Development of an Improved Fire Test Method and Criteria for Aircraft Electrical Wiring

Federal Aviation Administration

Presented to: The International Aircraft Material Fire Testing Working Group

By: John Reinhardt, Project Manager, PMP

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Outline

- Project Initiating Process
  - ✓ Project Charter
  - ✓ Preliminary Scope Statement
- Planning Process
  - ✓ Develop Project Mgt Plan

Initiating Process

PROJECT CHARTER

- Date of Request: 24 October 2007
- Sponsor: Jeff Gardlin, FAA Transport Airplane Directorate
- Program Manager: Gus Sarkos, FAA Fire Safety
- Project Manager: John Reinhardt, PMP, FAA Fire Safety
- FAA Business Needs (FAA Flight Plan FY 2008):

  ✓ Achieve the lowest possible commercial air carrier fatal accident rate:

  - Currently (2007): 8.8828 fatalities per 100 million persons onboard

  - FY 2012: 7.65 fatalities per 100 million persons onboard

  - FY 2025: 4.44 fatalities per 100 million persons onboard

Initiating Process

PROJECT CHARTER (CONT.)

- Project Justification:

  ✓ The FAA initiated efforts to improve the fireworthiness of hidden areas in the aircraft (T/A Insulation, ducting and wires)

  ✓ Report DOT/FAA/AR-TN04/32, “An Evaluation of the Flammability of Aircraft Wiring,” (Cahill) concluded that the current FAA *60 degree test* is not adequate for qualification of wire bundles.

  ✓ The *Sixty Degree Test*, Title 14 Code of Federal Regulations Part 25, Appendix F Part I (b)(7)) and Chapter 4 in the Aircraft Material Fire Test Handbook, must be replaced.

Initiating Process

Initiating Process

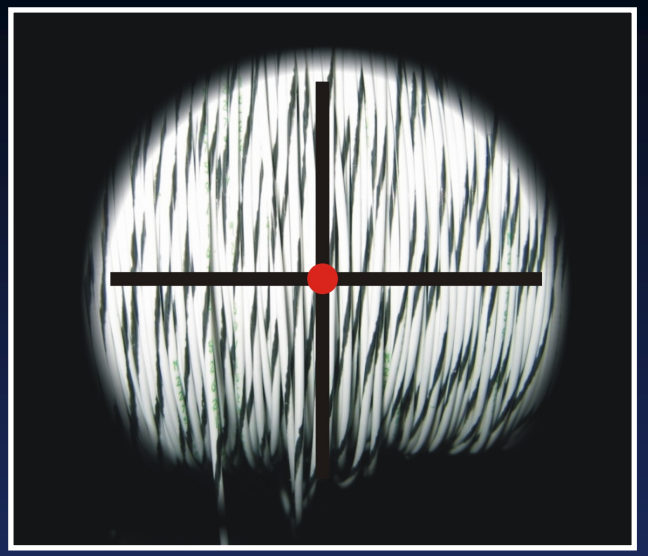
PROJECT CHARTER (CONT.)

- Objectives:
  - ✓Develop a fire test method for aircraft electrical wiring that could adequately discriminate between poorly performing wire insulation materials and fire worthy ones when exposed to a realistic fire scenario.
- Requirements:
  - ✓ Submit a final report documenting the developmental project and the new test method.
- Due Date (milestone):
  - ✓ 30 June 2009: Draft Final Report

Initiating Process

PRELIMINARY SCOPE STATEMENT

- This project will focus on the flammability characteristics of aircraft wiring insulation only.
- It will consider the Radiant Heat Panel test apparatus as a candidate replacement.
- Excluded: wire arcing, design issues, installation issues, maintenance issues, FAA policies, etc.



