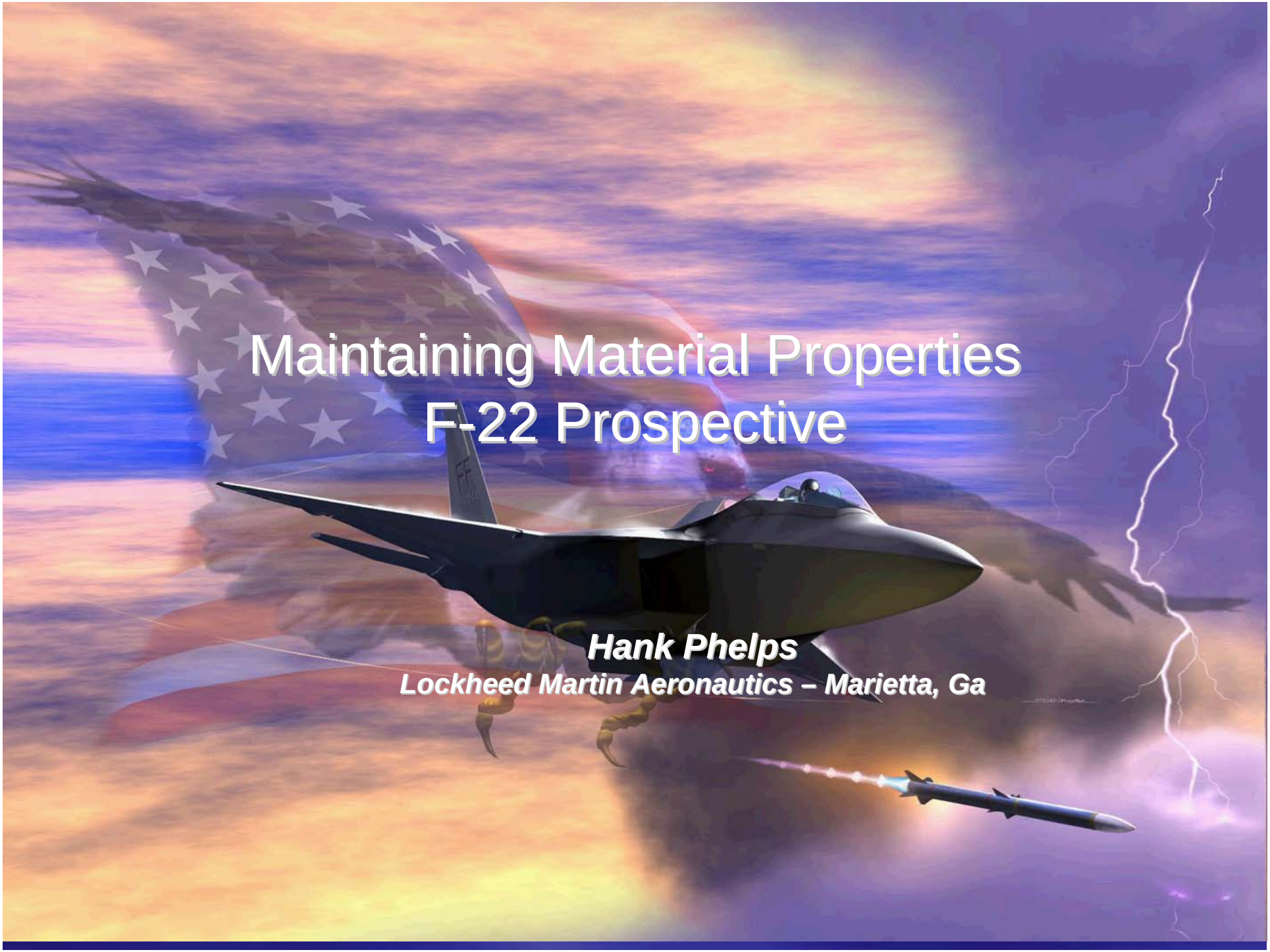


Maintaining Material Properties
F-22 Prospective

Hank Phelps
Lockheed Martin Aeronautics – Marietta, Ga

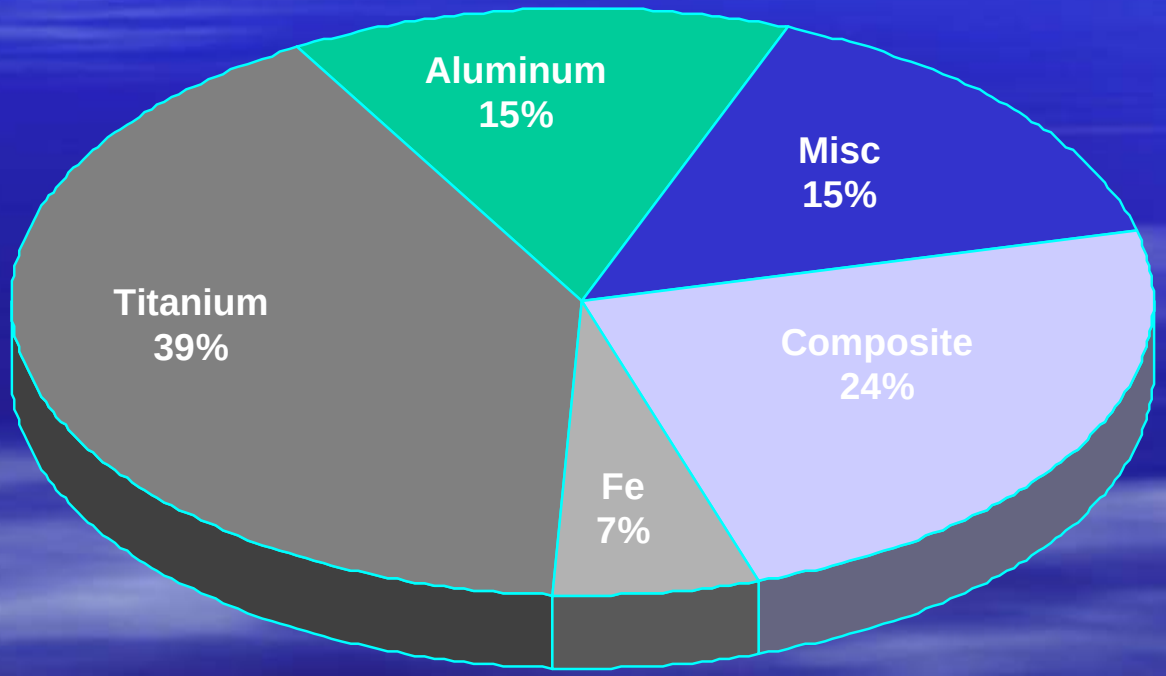
Outline

- F-22 Structural Materials Mix
- Design Allowables Development
- Factors Affecting Material Properties
- Maintaining Allowables in Production
- Summary
- Questions

