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JUN 80 J H ENDERS, E C WOOD
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U.S. Department of Transportation
Federal Aviation Administration

Special Aviation Fire and Explosion Reduction (SAFER) Advisory Committee

Office of Aviation Safety
Washington, D.C. 20591

Final Report
Volume IIB

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June 26, 1978 through
June 26, 1980

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16. Abstract

The Special Aviation Fire and Explosion Reduction (SAFER) Advisory Committee and its technical supporting groups spent nearly 13 months from May 1979 through June 1980 examining the factors affecting the ability of the aircraft cabin occupant to survive in the post-crash fire environment and the range of solutions available.

Presentations were made to the SAFER Committee by Committee members, technical supporting groups, the FAA, citizens and private firms. The broadly-constituted body of information developed and presented to the Committee formed the basis for Committee Findings and Recommendations.

This Volume contains the summary of the proceedings of the SAFER Committee, FAA's responses to the recommendations, pertinent correspondence and information on crew protection and passenger evacuation.

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(Documents are in order of appearance)

SUMMARY OF PROCEEDINGS

SAFER Advisory Committee Meeting of May 10-11, 1979
Washington, D.C.

A. Welcome address by Mr. Charles Foster, FAA's Associate Administrator for Aviation Standards, in which he outlined the events leading up to the formation of the SAFER Advisory Committee and set forth the tasks that the Committee was charged with, namely:

- By October 1, 1979, the Committee is to recommend to the Administrator specific regulatory action (within the Committee's scope) that can be taken on the basis of present-day technical knowledge and that could contribute significantly to safety.

- By June 26, 1980 (the termination date of the Committee) the Committee is to recommend to the Administrator ways to improve occupant survivability in the post-crash environment.

Mr. Foster also emphasized that the Committee was an independent body, in no way controlled by the FAA. To preserve this independence, FAA employees would not serve in the capacity of Committee Chairperson or Technical Group Leader. For this meeting only, Mr. Foster appointed Mr. J. O. Robinson, an FAA member of the Committee, as Temporary Chairperson.

B. Committee ground rules. The Temporary Chairperson announced several ground rules for the Committee's activities:

- All meetings will be open to the public, on a space available basis.

- A nonmember may make an oral statement at a meeting if he requests permission from the Executive Director not later than the day before that meeting. He may submit a written statement at any time.

- A member who is unable to attend (and who has no approved alternate) may designate another person to speak for him at that meeting. This person must be designated by letter to the Executive Director before the meeting.

- Each meeting of the Committee will be recorded by a court reporter. A verbatium transcript will be placed in the Committee's files.

- At the end of each Committee meeting, a draft summary of the Committee's proceedings will be discussed and revised as necessary by the Committee. A copy of that summary will be sent to each interested person.

C. Scope of the Committee. The Temporary Chairperson, on behalf of the FAA members, proposed the following scope for the Committee's activities:

- That the Committee confine itself to transport category airplanes.

- That, with respect to such airplanes, the Committee confine itself primarily to the post-crash fire issues discussed at the June 1977 public hearing on fire and explosion hazard reduction and at the November 1977 public hearing on compartment interior materials.

- That, when considering compartment interior materials issues, the Committee also consider the matter of carry-on materials (i.e., baggage, clothes, periodicals, etc.) and the fire-resistance of emergency evacuation slides.

- That other issues be considered only if they are comparably significant and directly related to the post-crash situation.

Several members suggested that the last element of the FAA proposal might lead the Committee into consideration of numerous issues (such as emergency evacuation criteria, crew training, etc.) concerning which the Committee has no expertise. It would be better, they believed, to spend the short time available on the basic issues, i.e., post-crash fire and compartment interior materials. Other members contended that the last element of FAA's proposal provided a needed flexibility in the deliberations of the Committee, that it should be free to consider other issues it believes comparably significant and directly related to the post-crash fire situation. After further discussion, it was the sense of the Committee that FAA's proposal be accepted, with the understanding that any "other issue" dealt with must not compromise accomplishment of the Committee's basic task.

D. Organization plan. The Temporary Chairperson, on behalf of the FAA members, proposed the following organization plan for the Committee:

1. That the 23 selected members/alternates be identified collectively as the "SAFER Advisory Committee," or simply the Committee.

2. That the Committee serve as the decision-making body which will ultimately determine what recommendations will be submitted to the Administrator.

3. That the Committee, at its first meeting, establish SAFER Technical Groups to provide technical expertise in at least the following general areas:

   - Post-crash fuel-fire hazard reduction.

   - Compartment interior materials (including the matter of carry-on materials and the fire resistance of emergency evacuation slides).

4. That, in general, the members of each SAFER Technical Group be drawn from the roster of applicants who responded to FAA's June 1978 notice inviting participation. FAA proposes the persons on the attached lists (Enclosures A & B) as members of the two SAFER Technical Groups identified above.

5. That a Group Leader be elected by the members of the Committee for each Technical Group established.

6. That the Committee's Executive Director, in collaboration with the appropriate SAFER Technical Group Leader, determine the time and place of each group meeting and notify all interested persons.

7. That the Committee, at each of its meetings, provide guidance and direction to each SAFER Technical Group and assign such specific tasks as it deems necessary.

8. That each SAFER Technical Group Leader attend each meeting of the Committee to report on the activities of his Group and to receive instructions from the Committee.

A member suggested that the term "fuel-fire" in the third item of the proposal would exclude consideration of other flammable fluids in the post-crash environment. The Committee agreed that the word "fuel" should be eliminated from the title of that Technical Group. Several members suggested that the proposed Technical Groups did not provide adequate expertise in certain technical areas and should be expanded accordingly. There was no objection from the Committee, and the Temporary Chairpersons asked that each person wishing to join a Technical Group write to the Executive Director, identifying that Group and explaining why his services would be needed.

A member suggested that a mechanism be provided to furnish a summary of R & D programs (both in industry and in government) now underway, to assist the Technical Groups. The AIA (for industry), NASA (for U. S. government), and FAA (for international R & D) agreed to accept this assignment.

E. Work plan. The Temporary Chairperson proposed the following general work plan for the Committee and its Technical Groups:

1. Review and update the service record, to gain insight into what our current safety problems actually are. The situtation may have changed since the 1977 public hearings.

2. Assess the adequacy of pertinent FARs, and propose rulemaking actions (changes or additions to current rules) which are within the state-of-the-art and are adequately supported. The Committee should, by October 1, 1979, determine whether the state-of-the-art would allow the early adoption of upgraded standards within its areas of concern.

3. Assess pertinent FAA-funded and FAA-conducted R & D programs (both those completed and those currently underway) in terms of their potential contribution to safety. On the basis of this assessment, determine --

- With respect to completed programs, whether the R & D findings warrant rulemaking action or the publication of guidance material;

- With respect to programs underway, whether they should be continued to completion, redirected along potentially more fruitful lines, or aborted altogether: and

- The need for new R & D programs.

4. Assess other pertinent government and industry R & D programs (both those completed and those underway) to determine --

- With respect to completed programs, whether R & D findings warrant rulemaking or other action by FAA; and

- With respect to programs underway, whether they warrant FAA support.

5. By October 1, 1979, submit a preliminary report containing the Committee's recommendations for early adoption of new or revised standards within its area of concern.

6. By June 26, 1980, prepare a final report describing the work of the Committee, outlining its findings and conclusions, and setting forth its recommendations to the Administrator for specific action.

Concerning the 5th item of the proposed work plan, several members raised the question whether the Committee had the alternative of concluding (after study) that there was no justification for early adoption of new or revised standards. The Temporary Chairperson stated that the FAA had no preconceived ideas as to what the Committee ought to recommend for any item in the proposed work plan.

F. Current status of R & D efforts and available funding. Oral presentations on this subject were made by the following persons:

- Charles W. McGuire - DOT - Office of Environment & Safety
- Joseph M. Del Balzo - FAA - National Aviation Facilities Experimental Ctr.
- Douglas E. Busby, M.D. - FAA - Office of Aviation Medicine
- John H. Enders - National Aeronautics & Space Administration
- Clayton Huggett - National Bureau of Standards

- Benito P. Botteri - Wright-Patterson AFB
- Lyle Wright - Aerospace Industries Assoc.

G. Election of the permanent Chairperson of the Committee. The following members were nominated as the permanent Chairperson, subject to approval by the Administrator:

- Lowell R. Perkins (who declined)
- James O. Robinson (who declined)
- S. Harry Robertson (who declined)
- John H. Enders (elected)

H. Election of the Technical Group Leaders. The following persons were nominated by the members:

- For the SAFER Technical Group on Post-Crash Fire Hazard Reduction: Mr. B. P. Botteri and Mr. E. G. Versaw. Mr. Botteri declined and Mr. Versaw was elected.