Outline

- Project Initiating Process
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  - ✓ Preliminary Scope Statement
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Planning Process

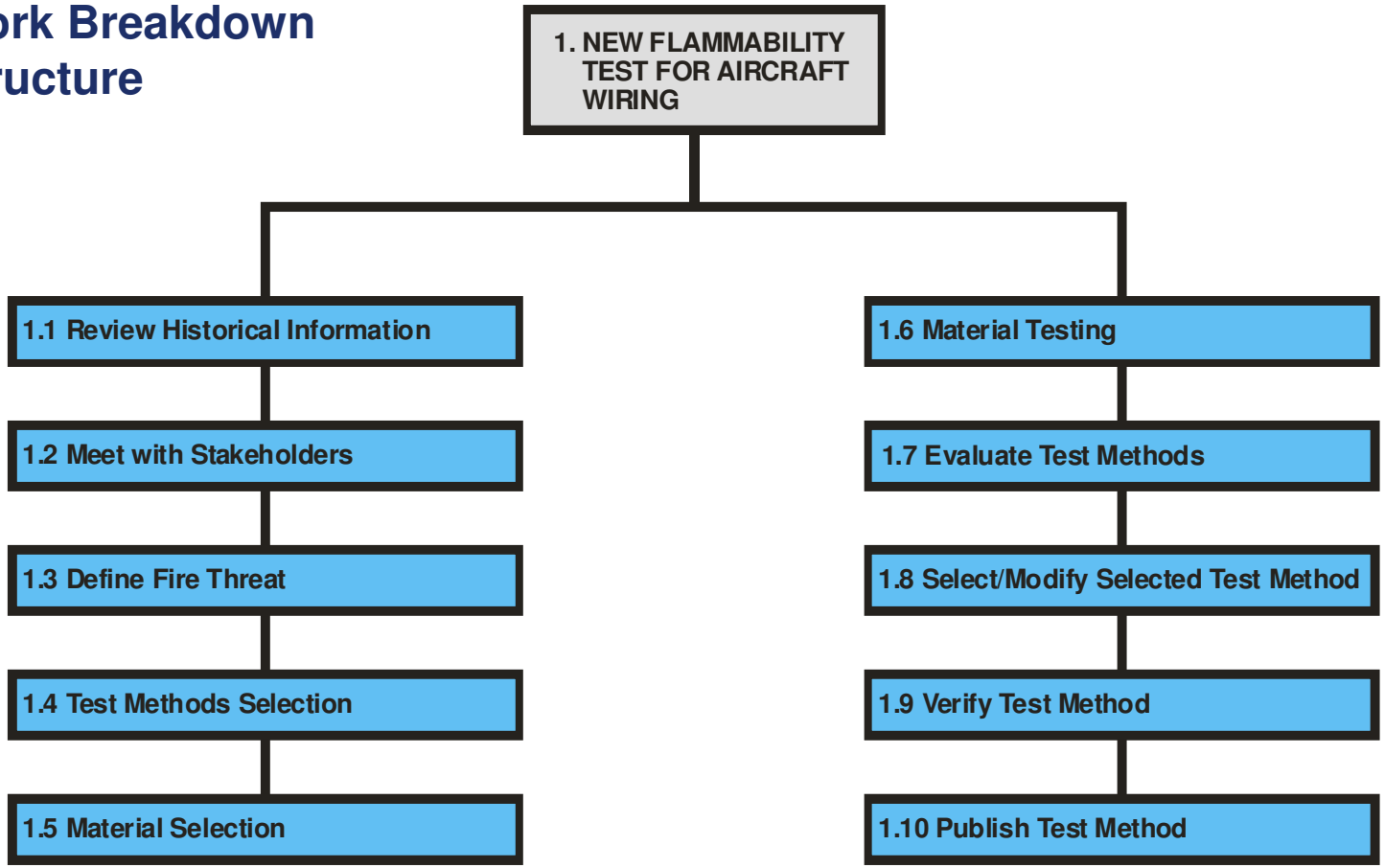
- **PROJECT MANAGEMENT PLAN**
  - Scope
  - Time
  - Cost
  - Quality
  - Human Resource
  - Communications
  - Risk
  - Procurement

Planning Process

- **SCOPE**
  - Planning
  - Definition
  - Create Work Breakdown Structure (see next slide)

