FAA Aging Electrical Systems Research Program Update

Prepared for:
Aging Transport Systems Rulemaking Advisory Committee
January 23, 2003

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Aging Electrical Systems Research Program ? AAR-480

Arc Fault Circuit Breaker Update

Arc Fault Circuit Breaker Phase II Development

- 28VDC, 1-25A
- 3-phase, 5-25A
- DC and 3-Phase Load Characterization
  - 24-28 February 2003
  - FAA WJHTC, Atlantic City Int'l Airport
  - B727, B737, B747
  - Bombardier CRJ200

Aging Circuit Breaker Update

Aging Circuit Breaker Recommendations

- Final report released: DOT/FAA/AR-01/118
- Aircraft Age-Related Degradation Study on Single- and Three-Phase Circuit Breakers
- Available at: actlibrary.tc.faa.gov
- Report contains detailed results and recommendations

Aging Circuit Breaker Recommendations

- Maintenance Manual: Review and update
  - Cycle all breakers off/on at least annually
  - Instructions on protecting the back of c.b. panels during routine maintenance
  - Instructions on cleaning back of c.b. panels

Aging Circuit Breaker Recommendations

- Maintenance Manual: Review and update
  - Instructions to examine c.b. panels for loose, broken, misapplied termination hardware and corrective procedures
  - Instructions to avoid cross-threading screws or thread-stripping terminals and require replacement of c.b. when this occurs

Aging Circuit Breaker Recommendations

- Maintenance Manual: Review and update
  - Instructions to inspect for overheating and electrical arcing
  - Instructions clearly specifying correct wire-termination hardware. No substitutions permitted.

Aging Circuit Breaker Recommendations

- Maintenance Manual: Review and update
  - Review all processes that use the c.b. as the primary on/off switch.
  - Breakers routinely used for this purpose shall be scheduled for replacement based upon design requirements for the breaker, or the circuit shall be redesigned with an appropriate switching device.

Aging Circuit Breaker Recommendations

- SAE Standards: ARP 1199
  - Recommend c.b. termination hardware be replaced with identical parts.
  - Standardize date code marking
  - Revise ARP 1199 and ARP 4404 to include definitive guidelines related to multiple circuits powered by a single c.b.

Aging Circuit Breaker Recommendations

- SAE Standards:
  - Revise AS 50881 & AS 5809 to develop guidelines on multiple wires terminated into one-lug attached to c.b. terminal and multiple-lugs attached to a c.b.

Aging Circuit Breaker Recommendations

- FAA Advisory Circulars:
  - Recommend that relevant AC's refer to SAE ARP 1199, ARP 4404, and AS 50881 for electrical distribution system guidance.

R&D Results, Recommendations, and Products

Technology Transfer/Implementation

???

ATSRAC

Technology Transfer/Implementation

Tech Xfr/Implementation

- FAA provides quarterly R&D reviews to ATSRAC
- Information exchange
- Research partnerships and cooperation

Tech Xfr/Implementation

- As EWIS rulemaking activities proceed establish a means to explore implementation of R&D products and knowledge
- Supports development of guidance, implementation, and technology transfer.

Tech Xfr/Implementation

Outputs:

- Liaison with ATSRAC membership concerning implementation of R&D products within the industry

Tech Xfr/Implementation

Outputs:

- Provide recommendations and comment to the FAA R&D program concerning implementation and potential additions, changes, or deletion of R&D that would enhance the implementation process

Tech Xfr/Implementation

Outputs:

- Recommend additions, changes, or deletion of implementation methods

Tech Xfr/Implementation

Outputs:

- Provide an interface between the FAA R&D program and the ATSRAC membership.
- Facilitate R&D cooperation and/or partnerships
- Facilitate transfer of technology to aviation community

Wire Test & Inspection Technology

Excited Dielectric Test

Wire Indenter
Complete: March 2003

Broadband Impedance Measurement
Complete: May 2004

Terahertz Reflectometry
Complete: March 2004

Pseudo-Random Binary Sequence Reflectometry
Complete: December 2004

Optical Chafe Detector
Complete: July 2004

Hi-Voltage Micro-Energy
Complete: November 2003

Pulsed Arrested Spark Discharge
Complete: September 2005

Validation Test Bed

Wire Degradation Research

Wire Degradation Research

- Test Data and Preliminary Age Models
  - April 2004
- Draft Final Report
  - August 2004
- Final Report
  - December 2004

Evaluation of Performance Requirements, Test Criteria and Procedures, for Aircraft Wire

Aircraft Wire Performance

- Task 1 – Review of Current Wire Specifications – complete
- Task 2 – Obtain Wire Performance Field Data – complete
- Task 3 – Evaluation/Assessment of Field Data vs. Performance Specifications – Mar 2003
- Task 4 – Draft Minimum Wire Performance Specification – Mar 2003

Evaluation of Aircraft Wiring Separation and Segregation Requirements and Practices

Wiring Separation and Segregation

Tasks

- Obtain and analyze electrical failure data relevant to separation and segregation – Aug 2003
- Identify failure modes that render the applicable separation and segregation requirement inadequate or otherwise reducing the effectiveness of the safety margin – Oct 2003.

