



Material and Processes Qualification Protocol

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Program Objective

- **Develop a protocol for qualifying new and alternate second source composite materials and processes for Naval aircraft primary and secondary structural applications.**

- **Office of Naval Research,
BAA 97-003**

- **April 1998 -
October 1999**



Program Team

- **Prime - BP Amoco**
- **Lead on protocol development - Boeing**
- **Processing - RTM - GKN Westland**
- **Prepregs - Cytec Fiberite and Hexcel**
- **Testing - Delsen Laboratories**
- **Analysis - Materials Sciences Corporation**
- **Novel Analysis - Dissipated Energy - NRL**

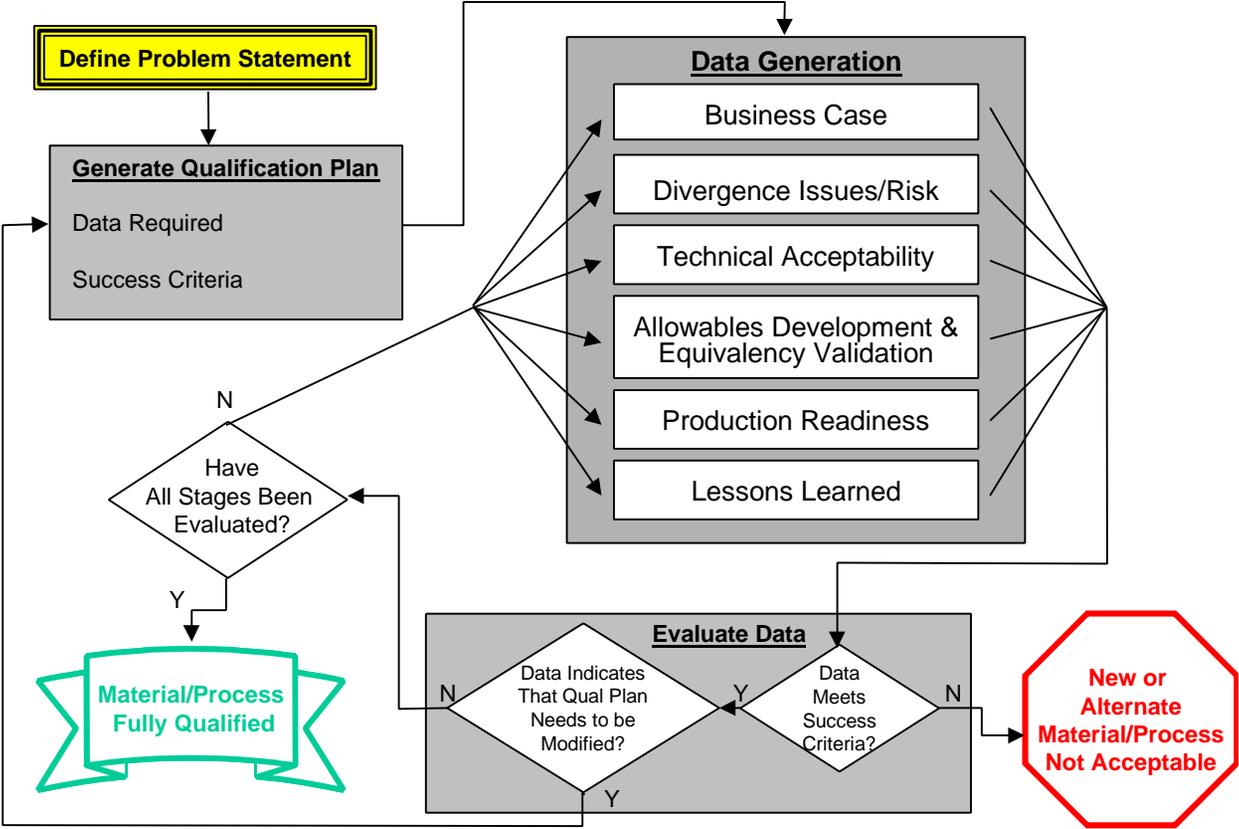
Common Ground

- **Protocol is comprehensive - from initial business case through production readiness**
- **Technical issues are common to the concerns of the E-beam community**

Qualification Protocol for New Materials, New Processes, and Alternative Second Source Materials

- Foreword (Navy)
- Scope
- 1. Introduction
- 2. Protocol - Overview
 - 2.1 Problem Statement
 - 2.2 Business Case
 - 2.3 Divergence Issues/Risk
 - 2.4 Technical Acceptability
 - 2.5 Allowables Development/
Equivalency Validation
 - 2.6 Production Readiness
 - 2.7 Lessons Learned
- 3. References
- 4. Appendices

Material/Process Qualification Procedure



Elements of Protocol

- **Business Case**
- **Divergence Issues/Risk**
- **Technical Acceptability**
- **Data Reduction and Allowables**
- **Development/Equivalency**
- **Validation**
- **Production Readiness**
- **Lessons Learned**

The Problem Statement

- **Bounds the program**
 - **Defines the objective**
 - **Defines business case elements**
 - **Sets the level of divergence**
 - **Establishes acceptable risk**

The Business Case

- **Validates the program**
- **Forces acceptance by each stakeholder**
- **Is based on the problem statement**

Business Case

- **Nonrecurring**
 - **Development**
 - **Implementation**
- **Recurring**
 - **Current Cost**
 - **Cost of Proposed**
 - **Breakeven**
 - **Return on investment**
- **Operating and Support Costs**

Divergence Issues/Risk

- **Understand divergence. It sets scope.**
- **Mitigate risk to an acceptable level.**

Technical Acceptability

- The requirements of the design and manufacturing procedures used to produce the design must be satisfied.
- Statistics and engineering judgement are utilized to judge success.