- For the SAFER Technical Group on Compartment Interior Materials: Mr. M. E. Wilfert and Mr. Sanford Davis. When the initial vote ended in a tie, a member suggested another vote on the basis that the winning nominee would serve as Group Leader and the other nominee would serve as Deputy Group Leader. The Committee agreed. Mr. Wilfert was elected as Group Leader. Mr. Davis will serve as Deputy Group Leader.

I. Oral Statements. The Temporary Chairperson recognized two nonmembers who made oral statements as follows:

- Edward Graham, of the Airline Safety Equipment Co., on aircraft compartmentation.
- Robert Mitchell, of LISI America, on ISOPHENOL - a rigid foam with a base of phenolic resins.

J. First Technical Group Meetings. The Executive Director, after consulting with the newly elected SAFER Technical Group Leaders (E. G. Versaw and M. E. Wilfert), announced a tentative agreement to convene a back-to-back meeting of both Technical Groups at FAA's NAFEC facility during the week of June 25, 1979. A formal announcement will be prepared by the Executive Director, published in the Federal Register, and distributed to all interested persons.

K. Members, Alternates, and Authorized Substitutes who participated in the meeting:

- E. L. Thomas, member
- J. P. Reese, member
- B. V. Hewes, member
- C. F. Hitchcock, member
- S. J. Green, member

- G. N. Goodman, member
- C. Huggett, member
- J. H. Enders, member
- L. R. Perkins, member
- J. M. Del Balzo, member
- J. O. Robinson, member and Temporary Chairperson
- D. E. Busby, member
- C. W. McGuire, member
- S. H. Robertson, member
- J. A. Bett, member
- J. E. Dougherty, member
- W. F. Fanning, member
- B. Webster, authorized substitute for E. L. Hutcheson
- G. E. Hartzell, authorized substitute for M. Goland
- D. R. Moir and N. Bennett, authorized substitutes for F. Slater
- [illegible] Fodolak, authorized substitute for D. E. Busby
- G. Bates, authorized substitute for J. M. Del Balzo
- R. W. Clarke, alternate for B. V. Hewes

L. Nonmember attendance. Other than members, alternates, and authorized substitutes, there were 5[illegible] persons in attendance at the meeting. Of these, nine were FAA employees.

M. Agenda, time, and place for the next meeting of the SAFER Advisory Committee. After some general discussion, it was agreed that action on this item would be deferred until the Technical Groups meet late in June. Mr. Enders, who plans to attend those meetings, will, at that time (in consultation with the Executive Director) determine the agenda, time, and place of the next SAFER Advisory Committee meeting, probably in late summer

Prepared By: Irving Fagin 5/14/79

Irving Fagin, Executive Director

Approved By: [signature]

James O. Robinson, Temporary Chairperson

Selected Membership for SAFER Technical Group on Post-Crash Fire Hazard Reduction

Name	Affiliation
Thomas G. Horeff	FAA; AFS-140
Robert Salmon	FAA-NAFEC; ANA-420
Alt. - Thor Eklund	
Richard A. Kirsch	FAA; ARD-520
Benito P. Botteri	Wright-Patterson AFB
Joseph T. Leonard	Naval Research Lab.
Charles M. Pedriani	USARTL, Fort Eustis
Alt. - Richard E. Bywaters	
Solomon Weiss	NASA; Lewis Research Center
Lyle A. Wright	Douglas Aircraft Co. (AIA)
Alt. - A. T. Peacock	
Don C. Nordstrom	Boeing Comm. Airplane Co.(AIA)
Edward G. Versaw	Lockheed-California Co. (AIA)
Tom W. Reichenberger	Gates Learjet Corp. (AIA)
N. R. Parmet	Trans World Airlines (ATA)
Elliot Nichols	Piper Aircraft Corp. (GAMA)
Alt. - A. Weiser	
Donald F. Thielke	Flight Engineers Int'l. Assoc.
J. D. Galloway	Uniroyal. Inc.
George J. Grabowski	Fenwal, Inc.
Lester Hebenstreit	Walter Kidde and Co.
Cleve C. Kimmel	Parker Hannifin Corp.
Alt. - At Lothrigel	
Scott A. Manatt	AiResearch Mfg. Co. of Calif.
Ira J. Rimson	System Safety Associates
H. D. Smith	Goodyear Aerospace Corp.
E. Philip Webb	Firestone Coated Fabrics Co.
Gerrit J. Walhout*	NTSB
Alt. - Matthew M. McCormick*	

* Observer only

Enclosure 3

Selected Membership for SAFER Technical Group on Compartment Interior Materials

Name	Affiliation
Robert Allen	FAA AFS-120
Henri Branting	FAA AFS-120
Charles R. Crane	FAA AAC-114
Richard [illegible] Kirsch	FAA ARD-520
Constantine Sarkos	FAA NAFEC
[illegible] Bara	Boeing Commercial Airplane Co. (AIA)
J. J. Fargo	Lockheed-California Co. (AIA)
M. E. Wilfert	Douglas Aircraft Co. (AIA)
John [illegible] Simon	Gates Learjet Corp. (AIA)
Robert Madding	Cessna Aircraft Co. (GAMA)
Arvin D. Delman	The Wool Bureau Inc.
William C. Long	Man-Made Fiber Producers Assoc.
C. L. Nelson	General Electric Co.
George B. Wear	General Tire and Rubber Co.
R. C. McAlister	Celanese Fibers Marketing Co.
Dale G. Ondecak	John Schneller and Associates
C. [illegible] May	Delta Air Lines (ATA)
Richard Bricker	NASA, Johnson Space Center
John A. Parker	NASA, Ames Research Center
D. [illegible] Thielke	Flight Engineers Int'l. Assoc.
Gerrit J. Walhout*	NTSB
Alt. - Matthew M. McCormick*	

* Observer only

SUMMARY OF PROCEEDINGS

SAFER Technical Group on Compartment Interior Materials
Meeting of June 26-27, at NAFEC

A. The Group was welcomed by Mr. Joseph Del Balzo, Acting Director of the National Aviation Facilities Experimental Center (NAFEC). Mr. John H. Enders, Chairman of the basic SAFER Advisory Committee, followed with an outline of the events leading up to formation of the SAFER Technical Group on Compartment Interior Materials. The Executive Director then introduced Mr. Martin E. Wilfert and Mr. Sanford Davis, the elected Group Leader and Deputy Group Leader, respectively, for this Group. For the remainder of the meeting (which was tape recorded), Mr. Wilfert presided.

B. Ground rules. The Group Leader announced several ground rules for the Group's activities, as follows

1. This meeting, and all subsequent meetings of the Group will be open to the public on a space-available basis.

2. A nonmember may make an oral statement before the Group if he asks permission from the Executive Director not later than a day before the meeting, and is recognized by the Group Leader. A nonmember may make a written statement to the Group (via the Executive Director) at anytime.

3. All members will have an equal say on what the Group will recommend to the basic SAFER Advisory Committee.

4. Sub-groups will be formed to study particular issues. Each will consist of members, and other interested persons, selected by the assigned sub-group chairman.

C. Scope and objectives. The Group Leader introduced a proposed "Scope of Activities" (Enclosure I) containing suggested initial and long-term objectives. After some discussion, the Group accepted the proposal with a number of minor changes (shown as inked revisions on Enclosure I).

D. Review and update of the pertinent service record. H. Branting presented several charts (Enclosure II) providing data on impact-survivable aircraft fire accidents (air carrier) during 1964-1978. During that period there were 31 such accidents world-wide with 1500 fatalities, of which 594 were believed to have been caused by fire. E. Bara questioned whether these 594 (estimated) deaths by fire had been verified, since impact could have been the cause of death. H. Branting indicated that the estimates were made by the NTSB, based on post-mortem examinations. E. Bara then asked whether any of the "fire" deaths could be attributed to interior materials rather than to the post-crash fuel fire itself. C. Sarkos estimated that about one-third of the fire fatalities during the 1965-1974 interval were attributable to interior materials, based on his engineering analysis of the available data, including toxicologic information. He also suggested that the Group ought not confine itself to accident statistics but should also consider the future potential for fire accidents. Other members disagreed with this view, contending that future design (and even prospective research programs) must be based on concrete evidence derived from actual service experience.