Wiring Separation and Segregation

Tasks

- Develop potential improvements – Feb 2004
- Conduct tests as necessary to investigate current requirements, support investigation and verification of potential improvements – Mar 2004
- Draft final report – May 2004

Effects of Related & Unrelated Maintenance on the Integrity of Aircraft Electrical Interconnect Systems

Maintenance Effects

Tasks

- Conduct an empirical evaluation of maintenance processes and effects.
- Evaluate collateral maintenance effects such as contamination of wire bundles, and insulation blankets.
- Simulate maintenance conditions to quantify maintenance effects
- Completion – Sep 2003

Evaluation of Mixed Wire Types

Evaluation of Mixed Wire Types

- Review wiring practices related to mixing of wire types
- Review of wire properties relative to mixing
- Testing
- Final report
- Completion – Sep 2003

Arc Fault Circuit Breaker:
Phase II

AFCB Phase II

- 28VDC and 115V/3-phase prototypes – Dec 2003
- Flight Testing - 2005

Advanced Risk Assessment Methods for Aircraft Electrical Systems

Advanced Risk Assessment Methods for Aircraft Electrical Systems

- Develop tools to enhance the risk assessment process and facilitate compliance with new and proposed rulemaking
- Contract Award: March 2002
- Completion: August 2004
- Lectromec

Questions

FAA Aging Mechanical Systems Research Program Update

Prepared for:
Aging Transport Systems Rulemaking Advisory Committee
January 23, 2003

Robert McGuire ? Federal Aviation Administration
Aging Electrical Systems Research Program ? AAR-480
609-485-4494

Aging Mechanical Systems Background

- FAA mandated by Congress to address Aging Systems
- Mandate includes both electrical and mechanical systems
- Mechanical systems research in its early stages
- Chance to be proactive in safety research

Objective

FAA Aging Mechanical Systems research program aims to develop technology and techniques to ensure the continued safe operation of aircraft mechanical systems

Current Research

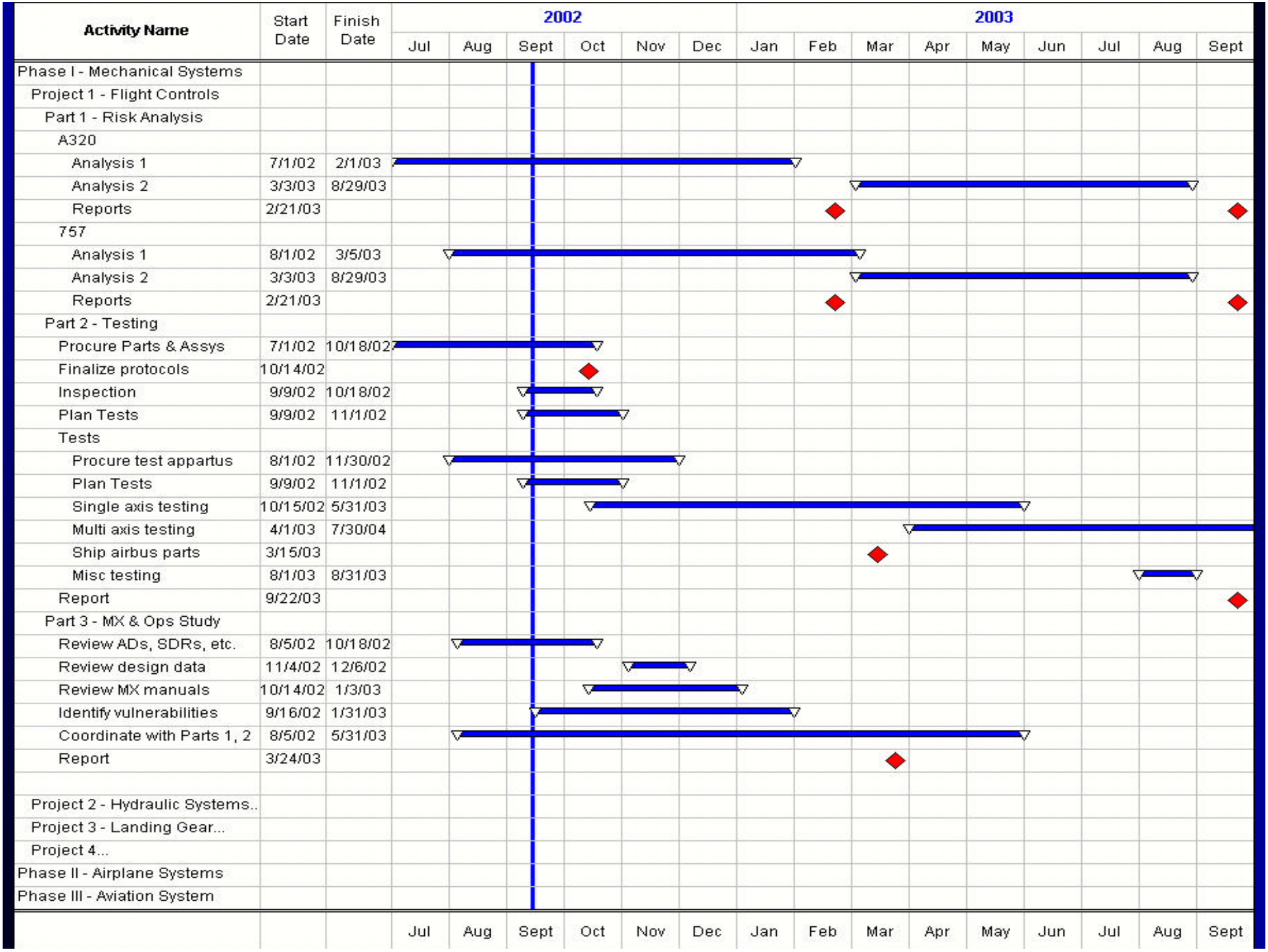
- Overall General Risk and Maintenance Assessment
- Destructive Testing of Flight Control Linkages
- Failsafe Continue-to-Operate Jackscrews
- Transport Aircraft Rudder Investigation