Planning Process: Scope

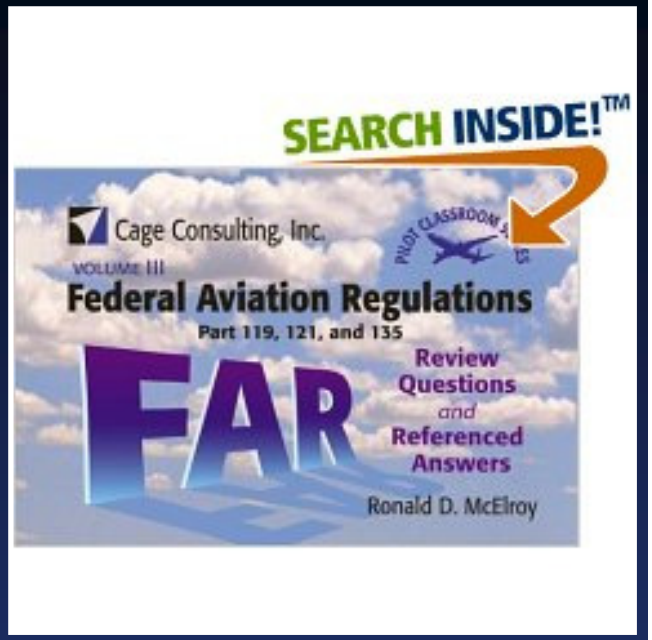
Work Breakdown Structure



Planning Process: Scope

WBS 1.1 Reviewed Historical Information

- Title 14 Code of Federal Regulations Part 25.1713: "Fire Protection: EWIS"
- Title 14 Code of Federal Regulations Part 25, Appendix F Part I(a)(3) – "Electrical System Components"
- Title 14 Code of Federal Regulations Part 25, Appendix F Part I(b)(7) – "Sixty Degree Test"
- Report DOT/FAA/AR-TN04/32 – "An Evaluation of the Flammability of Aircraft Wiring," Cahill, 2004
- Report DOT/FAA/AR-04/21 – "MIL-W-22759 Vertical Flammability Test Versu the 60 Degree Flammability Test," Gomez, 2004



Planning Process: Scope

WBS 1.1 Reviewed Historical Information

- Report DOT/FAA/AR–00/42, ‘‘Aircraft Materials Fire Test Handbook.’’ 2000
- Report DOT/FAA/CT-89/21 – “Flammability, Smoke, and Dry Arc Tracking Tests of Aircraft Electrical Wire Insulations” Cahill, 1989
- SAE Aerospace Standard AS4373, “Test Methods for Insulated Electric Wire.” 2007
- IEC 60332-1, “Tests on Electric Cables Under Fire Conditions – Part 1: Test on a Single Vertical Insulated Wire and Cable.”
- IEC 60332-3-10, “Tests on Electric Cables Under Fire Conditions – Part 3-10: Test for Vertical Flame Spread of Vertically-Mounted Bunched Wires or Cables – Apparatus


NORME INTERNATIONALE
CEI IEC
INTERNATIONAL STANDARD
60332-1-1
Première édition
First edition
2004-07
PUBLICATION GROUPÉE DE SÉCURITÉ
GROUP SAFETY PUBLICATION
Essais des câbles électriques et à fibres optiques soumis au feu –
Partie 1-1:
Essai de propagation verticale de la flamme sur conducteur ou câble isolé – Appareillage d'essai
Tests on electric and optical fibre cables under fire conditions –
Part 1-1:
Test for vertical flame propagation for a single insulated wire or cable – Apparatus
IEC
Numéro de référence
Reference number
CEI/IEC 60332-1-1:2004

International Electrotechnical Commission

Planning Process: Scope

WBS 1.1 Reviewed Historical Information

- "Assessing the Fire Performance of Electric Cables (FIPEC)" by P. Van Hees, and J. Axelsson, SP Sweden, S.J. Grayson and A.M. Green, Interscience Communications UK, H Breulet, ISSeP Belgium and U Vercellotti, CESI Italy
- Report Number UCRL-93936, "Procedure for Ranking Fire Performance of Electrical Cables" by Hasegawa, Staggs and Fernandez-Pello, 1986
- Federal Test Method Standard No. 228, "Cable and Wire, Insulated; Method of Testing,"1951