Data Reduction and Allowables Development/Equivalency Validation

- Data reduction methods
- Normalization techniques
- Allowables development
- Statistical data reduction and analysis
- B-basis knockdown factors development

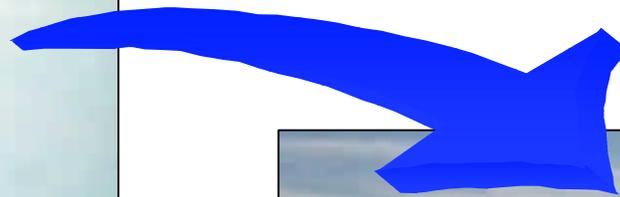
Production Readiness

- **Addresses the readiness of**
 - **Raw material suppliers**
 - **Product form suppliers**
 - **Part fabricators**
 - **Assembler**



Lessons Learned

- Incorporate past and current lessons learned
- Document current lessons learned



Stages of Material/Process Qualification

- **Feasibility/Candidate Identification**
- **Basic Properties and Decisions**
- **Qualification Properties**
- **Elements/Subelements**
- **Components/Production Verification**
- **Full Scale Flight/Ground Tests**

Elements and Stages of Material/Process Qualification

		(A) Feasibility/ Candidate Identification	(B) Basic Prop. & Decisions	(C) Qualification Properties	(D) Elements Subelements	(E) Components Production Verification	(F) Full Scale Tests	
		(1) Problem Statement		(2) <u>Business Case</u> <ul style="list-style-type: none"> •Supplier •Buyer •User 	<ul style="list-style-type: none"> • Acceptable Business Case to Proceed all Stakeholders • Plan 	<ul style="list-style-type: none"> • Confidentiality, Agreement, POC • Resources required for qual. understood and documented 	<ul style="list-style-type: none"> • Confirm case, modify if necessary 	<ul style="list-style-type: none"> • Confirm case, modify if necessary
(3) <u>Divergence Issues/Risk</u> <ul style="list-style-type: none"> • Risk Controlled • Divergence Understood 	<ul style="list-style-type: none"> • Document Divergence • Draft Risk Statements/Plans • Prioritize Needs 			<ul style="list-style-type: none"> • Risk Plans in Place 	<ul style="list-style-type: none"> • Confirm divergence issues • Modify risk analysis 	<ul style="list-style-type: none"> • Confirm divergence issues • Modify risk analysis 	<ul style="list-style-type: none"> • Confirm divergence issues • Modify risk analysis 	<ul style="list-style-type: none"> • Divergence understood • Risk controlled
(4) <u>Technical Acceptability</u> (Design Emphasis) <ul style="list-style-type: none"> • New • Second Source 	<ul style="list-style-type: none"> • Query Reputable Suppliers, Discuss Options to Problem Statement 			<ul style="list-style-type: none"> • Initiate high risk, long lead tests • Plan for Qual and Qual Matl combinations 	<ul style="list-style-type: none"> • Processing Established 	<ul style="list-style-type: none"> • Design guidelines established 	<ul style="list-style-type: none"> • Complete, met requirements 	
(5) <u>Allowables Dev. & Equiv. Validation</u> <ul style="list-style-type: none"> • New • Second Source 	<ul style="list-style-type: none"> • Pull all Available Data Together 			<ul style="list-style-type: none"> • Basic Properties and targets 	<ul style="list-style-type: none"> • Material spec. values determined 	<ul style="list-style-type: none"> • Allowables established 	<ul style="list-style-type: none"> • Compare results to predictions 	<ul style="list-style-type: none"> • Validate expected results
(6) <u>Production Readiness</u> (Manufacturing/Producibility Emphasis) <ul style="list-style-type: none"> • Supplier Production Ready • User Production Ready 	<ul style="list-style-type: none"> • Production Transition Understood, Feasible, Drafted 			<ul style="list-style-type: none"> • Production transition Plans in progress including matl supplier, processor, assembler, user 	<ul style="list-style-type: none"> • Draft Material and Process/man. specs - supplier, user, assembler 	<ul style="list-style-type: none"> • Approved Material and Process/manufacturing Specifications 	<ul style="list-style-type: none"> • Tooling guidelines established 	<ul style="list-style-type: none"> • Supplier production ready • Processor/user production ready
(7) <u>Lessons Learned</u> <ul style="list-style-type: none"> • Past and Present Lessons Learned Incorporated 	<ul style="list-style-type: none"> • Expertise needs identified for Problem Statement 			<ul style="list-style-type: none"> • Key Contacts Made • Documented Assessment 	<ul style="list-style-type: none"> • Document variation and unanticipated processing and test results 	<ul style="list-style-type: none"> • Document unanticipated processing and test results 	<ul style="list-style-type: none"> • Document unanticipated processing and test results 	<ul style="list-style-type: none"> • Lessons learned Incorporated

End State: Total System Performance Validation

- ✓ Complete Database
- ✓ Process and Allowable Validated

Test Methods Issues

- **Round robin/multi-site testing/analysis**
- **Exposure conditions**
- **Bond adhesives/tabs**
- **Holes/countersinks/fasteners**
- **Retest criteria/procedures**

Protocol Issues

- **Definition of equivalency**
- **Guidelines - test/analysis methods, when to use, which to use**
- **Introduction of variability, understanding sources of variability, robustness**
- **Pooling data, subsets of testing**
- **Scatter/coefficients of variation in composites, by test method or family of properties**
- **Statistical significance in iterations**
- **Scientific methods/statistics/engineering judgement**

Thank You
for serving as a sounding board to this development

- **If you have further interest/input, please contact: Gail Hahn at 314-233-1848, gail.l.hahn@boeing.com or John Banisaukas at 770-772-8456, jbanisaukas@amoco.com**