After some additional discussion, the Group agreed (in response to a proposal by E. Bara) to set up a sub-group to study the accident record to determine how many fire-related deaths were, in fact, attributable to interior materials, and how many of the total deaths in survivable accidents were, in fact, fire related. The Group Leader assigned S. Davis as Chairman of that sub-group and authorized him to solicit the services of others (members or nonmembers) to assist in the work (see Enclosure VII).

E. Assessment of the adequacy of pertinent Federal Aviation Regulations (FAR's).

1. Cabin materials fire safety; key issues. H. Branting suggested that the key regulatory issues involving cabin interior materials were as follows:

- In the post-crash fire environment, how much of the hazard, or threat to survival, can be attributed to burning cabin interior materials and how much to burning spilled fuel?

- If burning cabin interior materials present a significant threat, what is the relative significance (to fire safety) of materials properties such as flammability, smoke emission, and toxic gas emission? This involves a trade-off since a material's resistance to burning is often gained at the expense of increased smoke and toxic gas emission.

On the matter of trade-off, a member pointed out that in many instances a material's flammability characteristics can be improved without increasing smoke or toxic gas emission.

J. Parker suggested a ranking of the hazards associated with a post-crash materials fire (assuming that the fuel fire has penetrated the cabin) in the following order: flash fire; smoke and toxic gas emissions; effect on evacuation capability; long-term physical effects on occupants.

2. Current airworthiness rules covering compartment interior materials. H. Branting introduced this item, noting that the current rules applicable to passenger and crew compartments are contained in FAR 25.853 (Enclosure III). These rules specify simple bunsen burner tests for flammability, varying in severity with the manner in which the material is used in the cabin. FAR 25 also contains similar test standards for materials used in cargo and baggage compartments and for electrical wiring.

Discussion by the Group led to the conclusion that current FAR's deal primarily with the in-flight fire condition, since material properties relating to the post-crash fire condition (flash-fire potential, smoke/toxic emissions, lachrymal effects, etc.) and to the probability of escaping are not specified. It was the sense of the Group that its activities should include an evaluation of the need to specify material properties for the post-crash fire condition.

3. Fire protection of emergency evacuation slides. H. Branting raised the question whether there is a need to improve the fire resistance of emergency evacuation slides (deployed and inflated) when exposed to post-crash fuel fire, either by convection or by radiation. A member noted that current FAR standards do specify a flammability test for such slides, but that this test does not assure safe slide performance in the post-crash fire condition. It was agreed that the Group would look into the need for additional standards.

4. Flammability of passenger carry-on articles. H. Branting suggested that the Group assess the significance, as potential fuel sources in a post-crash fire, of passenger carry-on articles such as clothing, baggage and reading material, and determine whether fire-safety standards should cover these materials. He noted that certain carrier-furnished articles, such as blankets, pillows and head-rest covers, should also be considered from this standpoint. E. Bara suggested further that baggage in the cargo compartment should also be considered in this context. C. W. McGuire proposed including materials being shipped. The Group agreed that each of these potential fuel sources warranted study. As a related item, H. Branting distributed a briefing memorandum (Enclosure IV) dealing with proposed flammability standards for flight attendant uniforms.

5. Effects on in-service deterioration of the fire resistance characteristics of materials. H. Branting noted that there had been instances of materials which failed to meet their applicable flammability standards after some time in service, apparently because of aging and deterioration. He suggested that the Group investigate this problem and develop appropriate standards and practices suitable for industry-wide application. D. Onderak observed that there were practical difficulties in retesting materials, since detailed records would have to be kept on the actual exposure to wear, laundering, refurbishing, etc., to ensure that the test is meaningful. J. Parker questioned whether retesting to the current flammability standard would be meaningful with respect to the hazards of concern to the Group; namely, flash-fire potential and smoke/toxic-gas emissions. A. Delman suggested that materials could be tested to determine whether laundering (or dry-cleaning) degraded their flammability characteristics. Two members, representing aircraft manufacturers, stated that their company's materials specifications included provisions for testing after laundering and dry-cleaning.

J. Parker pointed out that there were widely-used cabin interior materials other than fabrics or carpets that could age to the extent that their performance in a post-crash fire would be degraded. Such aging could be caused by exposure to altitude and temperature. It was the sense of the Group that there was a need to look into these matters.

F. Review of current R & D programs.
Presentations were made on this subject by the following members:

1. C. Sarkos: "FAA-NAFEC R & D Programs on Cabin Fire Safety."

2. J. Enders: "Status Report on NASA Aircraft Fire Safety Research."

3. E. Bara: "Industry IRAD and CRAD Programs."

4. R. Kirsch: "International Cooperation on Aircraft Fire Safety Programs."

There ensued at this point a discussion on whether there were any short-term solutions to the cabin interior materials problem. E. Bara contended that there was at present no practical way of predicting, by laboratory tests, the safety performance of an interior materials configuration in the full-scale post-crash fire environment, and that the Group was not likely to devise one by October 1. J. Parker agreed, but suggested that there were materials within the state of the art today which, on the basis of laboratory tests alone, have been shown to be capable of significant hazard reduction. He referred specifically to new materials that have lower flash-fire potential, and to a window material with greater resistance to fire penetration. M. Salkind, referring to an earlier statement by another member concerning the improved fire-safety record shown by wide-body transport airplanes, suggested that the materials standards responsible for that improvement might be recommended by the Group as a short-term action.

G. Discussion of the need to redirect or modify existing R & D programs.
The Group Leader noted that the Group could not properly evaluate existing R & D programs without consulting with the various organizations (including the materials industry) that were engaged in these programs. Since this consultation would require more time than available at this meeting, he proposed establishment of an "R & D Review Sub-Group," chaired by M. Salkind, to look into this item and to report back to the Group at its next meeting. The Group agreed (see Enclosure VII).

H. Discussion of whether the state of the art would warrant short-term rule making, or other action within the Group's area of concern. C. Sarkos proposed that the Group consider for this purpose an "interim standard" (Enclosure V) developed recently by FAA technical people. A. Delman cautioned that ASTM test procedures were subject to change; if used, the date should be specified. He also questioned whether the modified NBS chamber test had adequate reproducibility, whether tests using animals (for determining toxic emission effects) were practical for routine use; and whether the combustion chamber tube method might provide misleading data with respect to the emission of HCN from materials that have no nitrogen in their molecular structure. J. Parker expressed concern that the proposed interim standard might eliminate good commercially-available materials. G. Nelson considered that a set of interim standards for early adoption could be developed by the Group based on the bunsen burner vertical test, the ASTM E-162 radiant panel test, and the NBS smoke chamber test at 2 1/2 watts. He believed, however, that other elements of C. Sarkos's proposal were still experimental.

H. Branting continued with a proposal (Enclosure VI) concerning the applicability of the interim standards proposed by C. Sarkos. Several members contended that it would be inappropriate to consider questions of applicability until the proposed interim standard (as well as other proposals) was evaluated and that there was not enough time left before October 1 to consider both the interim standard and its applicability. G. Nelson suggested that the Group take advantage of nonaviation experience with standard materials tests, since their use has significantly improved the fire safety of interiors. The Group Leader proposed that the interim standard issue be reviewed in depth by a "Short-Time Action Sub-Group" co-chaired by E. Bara and H. Schjelderup, and supported by the members designated in Enclosure VII. The co-chairman could solicit the services of other members, and also nonmembers, at their discretion. The Group Leader charged with the sub-group with two major tasks:

1. Advise as to what can be done in the short-term (subject to the October 1 deadline); and

2. Establish a draft list of long-term objectives aimed at increasing survivability in the post-crash fire environment.

I. <u>Members, Alternates, and Authorized Substitutes</u> who participated in the meeting:

- E. Bara, member
- H. P. Branting, member
- C. R. Crane, member
- S. Davis, Deputy Group Leader
- A. D. Delman, member
- J. J. Fargo, member
- R. G. E. Furlonger, observer
- J. R. Gibson, member
- R. A. Kirsch, member

- W. C. Long, member
- R. Mudding, member
- J. May, member
- K. C. McAlister, member
- C. W. McGuire, member
- G. Nelson, member
- D. Onderak, member
- J. A. Parker, member
- J. D. Ray, member
- C. Sarkos, member
- M. Salkind, member
- H. C. Schjelderup, member
- J. D. Simon, member
- D. R. Spicer, member
- G. Wear, member
- M. E. Wilfert, Group Leader

- A. T. Batey, authorized substitute for B. R. Aubin
- M. M. McCormick, observer, alternate for G. J. Walhout

J. Nonmember attendance. Other than members, alternates or authorized substitutes, there were 37 persons in attendance at the meeting. Of these, five were U.S. government employees.

