Development of a Burnthrough Test Standard For Thermal Acoustic Insulation







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Manchester 737 Accident, 1985



Full-Scale Testing of Surplus Aircraft





DC-8 Aircraft





Full-Scale Burnthrough Test Rig



Full-Scale Testing at FAA Tech Center



Full-Scale Test Results Using Various Materials





Laboratory Scale Test Development



Finalized Test Frame





Finalized Test Rig



Lessons Learned

Primary Factors Critical to Accurate Results:

Method of Blanket Attachment

Proper Calibration, Set-up, and Operation of Test Equipment

Intake Air Velocity Measurement



Initial Blanket Attachment Method





Test Method Improvements

Arrangement of Calibrating Equipment

Individual Calibration Rigs allow precise measurement of heat flux and temperature.

Data Collection Procedure

Heat Flux and Temperature measurements taken at precise time, for specific period of time, to account for the build-up of soot.

Burner Hardware

Initially, a variety of internal components were possible. Standardization has improved inter-lab correlation considerably.

Burner Set-up

The exact configuration of the internal components has a marked effect on the flame, and hence, the test results.



Correlation Using 6 GPH Burner (Full-Scale vs. Lab-Scale)





Round Robin Testing

Objective:

To identify and correct problems with proposed burnthrough test equipment to ensure inter-lab agreement

Methodology:

Prove similarity of test equipment between labs through testing of identical samples

Participants:

7 Domestic Labs, 3 European Labs

Status:

5 round robins completed

Round Robin 6 in progress











Failure Range (Seconds)



Failure Range (Seconds)





Decreasing Standard Deviation Trend Result of:

Standardization of Calibration and Test Procedures

Standardization of Test Burner/Apparatus

Overall Increased Familiarization with Proposed Test Method



Burnthrough Test Method Advisory Circular

Burnthrough Test Method Advisory Circular

AC is neither mandatory nor regulatory.

AC describes acceptable means, but not the only means, for demonstrating compliance.

The FAA will consider other methods of demonstrating compliance.

AC does not...

Change,

Create any additional,

Authorize changes in,

Permit deviations from,

... the regulatory requirements.



Conduct laboratory scale tests to investigate installation requirements

Overlap at vertical formers

Overlap at horizontal seams

Attachment Methods

Typical Airframe Construction



Blanket Overlap at Vertical Former

Gaps in insulation = potential fire entry route into cabin,

Insulation bags should completely cover the former,



Blanket Overlap at Vertical Former

A minimum overlap of 2 inches should be used,

Overlaps greater than 2 inches will provide greater protection times.







Minimum of 6 inches required to achieve satisfactory results,

Upper blanket should overlap lower blanket, W.R.T. fuselage interior,

Joints sealed with fire resistant tape, mechanical fastener, or other suitable means,

Overlapping of blankets not recommended at extreme fuselage bottom.





Horizontal Overlap Testing





Penetration of thermal acoustic liners should be avoided wherever possible,

Attachments that do not penetrate the liners are preferred (over-frame clips),

Attachments that provide good mechanical retention of thermal acoustic liners are more likely to provide good burnthrough protection.

Attachment methods that penetrate the insulation bag should be fire resistant,

Attachment pitch should be maximum of 14 inches,

Attachments should be installed as far away from skin as possible (min 1 inch).



Over-Frame Attachments

Definition: Attachments that do not penetrate the frame, but provide attachment for the insulation bags by clipping them over the top of the frame. The material of such clips and their pitch should provide good retention of the thermal acoustic liners. A maximum pitch of 14 inches for these attachments has been demonstrated to be acceptable.





The oil burner test described in Appendix F, part VII to part 25 is intended to represent the temperature and heat flux typical of a post crash fire. However, the scale of the test method does not replicate the scale of an actual fire. In addition, the test stand incorporates steel components to facilitate repeat testing.

It is therefore not necessarily adequate to simply incorporate a novel feature or design concept into the test burner stand to verify its acceptability. In some cases, larger scale testing will be required to support development of special conditions, and in other cases the test burner may be acceptable with slight modification to the sample holder (aluminum former & stringers).



The Advisory Circular assumes an encapsulated batting concept with respect to substantiation of installation details. Other concepts, such as foam blocks or spray-on applications, have not been investigated to the same extent, and reliable substantiation methods for installation have not been developed.

It would therefore be necessary to conduct realistic testing on these types of materials in order to establish guidance for their installation. Specifics regarding the amount of overlap, for example, are likely to be different.



Methods of attachment that vary significantly from those typically used will require substantiation with more representative fixturing. For example, a hook and pile type attachment would require substantiation by test, but could probably be accomplished using the test burner, with appropriate modification to the sample holder.



If the test fixture needs to be modified in order to generate meaningful test data, the existing vertical steel former is replaced with an aluminum former. Similarly, two of the steel horizontal stringers are replaced with aluminum stringers.

This methodology allows the aluminum members to melt and fail with the realism of an actual aircraft fuselage during a postcrash fire scenario. Under these conditions, not only are the blanket materials being tested, but rather the ability of the insulation system at preventing flame penetration is examined.





Steel Test Sample Frame





Modified Sample Frame w/Aluminum Members

Modified Test Sample Frame





Modified Test Frame w/Aluminum Members





The following 2 schematics are representations of systems that have been tested using actual aircraft structure and found to satisfy the requirement. These schemes are suitable for demonstration in the test rig, as defined in Appendix F, part VII, to part 25. Variations from the representations shown that would make the installation more critical (for example, increased fastener pitch) should be assessed using the fixture modification described previously.

Combination Fiberglass/Replacement Batting System



Barrier Material Used in Conjunction With Fiberglass





Continue lab-scale testing in support of advisory circular

Complete present round robin test series; analyze data

Continue visiting laboratories to observe operation of test equipment

Development of a "no-moving-parts" intake air measurement system

Development of a standardized burner for this and other FAA tests



The Fourth Triennial International Aircraft Fire and Cabin Safety Research Conference