F-22 Structural Materials Mix

F-22 Materials Mix

Airframe Structural Weight



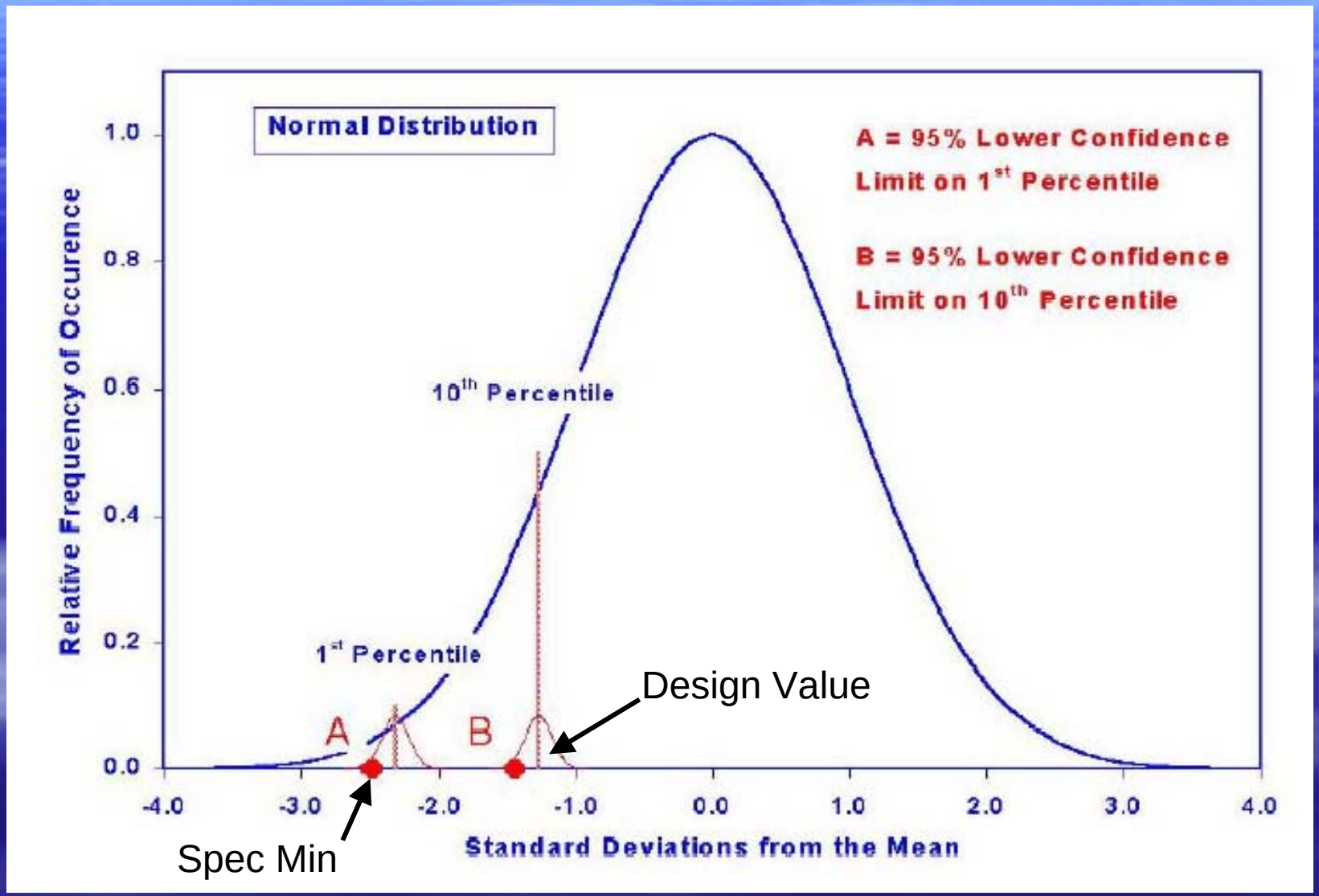
Representative of A/C 4028

Design Allowables Development

Design Allowables Development

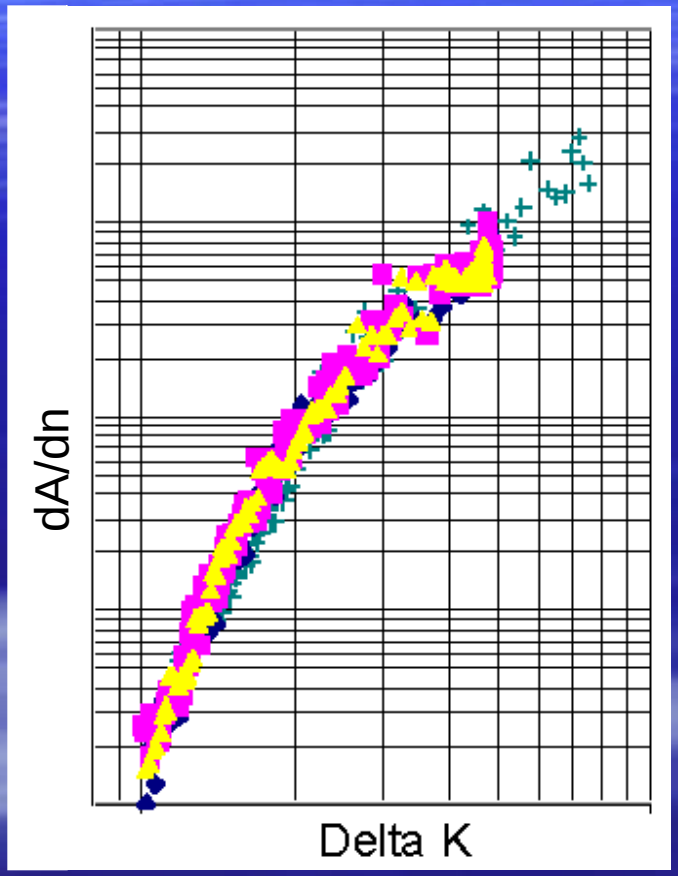
- Structural Development Test (SDT) Pgm
  - Material Spec Development
    - Spec Min Values Estimated
  - Mechanical Property Development
    - ~3,600 Titanium Coupon Tests
      - Static
      - Durability & Damage Tolerance (DADT)
    - Statistically Reduced Allowables Developed
      - “B” Basis
      - Spec Values Verified
    - DADT Design Properties Established