K. Agenda, time, and place for the next meeting of the SAFER Technical Group on Compartment Interior Materials. After consultation with J. Enders, M. Wilfert, and E. Versaw, the Executive Director announced that separate meetings of this Technical Group, the Technical Group on Post-Crash Fire Hazard Reduction, and the basic SAFER Advisory Committee were tentatively scheduled for the last full week of September 1979, at NASA's Ames Research Center in Palo Alto, California. The agenda for this group would include:

1. A discussion of the feasibility of short-term rule making.

2. Final draft of long-term objectives, to be submitted for endorsement by the basic SAFER Advisory Committee.

3. Preliminary reports by the R & D Review Sub-group and the Accident Statistics Review Sub-group.

Prepared By: Irving Fagin 7/10/79
Executive Director, SAFER Advisory Committee

7 Enclosures

ENCLOSURE I

p. 1 of 3

Proposed by Martin Wilfer at the 1st Meeting of the SAFER Technical Group on Compartment Interior Materials, June 26 27, 1979.

SAFER MATERIALS TECHNICAL GROUP
SCOPE OF ACTIVITIES
(PROPOSED)

RESTRICTED TO TRANSPORT AIRCRAFT

RESTRICTED TO POST-CRASH FIRE SCENERIO

INCLUDE ACTIVITIES PERTAINING TO:

- HUMAN TOLERANCES

  Fire
  Irritants/Intoxicants
  Smoke
  Toxicity

- CABIN INTERIOR CONSTRUCTION MATERIALS

  Transparencies
  Theromoforming Plastics
  Fabrics
  Cushions
  Decorative Plastics
  Floor Coverings

- MATERIALS EVALUATION AND ACCEPTANCE TESTING

  Lab Test/Analytical
  Full Scale Test

- CABIN INTERIOR CONSTRUCTION SYSTEMS

  Containment
  Compartmentalization
  Hardening

- IGNITION AND HEAT SOURCES
- Potential of Materials for Producing a Flash Fire
- PROTECTION SYSTEMS

  Fire Detection
  Extinguishment
  Personal

- PASSENGER CARRY-ON MATERIALS
- IMPROVED HEAT RESISTANCE OF EVACUATION SLIDES
- TRASH MANAGEMENT SYSTEMS
- ANALYTICAL STUDIES RELATED TO A FULL-SCALE FIRE SCENARIO

ENCLOSURE I
p. 2 of 3

SAFER MATERIALS TECHNICAL GROUP

INITIAL OBJECTIVES

(PROPOSED)

EVALUATE PERTINENT FARs

EVALUATE PERTINENT R&D PROGRAMS

- FAA Funded
- FAA Conducted
- Other Government and Industry

SUBMIT PRELIMINARY FINDINGS BY OCTOBER 1, 1979 INCLUDING:

- Recommendations as to short-term rule making or other action.
- Any initial recommendations to redirect, modify and/or fund existing/new R&D programs.

OBTAIN MAIN COMMITTEE ENDORSEMENT OF LONG-TERM OBJECTIVES

OBTAIN MAIN COMMITTEE GUIDANCE FOR OVERALL APPROACH

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SAFER MATERIALS TECHNICAL GROUP

LONG TERM OBJECTIVES

(PROPOSED)

ESTABLISH HUMAN TOLERANCES AND PROTECTIVE MEASURES

- Fire
- Irritants/Intoxicants
- Smoke
- Toxicity

IMPROVED CABIN MATERIALS

- Transparences
- Thermoforming Plastics
- Fabrics
- Cushions
- Decorative Plastics
- Floor Coverings
- Improved Cabin Interior Construction Systems

DEVELOP SIMPLE RELIABLE MATERIALS EVALUATION AND ACCEPTANCE TESTS

IMPROVED FIRE DETECTION AND SUPPRESSION SYSTEMS WITHIN THE CABIN & CARGO COMPARTMENTS

IMPROVED FIRE CONTAINMENT SYSTEMS

EVALUATE TRASH MANAGEMENT SYSTEMS

IMPROVED EVACUATION SYSTEMS

INVESTIGATION OF MEANS FOR SMOKE CONTROL

SUBMIT RECOMMENDATIONS ON LONG-TERM OBJECTIVES TO THE SAFER ADVISORY COMM. BY JUNE 26, 1980.

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Presented by H. Branting FAA, at the 1st mtg. of the SAFER Tech. group on Compartment Interior Materials, June 26-27, 1979

TOTAL SURVIVABLE/FATAL AIRCRAFT FIRE ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1964-1978

NO.	FUEL RELEASE MODE	FATALITIES TOTAL	FATALITIES DUE TO FIRE
18	WING SEPARATION	805	290*
10	TANK DAMAGE	601	210*
1	ENGINE COMPONENT DAMAGE	48	48
1	FUEL FIRE DAMAGE	43	43
1	UNKNOWN	3	3
31		1500	594*

*ESTIMATED 594 FATALITIES DUE TO FIRE REPRESENT 40% OF THE TOTAL FATALITIES IN THESE 31 FATAL FIRE ACCIDENTS.

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IMPACT SURVIVABLE/FATAL AIRCRAFT FIRE ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1977-1978

DATE	AIRCRAFT	LOCATION	FUEL RELEASE MODE	TOB	FATALITIES TOTAL	FIRE	IMPACT	UNKNOWN
3/27/77	B-747	TENERIFE	TANK DAMAGE	396	335	118	60	157
4/4/77	DC-9	NEW HOPE, GA	WING SEP.	85	62	20	42	0
7/6/77	L-188C	ST. LOUIS, MO	UNKNOWN	3	3	3	0	0
3/1/78	DC-10	LOS ANGELES, CA	TANK DAMAGE	200	2	2	0	0
				684	402	143	102	157

ENCLOSURE II

TOTAL SURVIVABLE/FATAL AIRCRAFT FIRE ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1964 - 1976

NO.	FUEL RELEASE MODE	FATALITIES TOTAL	FATALITIES DUE TO FIRE
17 (3)	WING SEPARATION	743	270*
8 (2)	TANK DAMAGE	264	90*
1 (1)	ENGINE COMPONENT DAMAGE	48	48
1	FUEL LINE DAMAGE	43	43
27 (6)		1098	450*

ESTIMATED 450 FATALITIES DUE TO FIRE REPRESENT ABOUT 39% OF THE FATALITIES IN THE TOTAL 32 SURVIVABLE/FATAL ACCIDENTS.

Copy of Federal Aviation Regulations Section 25.853
Fire Protection Standards for Compartment Interior
Materials; Transport Category Airplanes
(These Standards became effective May [illegible])

Enclosure II

§ 25.853 Compartment interiors.

Materials (including finishes or decorative surfaces applied to the materials) used in each compartment occupied by the crew or passengers must meet the following test criteria as applicable:

(a) Interior ceiling panels, interior wall panels, partitions, galley structure, large cabinet walls, structural flooring, and materials used in the construction of stowage compartments (other than underseat stowage compartments and compartments for stowing small items such as magazines and maps) must be self-extinguishing when tested vertically in accordance with the applicable portions of Appendix F of this part or other approved equivalent methods. The average burn length may not exceed 6 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 3 seconds after falling.

(b) Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and nondecorative coated fabrics, leather, trays and galley furnishings, electrical conduit, thermal and acoustical insulation and insulation covering, air ducting, joint and edge covering, cargo compartment liners, insulation blankets, cargo covers, and transparencies, molded and thermoformed parts, air ducting joints, and trim strips (decorative and chafing), that are constructed of materials not covered in paragraph (b-2) of this section, must be self extinguishing when tested vertically in accordance with the applicable portions of Appendix F of this part, or other approved equivalent methods. The average burn length may not exceed 8 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.

(b-1) Motion picture film must be safety film meeting the Standard Specifications for Safety Photographic Film PH 1.25 (available from the United States of America Standards Institute, 10 East 40th Street, New York, NY 10018), or an FAA-approved equivalent. If the film travels through ducts, the ducts must meet the requirements of paragraph (b) of this section.

(b-2) Acrylic windows and signs, parts constructed in whole or in part of elastomeric materials, edge lighted instrument assemblies consisting of two or more instruments in a common housing, seat belts, shoulder harnesses, and cargo and baggage tiedown equipment, including containers, bins, pallets, etc., used in passenger or crew compartments, may not have an average burn rate greater than 2.5 inches per minute when tested horizontally in accordance with the applicable portions of Appendix F of this part, or other approved equivalent methods.