Overall General Risk and Maintenance Assessment

- Phase I: Flight Control Systems
- Phase I Project I: One axis of control systems on A320 and B757
  - Models are chosen to develop evaluation procedures
  - Partnering with Boeing , Airbus, and JAA
- Approach
  - Part 1: Assessment of the design and service history associated with each flight control.
  - Part 2: Assessment of manufacturer's maintenance instructions associated with each flight control.

Destructive Testing of Flight Control Linkages

- Assess the condition of flight control linkages on aging aircraft
- Main effort Single Element-Dual Load Path
- Possibly Single Element Single Load Path


Activity Name
Start Date
Finish Date
2002
2003
Jul
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Phase I - Mechanical Systems
Project 1 - Flight Controls
Part 1 - Risk Analysis
A320
Analysis 1 7/1/02 2/1/03
Analysis 2 3/3/03 8/29/03
Reports 2/21/03
757
Analysis 1 8/1/02 3/5/03
Analysis 2 3/3/03 8/29/03
Reports 2/21/03
Part 2 - Testing
Procure Parts & Assys 7/1/02 10/18/02
Finalize protocols 10/14/02
Inspection 9/9/02 10/18/02
Plan Tests 9/9/02 11/1/02
Tests
Procure test appartus 8/1/02 11/30/02
Plan Tests 9/9/02 11/1/02
Single axis testing 10/15/02 5/31/03
Multi axis testing 4/1/03 7/30/04
Ship airbus parts 3/15/03
Misc testing 8/1/03 8/31/03
Report 9/22/03
Part 3 - MX & Ops Study
Review ADs, SDRs, etc. 8/5/02 10/18/02
Review design data 11/4/02 12/6/02
Review MX manuals 10/14/02 1/3/03
Identify vulnerabilities 9/16/02 1/31/03
Coordinate with Parts 1, 2 8/5/02 5/31/03
Report 3/24/03
Project 2 - Hydraulic Systems..
Project 3 - Landing Gear...
Project 4...
Phase II - Airplane Systems
Phase III - Aviation System

Characterization of Test Bed Aircraft

- To assist the study of aging systems a test bed airplane (B747) is available to support investigations of mechanical systems and their relationship/interactions
- Asses which mechanical systems are functioning and to what extent
- Determine requirements for repair of nonfunctioning systems

Failsafe Continue-to-Operate Jackscrews

- National Transportation Safety Board, Safety Recommendations suggest
  - Conduct systematic engineering review to eliminate catastrophic effects if total failure
  - Avoid single-point catastrophic failure mode
- NASA has prototype design. FAA would like to do additional testing.

Transport Aircraft Rudder Investigation

- Study on rudder pedal force
- Possible overstressing the vertical stabilizer
- Research in conjunction with University of California

Future Research

- Additional mechanical systems to be addressed in future phases
  - Hydraulics/pneumatics
  - Oxygen/environmental systems
  - Evacuation slides/doors
  - Landing gear
  - Ice and rain protection
  - Fire systems