Design vs Spec Values

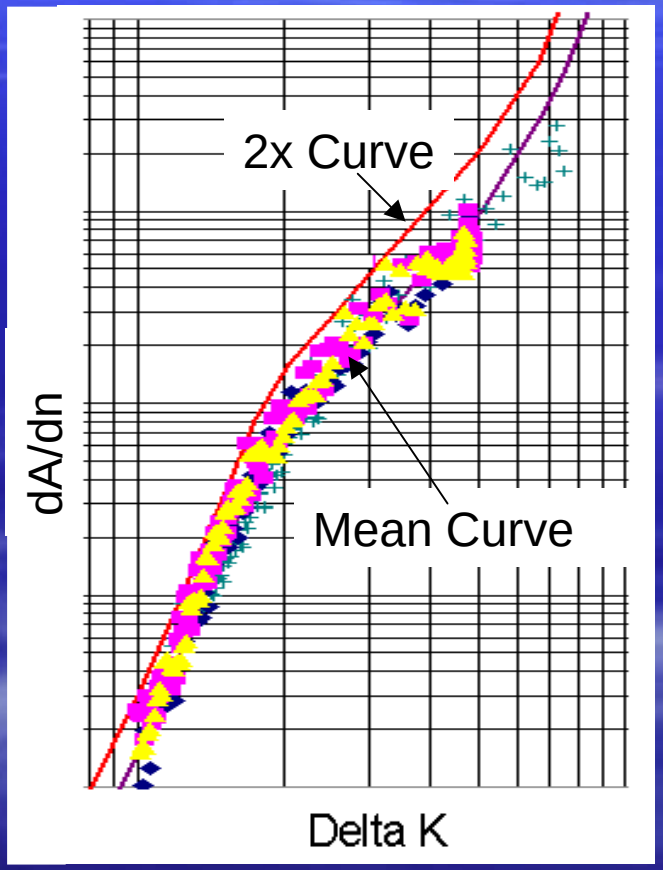


Note: From Metallic Materials Properties Development and Standardization

Crack Growth Rate



Collect Crack Growth Data



Develop Mean & 2 x Rate Curves

Factors Affecting Material Properties

Factors Affecting Mechanical Properties

Raw Materials

Source
Mfg Process
Quality
Morphology

Consolidation

Electrode Fab
Melt Practice

Conversion

Ingot to Product
TMP Route

Heat Treatment

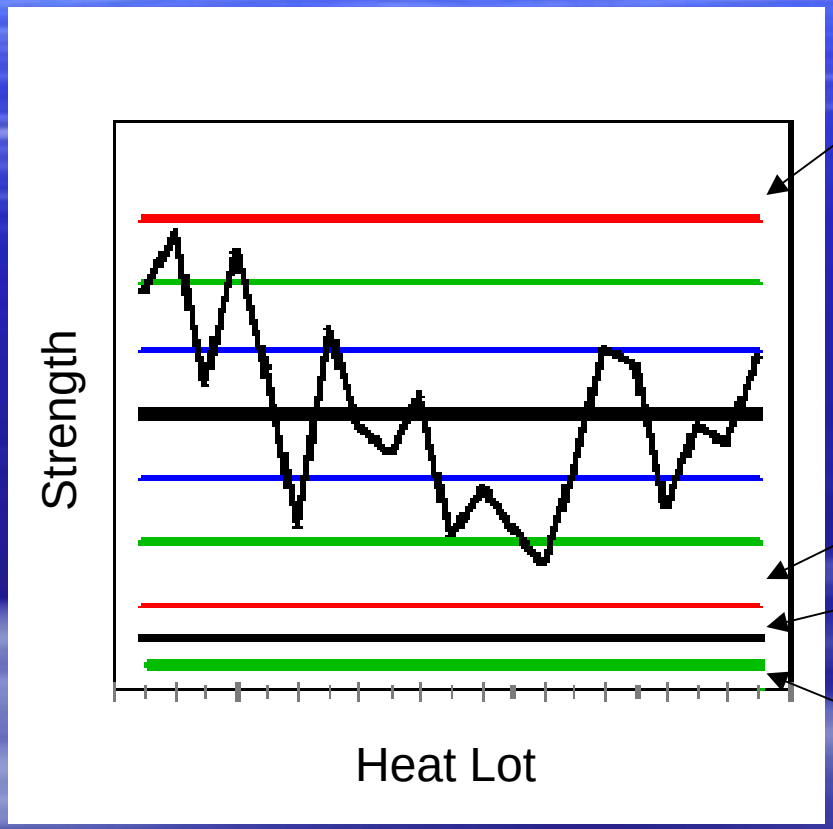
Solution Heat Treat Temp
Dwell Time
Cooling Rate
Age or SR Cycle

Maintaining Allowables in Production

Maintaining Allowables

- Existing Processes
  - Establish Fixed Practice Ageements (FPAs)
  - Monitor
    - SPC
- Qualify New Processes
  - Insure Design Allowables Supported
    - Static
    - DADT