(b-3) Except for electrical wire and cable insulation, and for small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that the Administrator finds would not contribute significantly to the propagation of a fire, materials in items not specified in paragraphs (a), (b), (b-1), or (b-2) of this section may not have a burn rate greater than 4.0 inches per minute when tested horizontally in accordance with the applicable portions of Appendix F of this part or other approved equivalent methods.

(c) Each compartment where smoking is to be allowed must have self-contained removable ash trays, and each other compartment must be placarded against smoking.

(d) Each receptacle for towels, paper, or waste must be at least fire resistant and must have means for containing possible fires.

(e) There must be at least one hand fire extinguisher conveniently located in the pilot compartment.

(f) There must be at least the following number of hand fire extinguishers conveniently located in passenger compartments:

Passenger capacity	Minimum number of hand fire extinguishers
7 through 30	1
31 through 60	2
61 or more	3

[illegible] Stat. 778, 49 U.S.C. 1424) [illegible] 5066, 29 F.R. 18291, Dec. 24, 1964, as amended by Amdt. 25-15, 32 F.R. 5676, Apr. 8, 1967; Amdt. 25-32, 37 F.R. 3971, Feb. 24, 1972]

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Appendix F

[illegible] Test Procedure for showing [illegible] §§ 25.853, 25.855 and 25.[illegible]

(a) Conditioning. Specimens must be conditioned to 70° F. plus or minus 5° and at 50 percent plus or minus 5 percent relative humidity until moisture equilibrium is reached or [illegible] 24 hours. Only one specimen at a time may be removed from the conditioning environment immediately before subjecting it to the flame.

(b) Specimen configuration. Except as provided [illegible] used in electrical wire and cable insulation and in small parts, materials must be tested either as a section cut from a fabricated part as installed in the airplane or as a specimen simulating a cut section, such as a specimen cut from a flat sheet of the material or a model of the fabricated part. The specimen may be cut from any location in a fabricated part; however, fabricated units, such as sandwich panels, may not be separated for test. The specimen thickness must be no thicker than the minimum thickness to be qualified for use in the airplane [illegible]. Thick foam parts, [illegible] must be tested in ½-inch thickness. [illegible] showing compliance with § 25.853(a)(3) for materials used [illegible] must be tested the material [illegible] no more than ⅛-inch [illegible] showing compliance [illegible] materials used in electrical wire and cable insulation. The wire and cable specimens must be the same size as used in the airplane. In the case of fabrics, both the warp and fill directions of the weave [illegible] determine the most critical flammability conditions. When performing the tests prescribed in paragraphs (d) [illegible] of this appendix, the specimen [illegible] in a metal frame so that [illegible] of paragraph (d), [illegible] upper edge are [illegible] horizontal test of [illegible] edges and the [illegible] are held securely; [illegible] specimen is at [illegible] long, unless [illegible] is smaller [illegible] which the burner [illegible] of the [illegible] of the specimen [illegible] of the actual [illegible] material or part in[illegible]. When performing the test [illegible] paragraph (f) of this appendix, the specimen must be mounted in [illegible] all four edges are held [illegible] area of the specimen [illegible] by 8 inches.

[illegible] provided in paragraph [illegible] appendix, tests must be conducted [illegible] free cabinet in accordance with [illegible] Test Method Standard 191 [illegible] (revised Method 5902) for the [illegible] 5906 for horizontal [illegible] the General Services Administration [illegible] Business Service Center, Regional [illegible] Streets SW., Washington, [illegible] equivalent [illegible] which are too large for the cabinet must be tested in similar draft-free conditions.

(d) *Vertical test, in compliance with § 25.853 (a) and (b).* A minimum of three specimens must be tested and the results averaged. For fabrics, the direction of weave corresponding to the most critical flammability conditions must be parallel to the longest dimension. Each specimen must be supported vertically. The specimen must be exposed to a Bunsen or Tirrill burner with a nominal ⅜-inch I.D. tube adjusted to give a flame of 1½ inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame must be 1,550° F. The lower edge of the specimen must be three-fourths inch above the top edge of the burner. The flame must be applied to the center line of the lower edge of the specimen. For materials covered by § 25.853(a), the flame must be applied for 60 seconds and then removed. For materials covered by § 25.853(b), the flame must be applied for 12 seconds and then removed. Flame time, burn length, and flaming time of drippings, if any, must be recorded. The burn length determined in accordance with paragraph (g) of this appendix must be measured to the nearest one-tenth inch.

(e) *Horizontal test in compliance with § 25.853 (b-2) and (b-3).* A minimum of three specimens must be tested and the results averaged. Each specimen must be supported horizontally. The exposed surface when installed in the aircraft must be face down for the test. The specimen must be exposed to a Bunsen burner or Tirrill burner with a nominal ⅜-inch I.D. tube adjusted to give a flame of 1½ inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame must be 1,550° F. The specimen must be positioned so that the edge being tested is three-fourths of an inch above the top of, and on the center line of, the burner. The flame must be applied for 15 seconds and then removed. A minimum of 10 inches of the specimen must be used for timing purposes, approximately 1½ inches must burn before the burning front reaches the timing zone, and the average burn rate must be recorded.

(f) *Forty-five-degree test, in compliance with § 25.855(c-1).* A minimum of three specimens must be tested and the results averaged. The specimens must be supported at an angle of 45° to a horizontal surface. The exposed surface when installed in the aircraft must be face down for the test. The specimens must be exposed to a Bunsen or Tirrill burner with a nominal ⅜-inch I.D. tube adjusted to give a flame of 1½ inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the center of the flame must be 1,550° F. Suitable precautions must be taken to avoid drafts. One-third of the flame must contact the material at the center of the specimen and must be applied for 30 seconds and then removed. Flame time, glow time, and whether the flame penetrates (passes through) the specimen must be recorded.

(g) *Sixty-degree test in compliance [illegible] § 25.1359(d).* A minimum of three specimens of each wire specification (make and size) must be tested. The specimen of wire or cable (including insulation) must be placed at an angle of 60° with the horizontal in the cabinet specified in paragraph (c) of this appendix with the cabinet door open during the test or must be placed within a chamber approximately 2 feet high x 1 foot x 1 foot, open at the top and at one vertical side (front), and which allows sufficient flow of air for complete combustion, but which is free from drafts. The specimen must be parallel to and approximately 6 inches from the front of the chamber. The lower end of the specimen must be held rigidly clamped. The upper end of the specimen must pass over a pulley or rod and must have an appropriate weight attached to it so that the specimen is held taut throughout the flammability test. The test specimen span between lower clamp and upper pulley or rod must be 24 inches and must be marked 8 inches from the lower end to indicate the central point for flame application. A flame from a Bunsen or Tirrill burner must be applied for 30 seconds at the test mark. The burner must be mounted underneath the test mark on the specimen, perpendicular to the specimen and at an angle of 30° to the vertical plane of the specimen. The burner must have a nominal bore of three-eighths inch, and must be adjusted to provide a 3-inch-high flame with an inner cone approximately one-third of the flame height. The minimum temperature of the hottest portion of the flame, as measured with a calibrated thermocouple pyrometer may not be less than 1,750° F. The burner must be positioned so that the hottest portion of the flame is applied to the test mark on the wire. Flame time, burn length, and flaming time of drippings, if any, must be recorded. The burn length determined in accordance with paragraph (h) of this appendix must be measured to the nearest one-tenth inch. Breaking of the wire specimens is not considered a failure.

(h) *Burn length.* Burn length is the distance from the original edge to the farthest evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring, or embrittlement, but not including areas sooted, stained, warped, or discolored, nor areas where material has shrunk or melted away from the heat source.

[Amdt. 25-32, 37 F.R. 3971, Feb. 24, 1972; 37 F.R. 5284, Mar. 14, 1972]

ENCLOSURE 1
A

BRIEFING MEMORANDUM

SAFER Technical Group on Compartment Interior Materials
Meeting on June 26-27, 1979 at NAFEC

SUBJECT: Flammability Standards for Flight Attendant Uniforms

Early in 1974, the Association of Flight Attendants (AFA) petitioned the FAA to improve the safety of uniforms worn by its members. AFA's petition made reference to burn tests on typical uniforms conducted by the Gillette Research Institute. The tests indicated that some uniforms (particularly cotton-polyester types) burned vigorously once they were ignited. Ignition was effected by means of a paper napkin pinned to the uniform - an accepted test procedure at the National Bureau of Standards (NBS) and other government agencies studying the threat.

