DEVELOPMENT OF LIGHTWEIGHT, FIRE-RETARDANT, LOW SMOKE,
HIGH STRENGTH, THERMALLY STABLE AIRCRAFT FLOOR PANELING

Roy A. Anderson and Richard J. Karch
Boeing Commercial Airplane Company
Seattle, Washington 98124
DEVELOPMENT OF LIGHTWEIGHT,
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HIGH STRENGTH, THERMALLY STABLE
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By

Roy A. Anderson and Richard J. Karch

BOEING COMMERCIAL AIRPLANE COMPANY
P.O. Box 3707
Seattle, Washington  98124
This presentation describes Boeing's participation in a NASA-funded program (FIRMEN) to develop materials for use as floor panels possessing flammability, smoke and toxicity (FS&T) characteristics superior to current materials. The objectives of the program are to develop an aircraft floor paneling suitable for high traffic areas, e.g., aisle or galley and to install and certify the panel in a commercial aircraft for service evaluation.

The development of a light weight, fire-retardent, low smoke, high strength, thermally stable aircraft floor panel has been completed. The service evaluation of a panel in a commercial aircraft is in progress and scheduled to be completed in March 1978.
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AIRCRAFT FLOOR PANELING

NAS 9-15062
INTRODUCTION

PRESENT AIRCRAFT FLOORING

FACE SHEET

HONEYCOMB CORE

BONDING MATERIAL

COMPLETED SANDWICH STRUCTURE
INTRODUCTION

PRESENT AIRCRAFT FLOORING

- FACE SHEETS - Epoxy impregnated unidirectional fiberglass
- ADHESIVE - Epoxy resin
- CORE - Phenolic/nomex honeycomb core
INTRODUCTION

- CONTRACT NAS 9-14753 - PRIMARY OBJECTIVES
  - INCREASE FIRE RESISTANCE
  - LESS SMOKE AND TOXICANTS
  - INCREASE BURN THROUGH RESISTANCE

- CONTRACT NAS 9-15062 IS A FOLLOW ON TO NAS 9-14753
INTRODUCTION

FLOOR PANEL EVALUATION

- FLAMMABILITY, SMOKE AND TOXICITY TESTS (F, S&T)
- MECHANICAL STRENGTH TESTS
- HUMIDITY RESISTANCE TESTS
INTRODUCTION

- NAS 9-15062 PRIMARY OBJECTIVES
  - DEVELOP A HIGH-TRAFFIC PANEL
  - IMPROVE BURN THROUGH RESISTANCE
  - SERVICE TEST (Five year flight test)
INTRODUCTION

NAS 9-15062 - STATUS

- SERVICE EVALUATION PANEL HAS BEEN PROVIDED TO UNITED AIRLINES
- PANELS HAVE BEEN PROVIDED FOR LARGE SCALE TESTING IN SUPPORT OF CONTRACT NAS 9-15168
- LABORATORY TEST SPECIMENS HAVE BEEN PROVIDED IN SUPPORT OF CONTRACT NAS 9-15168
INTRODUCTION

PRESENTATION OBJECTIVES

• APPROACH USED TO DEVELOP THE SERVICE EVALUATION PANEL
• SELECTED TEST RESULTS
• CONCLUSIONS
INTRODUCTION

APPROACH

- SCREENING TESTS (14 candidates)
- VERIFICATION TESTS (3 candidates)
- END ITEM FABRICATION (1 system)
APPROACH

○ SCREENING TESTS - FLAMMABILITY

• VERTICAL BURN (12 & 60 second FAR 25-32)
• BURN THROUGH (10 minute exposure)
• SMOKE DENSITY \( D_s \) at 1.5, 4 minutes and maximum
• TOXIC GAS EMISSION \( (\text{HCN, HCl, HF, CO, SO}_2, \text{ & NO}_x) \)
• OXYGEN INDEX TESTS \( (\text{LOI}) \)
• CHEMICAL PROPERTIES \( (\text{TGA}) \)
APPROACH

○ SCREENING TESTS - MECHANICAL STRENGTH/DURABILITY

- IMPACT (flat point dart test)
- FATIGUE (food roller cart)
- WEIGHT
- FLEXURE (long beam and short beam)
RESULTS

- SCREENING TEST RESULTS (3 MOST SATISFACTORY CANDIDATES)
  - NORDAM CONSTRUCTED
  - AIR LOGISTICS CONSTRUCTED
  - BOEING CONSTRUCTED
APPROACH

- VERIFICATION TESTS - FLAMMABILITY
  - SCREENING TESTS
  - HORIZONTAL BURN
  - FLAMMABILITY PROPERTIES (Lennox oil burner)
INTRODUCTION

○ NAS 9-14753 - CONCLUSIONS AND RECOMMENDATIONS

● EXPERIMENTAL FACE SHEETS, ADHESIVES, AND CORE SYSTEMS CAN BE DEVELOPED INTO A SATISFACTORY FLOOR PANEL

● ADDITIONAL FLAMMABILITY AND MECHANICAL TESTING IS REQUIRED

● SERVICE EVALUATION IS REQUIRED
APPROACH

○ VERIFICATION TESTS - MECHANICAL STRENGTH/DURABILITY

○ SCREENING TESTS
○ WARPAGE
○ PEEL (rolling drum)
○ INSERT PULL OUT
○ PANEL IN-PLANE SHEAR
APPROACH

O VERIFICATION TESTS - HUMIDITY EXPOSURE

• WEIGHT GAIN

• PEEL (rolling drum)

• FLEXURE (long beam and short beam)
RESULTS

VERIFICATION TEST RESULTS (ONE PANEL FOR END ITEM FABRICATION)

BOEING CONSTRUCTED

FACE SHEETS - Modified phenolic impregnated unidirectional S-glass (Deco XMP-100)

ADHESIVE - Modified phenolic film (Narmco 9252)

CORE - Phenolic/nomex honeycomb (Orbitex) filled with polyimide foam (Solar)
RESULTS

TEMPERATURE AT 10 minutes (°F)

BOEING BURN THROUGH
LENNOX OIL BURNER
BURN THRU TEST PANEL #54
2000°F

Δ = FLAME QUIT

PANEL BACKFACE TEMP., °F X 10

TIME, min
LENNIX OIL BURNER
BURN THRU TEST PANEL #76
2000°F OIL BURNER BLOWER

FLAME TEMPERATURE, °F

BACKFACE TEMPERATURE, °F X 10

TIME, min

120
LENNOX OIL BURNER
BURN THRU TEST PANEL #68
2000°F OIL BURNER BLOWER AT 3.5 INCHES FROM FACE

FLAME TEMPERATURE °F
AT START

BACKFACE TEMPERATURE, °F X 10

TIME, min
RESULTS,

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<tr>
<th></th>
<th>128 lb/wheel</th>
<th>158 lb/wheel</th>
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<tbody>
<tr>
<td>AIR LOGISTICS</td>
<td>NO FAILURE</td>
<td></td>
</tr>
<tr>
<td>NORDAM</td>
<td>NO FAILURE</td>
<td></td>
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<td>BOEING CONSTRUCTED</td>
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ROLLER CART REVOLUTIONS X 10^-3

0 30 60 90 120 150 180
CONCLUSION

- A LIGHTWEIGHT, FIRE-RETARDANT, LOW SMOKE, HIGH STRENGTH, THERMALLY STABLE AIRCRAFT FLOOR PANEL CAN BE CONSTRUCTED FOR UNDERSEAT AND HIGH TRAFFIC AREAS.