Planning Process: Scope

WBS 1.2 Meet with Stakeholders

- FAA Sponsor
- FAA Program Manager
- FAA Fire Safety Researchers
- International Aircraft Materials Fire Test Working Group
- OEMs
- Other

Planning Process: Scope

WBS 1.3 Define Fire Threat

- Report DOT/FAA/AR-99/44 – "Development of Improved Flammability Criteria for Aircraft Thermal Acoustic Insulation," September 2000
- And, Report DOT/FAA/AR-08/XX – "Development of Improved Flammability Criteria for Aircraft Ducting," 1st Qtr 2008
- **Fire Threat**: 101.6 by 101.6 by 228.6-mm Urethane Foam Block (Density: 16.02 kg/m^3)
- Environment:
  - ✓ Sea Level
  - ✓ Narrow-body attic
  - ✓ Insulation blankets in attic
  - ✓ Insulated duct in attic
  - ✓ Quasi-Std Ambient Temperature

Planning Process: Scope

WBS 1.4 Test Methods Selection

MEASUREMENT	MATERIAL TEST METHOD			
	60-Degree Bunsen Burner Test	Intermediate-Scale	Microscale Combustion Calorimeter	Radiant Heat Panel
Fire Propagation	●	●		●
Burn Area		●		
After Flame Time	●	●		●
Drip Flame Time	●			
Total Heat Release			●	
Heat Release Rate			●	
Onset Temperature			●	
Combustion Temperature			●	
% Char			●	

Planning Process: Scope: WBS 1.5 Material Selection

Item No.	Wire Specification	AWG	Insulation Material	Jacket Material	Temp Rating (degC)	Comments
1	Hitachi Riser Cable Cat 3		PVC	Fire Retardant Thermoplastic	60	Other Industry Usage
2	Hitachi Riser Cable (Cat 5e:)		Polyolefin	Fire Retardant Thermoplastic	60	Other Industry Usage; POLYOLEFIN: Polyethylene, Polypropylene, Cellular Polyolefin, Flame Retardant PE?
3	Computer Cable Polypropylene Insulated		Polypropelene	PVC	60	Other Industry Usage
4	M17/28-RG58 (Coaxial Cable Type IIIA)		PE	-	80	Other Industry Usage
5	Neoprene Hook-up Wire		Neoprene	-	90	Other Industry Usage
6	MS 5086/1 (~ BMS13-13)	20	PVC	Nylon	105	Past Aircraft Production
7	Fiber Optic Riser Cable		-	PVC	105	Other Industry Usage
8	Hypalon Hook-up Wire		Hypalon	-	105	Other Industry Usage
9	SAE AS 22759/14	20	Extruded FEP	PVDF	135	Past Aircraft Production
10	MS 22759/32	20	Zelrad 150-S, XL-ETFE	-	150	Current In-Flight Entertainment/Other Passenger Systems
11	BMS13-48 (~ MS 22759/34)	20	ETFE	-	150	Current Aircraft Production; Aircraft, In-Flight Entertainment/Other Passenger Systems
12	BMS13-60T01C01	20	Polyimide	PTFE	150	Current Aircraft Production
13	MS 81044/6 (~ BMS13-38)	20	Crosslinked Polyalkene	PVDF	150	Past Aircraft Production
14	MS 81381/21	20	Polyimide Tape	Polyimide Resin	150	Past Aircraft Production
15	Braidless Silicone 150 Lead Wire		Silicone Rubber	-	150	Other Industry Usage
16	SAE AS22759/33	20	Crosslinked ETFE Single Layer	-	200	Current In-Flight Entertainment/Other Passenger Systems
17	BMS13-55	20	Impregnated Inorganic Fiber	PTFE	200	Current Aircraft Production
18	BMS13-72	20	PTFE	FEP	200	Current Aircraft Production
19	SAE AS 22759/5	20	Extruded PTFE	-	200	Past Aircraft Production
20	SAE AS 22759/11	20	TFE	-	200	Past Aircraft Production
21	SAE AS22729 (MS 22759/86)	20	Composite: Fluoropolymer/Polyimide Tape	-	260	Current Aircraft Production; Current In-Flight Entertainment/Other Passenger Systems

Planning Process: Scope

WBS 1.6 Material Testing

- Tests to be conducted:
  - 60-Degree Bunsen Burner Test
  - Micro-scale Combustion Calorimeter
  - Intermediate-scale Fire Test
  - Radiant Heat Panel Test (Aircraft Ducting Version)
  - Other (as needed)
- Results will help rank materials based on their flammability characteristics.