Responding to AFA's petition, FAA entered into an inter-agency agreement with NBS for development of an appropriate flammability standard. The terms of reference required NBS to --

1. Evaluate the flammability of a group of typical flight attendant uniforms (both male and female) by igniting each garment and allowing it to burn for 90 seconds, the prescribed emergency evacuation interval. These tests were performed using a temperature-instrumented manikin, and the data interpreted in terms of second-degree burns.

2. Identify advanced fabrics (such as NOMEX, flame-retarded polyester, and flame-retarded cotton) that could be substituted for current fabrics.

3. Manufacture uniform components (such as shirts, slacks, and blouses) and conduct manikin tests to demonstrate that flammability improvement was possible.

4. Prepare proposed flammability standards based on the self-extinguishing characteristics of the Flammable Product Standard for Children's sleepwear, which had been adopted in 1973. Since flight attendants may be exposed to radiant/convective heat during a cabin fire, it was necessary that the proposed standard include a heat resistance test.

To support this development effort, the FAA issued an Advanced Notice of Proposed Rule Making (Notice 75-13, copy enclosed) in 1975 which solicited comment on the durability, color possibilities, and styling limitations of materials that had been treated for fire retardation. In addition, comment was solicited on the possibility of treating

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summer-weight fabrics for fire retardation.

The standard proposed by NBS is described in Appendix C of FAA Report FAA-RD-75-176,* dated August 1976. This standard (rationalized as a result of follow-on NBS tests performed on numerous additional fabrics), and the comments received in response to Notice 75-13, will form the technical basis for a Notice of Proposed Rule Making (NPRM) that is being developed by FAA for release late in 1979. As presently conceived, the NPRM would cover the uniforms worn by all crewmembers.

*Available from the National Technical Information Service, Springfield, Virginia 22161. Ask for NTIS #ADA-033740.

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Notice [illegible]

ATTACHMENT

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

[14 CFR Part 121]

[Docket No. 14461 Notice No. 75-13]

FLIGHT ATTENDANT CLOTHING

Flammability Standards; Advance Notice of Proposed Rule Making

The Federal Aviation Administration is considering the need to amend Part 121 of the Federal Aviation regulations to require that the clothing worn by the flight attendants required to be aboard passenger-carrying aircraft meet certain standards and specifications with respect to flammability.

This advance notice of proposed rule making is being issued pursuant to the FAA's policy for the early institution of public proceedings in actions related to rule making. An advance notice is issued to invite early public participation in the identification and selection of a course or alternate courses of action with respect to a particular rule making problem.

Interested persons are invited to participate in the making of the proposed rule by submitting such written data, views, or arguments as they may desire. Communications should identify the regulatory docket or notice number and be submitted in duplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket, AGC-24, 800 Independence Avenue, SW., Washington, D.C. 20591. All communications received on or before May 12, 1975, will be considered by the Administrator before taking action on the proposed rule. The proposals contained in this notice may be changed in the light of comments received. All comments submitted will be available, both before and after the closing date for comments, in the Rules Docket for examination by interested persons.

Section 121.391 of the Federal Aviation regulations requires that each certificate holder provide one or more flight attendants on each passenger-carrying airplane, the number directly proportional to the seating capacity of the airplane. These flight attendants would be called upon to assist in an emergency evacuation should one become necessary. In addition to the training set forth in § 121.421 (a)(1) flight attendants are required [illegible] to receive the emergency training set forth in § 121.417 which includes instruction in the handling of emergency situations including fire in flight or on the surface, emergency evacuations, fire extinguishing and smoke control. It is apparent that flight attendants' clothing constructed of conventional fabrics may be hazardous under many of the emergency conditions that may result from unusual occurrences. Accordingly, the FAA is interested in obtaining comments from informed fabrics research and manufacturing sources in order that current technology may be included in the establishment of uniform flammability standards and specifications.

Flammability standards have not been established by the FAA with respect to the clothing of flight attendants, however, the FAA has become aware of the urgent requirement for such standards as a result of recent flammability tests in which flight attendant uniforms readily caught fire and, in some instances, the uniforms afforded insufficient coverage to provide protection from exposure to heat and flame. These tests indicated that uniforms made of polyester, cotton blends, nylon and other synthetics can be ignited by small fires and will continue to burn independently after ignition.

The objective of this Advance Notice is the establishment of basic flammability specifications for flight attendant uniforms which will also take into consideration the practical aspects of cost, wearability, comfort, and cleanability while providing a reasonable degree of protection against heat and flame when used singly or in combination as parts of a uniform assembly.

The Secretary of Commerce has adopted certain Commercial Standards with respect to flammability of clothing textiles pursuant to the Flammable Fabrics Act (15 U.S.C. 1191; 67 Stat. 111 as amended, 81 Stat. 568). It is anticipated that fabrics and materials selected for uniforms and flight attendant apparel will satisfy the flammability standards set forth in the rules and regulations under that Act that are set forth in Part 302 of Chapter I of Title 16, the regulations of the Federal Trade Commission.

Based on the foregoing, the FAA solicits the views of all interested persons concerning the establishment of standards of flammability for the materials used in the apparel of the flight attendants required by Part 121 to be aboard passenger-carrying aircraft. Views regarding the design or construction of clothing to withstand heat will also be welcome. In addition, the FAA is interested in information concerning the shrinkage, melting points and drip characteristics of any materials that may be used in flight attendant wearing apparel or accessories.

The FAA is particularly interested in receiving comments regarding the following questions:

1. Could the materials that are treated for fire retardation be constructed to be as durable as, or more durable than, fabrics that are currently being used for flight attendant apparel?

2. Will the materials that are treated for fire retardation be limited with respect to color?

3. Would the materials that are treated for fire retardation place limitations on the styling and tailoring of flight attendant apparel? If so, in what respects would such limitations be detrimental?

4. When could materials that are treated for fire retardation, especially polyester and cotton blend fabrics, be available commercially?

5. Is there available a means for chemical processing of fabrics, especially polyester and cotton blend fabrics, to increase or to rejuvenate their capacity to retard combustion?

6. Will flame retardant properties remain in the fabric after repeated cleaning or laundering?

7. Could summer weight fabrics be effectively treated for fire retardation?

8. Can characteristics of shrinkage, low melting points and dripping be reduced or eliminated from thermoplastic materials to be used for flight attendant apparel?

Comments are welcome on these areas of interest as well as any additional areas regarding the safety aspects relating to the apparel of flight attendants with respect to the hazards created by extreme heat and fire.

(Secs. 313(a), 601, 604, Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, and 1424); sec. 6(c), Department of Transportation Act (49 U.S.C. 1655(c)).)

Issued in Washington, D.C., on March 6, 1975.

JAMES M. VINES,
Acting Director,
Flight Standards Service.

(As published in the Federal Register [illegible] on March [illegible])

ENCLOSURE V

Presented to C. Sarkos on the 1st meeting of the SAFER Tech Group on Compartment Interior Materials

FAA Proposed Interim Standard for Cabin Materials

Background

An ad-hoc committee was recently convened, composed of FAA individuals involved and familiar with fire testing and research, to discuss whether an interim fire standard for aircraft cabin materials was feasible and, if so, the structure of such a standard. Based on the state-of-the-art, it was agreed that an interim standard may be feasible within the near future, but that additional work, perhaps over the next 12 months, was needed to develop and verify the standard. The committee concentrated its efforts primarily on reaching some sort of concensus on test methodology that could be proposed at the initial session of the SAFER Technical Group on Compartment Interior Materials, scheduled for June 26-27, 1979, at NAFEC.

Proposed Test Methodology

The committee felt that the most practical interim standard would be composed of individual tests for flammability, smoke, and toxicity. Although considered, it was felt that present modeling technology and knowledge of human tolerance limits would not permit the derivation of weighing factors for each of these "hazards." Instead, the committee selected separate test methods for each "hazard" that were standardized or sufficiently developed. These are shown on the attached table for utilization under two possible strategies, which are presented later for consideration. Both strategies incorporate the same test methods; however, the test conditions are different. An important feature of the proposal is that smoke and toxicity are measured under pyrolytic or nonflaming conditions. For most aircraft materials, research experience to date indicates that the thermal mode that yields the most-toxic and smokiest products is the hottest environment possible that does not cause spontaneous flaming ignition. Fortunately, correlation of small-scale nonflaming pyrolysis tests with full-scale results is both theoretically defensible and appears to be experimentally demonstrated.