SPC



UCL

LCL

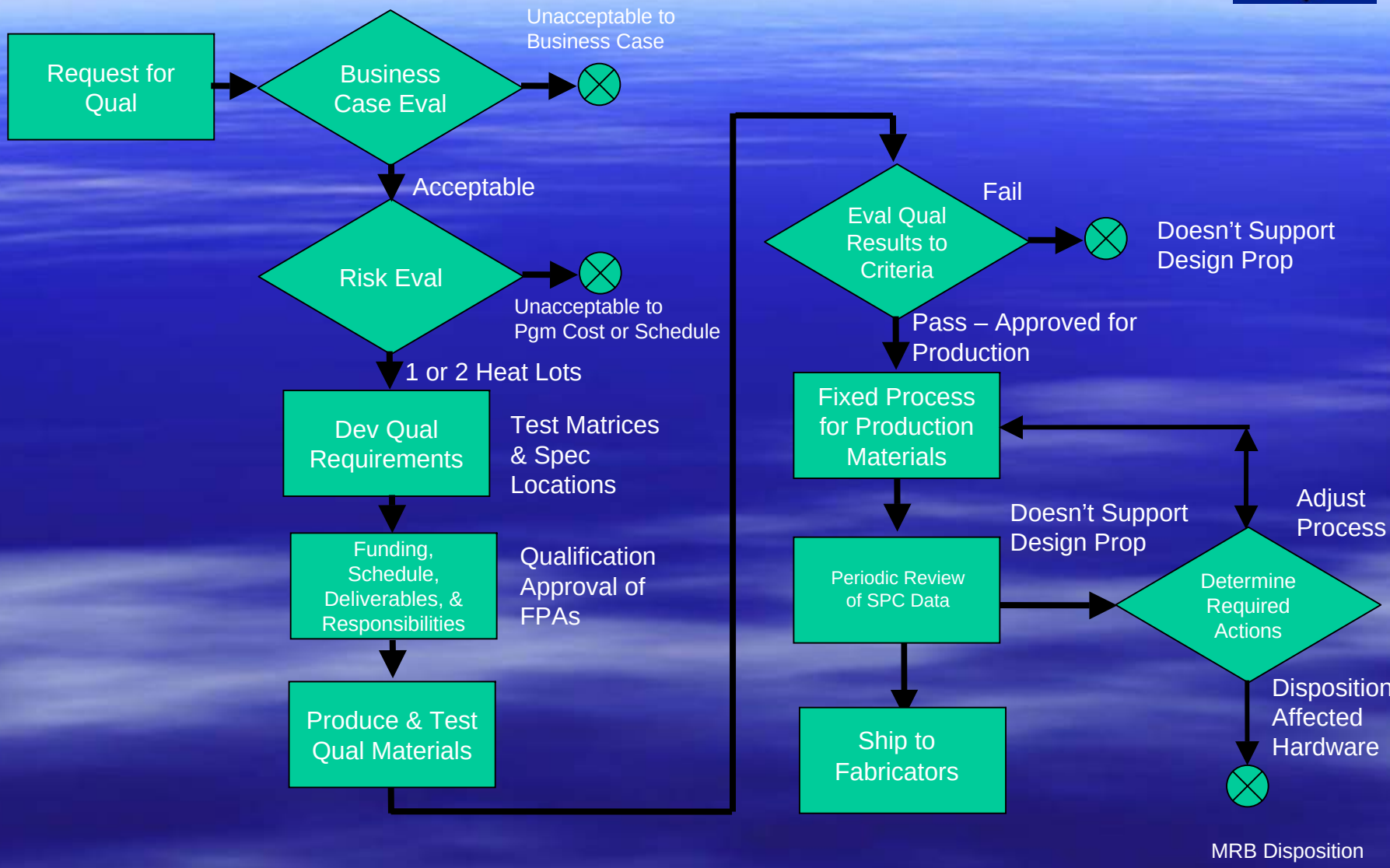
B-Basis

Spec Min

New or Changed Process

- Insure that new vendors &/ or processes:
  - Warrant expenditure of program & vendor resources
  - Do not increase the program risks
  - Support existing design properties
  - Maintain consistent properties when transferred to production

Qualification Flow



Acceptance Criteria

Test Type	Acceptance Criteria	Comment
Chemistry	Material Spec	
Micro & Macro Structure	Material Spec	
Tensile RT RT Exposed 700 F	 Support “B” Support “B” Consistent w SDT	 No Loss in properties Loss consistent with F/A-22 Database
Strain Life	No Results < 25% D.L. Geom Avg ≥ 80% D.L.	Replicates at three strain levels
FCGR	Smoothed Data does not exceed 2X Curve	
Fracture Toughness	Material Spec	
Stress Corrosion	Material Spec	

Summary

- F-22 structural integrity is based on production materials supporting the design properties
- Multiple factors can affect material properties
- Need to monitor existing processes
  - Detect detrimental trends & take corrective actions
- New process / vendor qualification
  - Support design values
    - Static
    - DADT

Questions