Planning Process: Scope

WBS 1.7 Evaluate Test Methods

MEASUREMENT	MATERIAL TEST METHOD			
	60-Degree Bunsen Burner Test	Intermediate-Scale	Microscale Combustion Calorimeter	Radiant Heat Panel
Fire Propagation	●	●		●
Burn Area		●		
After Flame Time	●	●		●
Drip Flame Time	●			
Total Heat Release			●	
Heat Release Rate			●	
Onset Temperature			●	
Combustion Temperature			●	
% Char			●	

Current small-scale test measures:

- Fire Propagation (Burn Length)
- After flame time
- Drip flame time

Radiant heat panel test measures:

- Fire Propagation
- After Flame Time

Planning Process: Scope

WBS 1.8 Select/Modify Selected Test Method

- The Radiant Heat Panel (RHP) test machine is the platform currently used to test the flammability of aircraft thermo acoustic insulation materials and possibly, in the future, aircraft ducting.
- The RHP test machine will be evaluated to determine if it could be used as a testing platform for aircraft electrical wire bundles.
- If the RHP platform doesn't work out, another platform will be identified, evaluated, and selected.

Planning Process: Scope

WBS 1.9 Verify Test Method (Scope Verification)

• The results of the data obtained from the developed fire test method will be compared against the results obtained during the intermediate-scale fire test. Of interest, will be information about fire propagation and burning time.

Planning Process: Scope

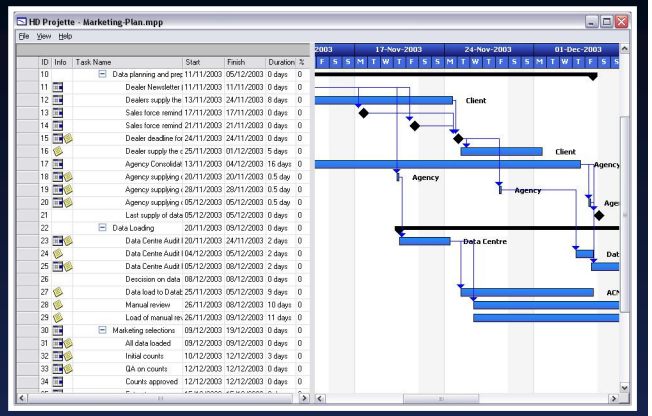
WBS 1.10 Publish Test Method

- Major Milestone
- Draft Final Report must be submitted by 30 June 2009

Planning Process

- TIME

- Project Activity Definition
- Project Activity Sequencing
- Project Activity Resource Estimate
- Project Activity Duration Estimate
- Schedule
  - Gantt Chart



-COST

- Estimating & Budgeting (TBD)

- QUALITY

- Material Inspection & Conditioning
- Systems/instrumentation calibrations
- Measurements Accuracy

Planning Process

-HUMAN RESOURCE

- Input from IAMFTWG task group members will be requested
- Work will be conducted by FAA Fire Safety Team & SRA technical staff
- Responsibility Assignment Matrix will be provided

- COMMUNICATIONS

- Informal Oral Presentations: FAA internal
- Formal Oral Presentations: IAMFTWG
- Informal Written (E-mails): FAA & IAMFTWG
- Final Formal Written Report

Planning

RISK PLAN

- FAA Safety Office
- OSHA
- Risk Mitigation/Response Plan
- Etc.

-PROCUREMENT PLAN

- Create list of required materials, equipment, and other resources
- Request sellers response
- Select vendors
- Purchase require resources

Final Words

Questions?

Anyone interested in joining this task group?

Contact:

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