Flammability

Two standardized test methods are proposed: the vertical Bunsen burner test (FAR 25.853) and the radiant panel test (ASTM E-162). The former is the basis for existing FAA standards and would be retained in order to continue to minimize the likelihood of an in-flight fire from a small ignition source. In order to evaluate materials in the intense postcrash cabin fire environment, a more severe exposure condition is required. A suitable test for this purpose is the radiant panel test, which measures both flame spread rate and heat evolution.

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Smoke

It is proposed that smoke emission be measured with the widely-used NBS smoke chamber. This test method has been standardized by NFPA at a radiant heat exposure level of 2.5 w/cm^2, which was selected primarily for evaluating building materials. Fire resistant cabin materials require evaluation under more intense heat levels, which are attainable with any one of a number of special heaters, in order to characterize their smoke emissions in a postcrash cabin fire.

Toxicity

A relatively reliable, simple, and accurate procedure for evaluating the toxicity of an aircraft material due to thermal decomposition is the CAMI combustion tube test method. Toxicity is determined by the time-to-incapacitation of the albino rat inside a motor-driven, rotating cage. The combustion tube furnace should be charged with a weight of the sample material that will produce a load of 50 mg. of sample per liter of total enclosed atmospheric volume. It is proposed that the toxicity be converted to a numerical value (global toxicity) that represents the relative toxic hazard of that weight of each material required in the end-use configuration.

Proposed Test Conditions

Two-Zone Strategy

The two-zone strategy recognizes the significant stratification of heat throughout the cabin from an external fuel fire. The ceiling is heated primarily by convection and radiation from the hot smoke layer moving down the cabin with additional radiative heating near the initial fire source, and the hot smoke layer in turn radiates heat to the lower zone of the cabin. Every full-scale fire test and aircraft cabin fire accident has vividly demonstrated that the upper zone cabin materials are exposed to a much higher heat flux than the materials in the lower zone. Therefore, it is proposed that smoke and toxicity be measured, under nonflaming conditions, at 2.5 w/cm^2 in the lower zone and at 5.0 w/cm^2 in the upper zone. These test conditions are approximated representative heat flux levels within each zone, and may have to be adjusted when additional data and information becomes available. With regard to flammability, the current Bunsen burner test (FAR 25.853) will be retained for lower zone materials in order to maintain control over in-flight fires. However, for

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materials located in the upper zone, where the exposure conditions are much more severe and extensive, the radiant panel test for flammability is needed to exercise some control over flame spread rate and heat evolution.

Worst Test Condition Strategy

The worst test condition strategy recognizes that an infinite number of cabin fire scenarios are theoretically possible, and that the exposure condition a material is subjected to can differ significantly for different scenarios. Moreover, for any given scenario, the heat exposure of any material changes (it usually increases) with time and is greatly dependent on the location of that material within the cabin. Therefore, it is impossible to define with an acceptable degree of accuracy a representative exposure condition for any material. Instead, it is proposed that smoke and toxicity be measured at the maximum heating level that does not cause the sample to ignite spontaneously, which corresponds to the smokiest or most-toxic condition for most aircraft materials. The two-zone concept is proposed for flammability, since both the Bunsen burner and radiant panel test incorporate piloted ignition sources (in contrast to the nonflaming smoke and toxicity tests).

Research Requirements

The detailed research requirements to develop and verify the interim standard proposal have not yet been developed; however, some basic requirements are evident. These requirements are related to two areas: laboratory testing and fire dynamics. In the laboratory scale work, the greatest needs exist in the toxicity area, where a data bank must be generated upon which to base acceptance limits. This data is not available for either the two-zone or worst test condition strategy. In addition, it is desirable to modify the exposure conditions within the combustion tube furnace to provide a more realistic unidirectional exposure for composite materials (panels). With regard to the radiant panel and NBS smoke chamber tests, some additional data may have to be generated. In the area of fire dynamics, the full-scale and modeling tests at NAFEC, and perhaps other Facilities, must be redirected to focus attention on stratification effects and radiative exposure conditions within the cabin. It may also be desirable to refocus mathematical modeling work on the tractability and behavior of smoke in the fuselage cabin, and the radiation resulting therefrom. Finally, the worth of any standard must be judged primarily on the safety benefit it provides. Therefore, it would be necessary to evaluate the safety benefit of the proposed interim standard by conducting full-scale post crash fire tests using the C-133 test article.

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FAA PROPOSED INTERIM STANDARD

	TWO ZONE		WORST TEST CONDITION
	LOWER ZONE	UPPER ZONE	
FLAMMABILITY	Vertical Bunsen Burner Test (FAR 25.853) Existing Exposures	Radiant Panel Test (ASTM E-162) Existing Exposures	UPPER ZONE: Radiant Panel Test LOWER ZONE: Bunsen Burner Test
SMOKE	Modified NBS Smoke Chamber Non-Piloted 2.5 W/cm^2	Modified NBS Smoke Chamber Non-Piloted 5.0 W/cm^2	Modified NBS Smoke Chamber Non-Piloted Maximum Non-Flaming Exposure
TOXICITY	Combustion Tube Non-Flaming 2.5 W/cm^2 (550°C)	Combustion Tube Non-Flaming 5.0 W/cm^2 (700°C)	Combustion Tube Maximum Non-Flaming Exposure

ENCLOSURE VI

Presented by H. Brantino at the 1st meeting of the SAFER Technical group on Compartment Interior Materials, June 26-27, 197[illegible].

APPLICABILITY OF PROPOSED INTERIM CABIN MATERIALS STANDARDS

The proposed interim standard would apply to the following:

- Models under future application for type certificate and models currently undergoing type certification.
- Materials used in complete cabin refurbishments as described in FAR 121.312.
- After a 3 year grace period, materials used in seat cushions, upholstery and carpets under FAR 121.

SUB-GROUP ASSIGNMENTS

(SAFER Technical Group on Compartment Interior Materials)

A. Accident Statistics Review Sub-Group
Chairman: S. Davis

B. R & D Review Sub-Group
Chairman: M. Salkind

C. Short-term Action Sub-Group

1. Co-chairman: E. Bara
   - Materials systems: C. Sarkos; J. Simon
   - Materials:

     --Fabrics: W. Long
     --Polymers: J. Parker; G. Nelson; G. Wear

2. Co-chairman: H. Schjelderup
   - Toxicology: C. Crane
   - Materials evaluation and testing: R. Bricker; G. Nelson; G. Wear
   - Airline operations:

     --Evacuation slides: J. Fargo
     --Passenger carry-on materials: C. May; B. Aubin

SUMMARY OF PROCEEDINGS

SAFER Technical Group on Post-Crash Fire Hazard Reduction
Meeting of June 28-29, 1979, at NAFEC

A. The group was welcomed by Mr. Tom O'Brien, Acting Deputy Director of the National Aviation Facilities Experimental Center (NAFEC), who announced that FAA's entire fire safety R & D effort would be concentrated at NAFEC in the future. Mr. John H. Enders, Chairman of the basic SAFER Advisory Committee, followed with an outline of the Committee's goals. The Executive Director then introduced Mr. Edward F. Versaw, the elected Group Leader for this Group, who presided for the entire meeting. The proceedings were recorded on tape.

B. Ground rules. The Group Leader announced several ground rules covering the Group's activities, including the following:

1. This meeting, and all subsequent meetings of the Group, will be open to the public on a space-available basis.

2. A nonmember may make an oral statement before the Group if he asks permission from the Executive Director not later than a day before the meeting, and is recognized by the Group Leader. A nonmember may make a written statement to the Group (via the Executive Director) at any time.

3. A summary of the Group's proceedings will be prepared by the Executive Director and distributed to all interested persons.

C Scope and objectives. The Group Leader stated that the Group, under the SAFER Advisory Committee charter, was to examine the factors affecting the ability of the aircraft cabin occupant to survive in the post-crash environment and the range of solutions available. To define the Group's scope, he added that the Group would:

1. Confine itself to transport category airplanes, and to the reduction of hazards associated with combustible fluid fires;

2. Evaluate the state of the art of existing and completed R & D programs in terms of their contribution to airplane safety, and determine:

- With respect to completed programs, whether the R & D findings warrant rule making action or the publication of guidance material;

- With respect to existing programs, whether they should be continued to completion, redirected along potentially more fruitful lines, or aborted altogether; and

- The need for new R & D programs;

3. By October 1, 1979, submit a preliminary report containing the Group's recommendations (if any) for early adoption of new or revised standards within its area of concern.

D. <u>Review and update of the pertinent service record</u>. T. Horeff presented a series of charts (Enclosure I) summarizing the data currently available on impact-survivable accidents involving U.S. air carriers world-wide, and some additional data on fuel tank explosion incidents/accidents involving civil and military transport airplanes. In answer [illegible] questions asked by various members, T. Horeff stated that:

1. There had been a number of fire incidents/accidents in which hydraulic fluid was the source of fuel, but he knew of none involving fatalities;

2. An "impact-survivable" accident was defined as one in which at least one person survived.

3. In general, the fire fatality data available are not differentiated with respect to causative factors, such as burning or inhalation of toxic gases. It is only in recent years that the NTSB has attempted to collect such data.

4. Except for the KC-135 accident, the incidents/accidents dealing with fuel tank explosions (Enclosure I, last page) were not impact survivable.

5. The vast majority of the airplanes involved in the accident record carried Jet A fuel.

6. The impact-survivable accident record for U.S. air carriers [illegible] generally similar to the record for world air carriers.

T. Horeff continued with a chart (Enclosure II) listing recent fire accident studies. The Executive Director said that he would attempt to obtain a copy of any of these studies for any member who asks for it.

E. <u>Assessment of the adequacy of pertinent Federal Aviation Regulations (FAR's)</u>.

1. T. Horeff listed (Enclosure III) a number of current FAR's [illegible] at minimizing fuel spillage in transport airplanes, and discussed the rationale behind their adoption.

2. [illegible] Peacock then described in detail how the airframe industry complies with the FAR's that deal with fuel system safety, [illegible]

following major areas: power-plant protection; fuel system fire protection; and fuel tank crashworthiness.

In answer to questions posed by various members, T. Peacock stated that:

- Auxiliary tanks are not generally subjected to crash tests. He knows of no crash data documentation on those tanks

- Flame arrestors are not installed in the vent systems within the tanks; they are not effective in preventing flash-over between tanks.

- Fuel spillage via fuel tank vent lines is not likely to occur in the crash situation.

- Bladder weight represents only a small fraction of the total weight (including the containing structure) chargeable to a bladder cell installation.

- Under crash conditions, assuming the loads imposed were high enough for penetration and low enough to allow the tanks to break away from the structure, bladder cells are more likely to contain their fuel than integral wing tanks.

3. T. Horeff continued with a presentation (Enclosure IV) on NTSB recommendations to FAA concerning fuel system safety, and FAA's response to those recommendations. In answer to a question by E. Volz, T. Horeff stated that the three fuel system safety approaches mentioned in NPRM 74-16 were: reticulated polyurethane foam; liquid nitrogen fuel tank inerting; and explosion suppression.

F. Review of current R & D programs. The Group Leader urged the Group, when listening to the presentations that several members were scheduled to make various approaches to post-crash fire hazard reduction, to consider the following pertinent factors: effectiveness; reliability; weight; maintenance; retrofit; cost; and development status. He proposed that each member rate the various approaches with respect to those factors using a simple code as follows: U (for unfavorable); F (for favorable); and O (for neutral). After the presentations were completed, a Group rating would be attempted. The individual presentations were as follows:

1. Crashworthy fuel systems

- C. Pedriani, "Crashworthy Fuel Systems" (slides & film).

- T. Horeff, "FAA Fuel System Safety Activities, General Aviation Aircraft" (slides).

2. Anti-misting fuels.

- R. Kirsch, "FAA R & D Aircraft Safety Program" (slides)

- H. Skavdahl, "Tests on Modified Fuel and Flame Arrestors" (slides and film).

3. Fire-resistant fuels.

- W. Weatherford, "Research Conducted by U.S. Army on Development of Fire Resistant Fuels for Helicopters and Diesel Engines" (slides & film).

4. Fuel tank inerting systems

- B. Botteri, "Aircraft Fuel Tank Fire and Explosion [illegible] Systems" (slides).

- C. Kimmel, "Liquid Nitrogen Fuel Tank Inerting System" (slides).

- S. Manatt, "Inert Gas Generating System for Fuel Tank Inerting" (slides).

- G. Grabowski, "Explosion Suppression Systems" (no slides).

Following these presentations, R. Kirsch and R. Salmon provided some clarification on FAA-NAFEC's fuel wing spillage test facility and T. Peacock made some additional remarks about the application of crash resistant tanks to transport category airplanes.

The Group Leader also noted receipt of a written statement, submitted by O. J. Goodrum of Fairchild Industries, which dealt with a total fire suppression system being supplied to the Air Force.

C. Discussion of the need to redirect or modify existing R & D programs and whether the state of the art warranted short-term rule making. The Group Leader now proposed that the Group attempt a rough screening of various approaches to post-crash fire hazard reduction which are under current development so as to concentrate the Group's efforts on the most promising for the short term. For the screening exercise, he identified the approaches listed below and suggested that the screening factors be effectiveness; reliability; weight; maintenance; retrofit; cost; and development status.

1. Explosion suppression
2. Fuel tank foam/foil
3. Fuel tank inerting

4. Crash resistant tanks
    - wing
    - fuselage
5. Anti-misting fuel

In the discussion that followed, various members raised questions concerning: the fire scenarios to be considered; the [illegible] the proposed screening factors; the need for additional screening factors; and the significance of the "unfavorable/favorable/neutral" screening code that had been suggested by the Group Leader. It became clear that these questions could not be completely resolved in the time available to the Group. T. Peacock then suggested that sub-groups be formed to continue with the work assignments of the Group (including any necessary screening) within the framework established by the basic SAFER Advisory Committee. These sub-groups would report to the Group at its next meeting. There was general agreement on this suggestion.

After some additional discussion of the number, scope and membership of the sub-groups that should be established, the Group Leader (with the Group's approval), set up the following sub-groups: a Sub-group on Explosion Suppression (Fuel Tank Foam/Foil) and Fuel Tank Inerting; a Sub-group on Crash Resistant Fuel Tanks; a Sub-group on Anti-misting Fuels; and a Drafting Sub-Group. Members were selected or volunteered for service on these sub-groups as shown in Enclosure V.

T. Peacock emphasized that the sub-groups (and the Group itself) are charged with the following basic tasks: first, to determine what specific short-term rule making action (if any) can be taken, on the basis of present technical knowledge, which could contribute significantly to safety; and second, to assess pertinent R & D programs and determine whether they should be continued to completion, redirected along potentially more fruitful lines, or abandoned altogether. K. Rosen suggested a further charge: if there are additional development activities that are necessary before rule making can be undertaken, the sub-group is to report that fact to the Group.

The Group Leader noted that the Drafting Sub-Group would prepare the Group's report to the basic SAFER Advisory Committee. A draft of that report would be reviewed by the Group at its next meeting.

H. Technical group members, alternates, and authorized substitutes who participated in the meeting:

- B. Botteri, member
- W. G. Dukek, member
- K. Fisher, member
- R. G. E. Furlonger, observer
- J. D. Galloway, member

- G. J. Grabowski, member
- L. Hebenstreit, member
- T. Horeff, member
- C. C. Kimmel, member
- R. A. Kirsch, member
- S. A. Manatt, member
- H. C. L. Noordermeer, member
- N. R. Parmet, member
- C. M. Pedriani, member
- K. Rosen, member
- R. Salmon, member
- H. W. Smith, member
- E. F. Versaw, Technical Group Leader
- R. Volz, member
- W. D. Weatherford, member
- E. P. Webb, member
- S. Weiss, member
- J. H. Wivell, member

- R. D. Appleyard, authorized substitute for I. Burgess
- H. Skavdahl, alternate for D. C. Nordstrom
- T. C. Street, alternate for T. W. Reichenberger
- M. M. McCormick, observer, alternate for G. J. Walhout
- R. J. Mannheimer, alternate for W. D. Weatherford
- A. T. Peacock, alternate for L. A. Wright

I. Nonmember attendance. Other than members, alternates or authorized substitutes, there were 25 persons in attendance at the meeting. Of these, 3 were U.S. government employees.

J. Agenda, time, and place for the next meeting of the SAFER Technical Group on Post-Crash Fire Hazard Reduction. The Executive Director announced that separate meetings of this Technical Group, the Technical Group on Compartment Interior Materials, and the basic SAFER Advisory Committee were tentatively scheduled for the last full week of September 1979, at NASA's Ames Research Center in Palo Alto, California. The agenda for this Group would include, among other things, a review of the Drafting Sub-Group's draft report.

Prepared By: Irving Fagin 7/16/79
Executive Director, SAFER Advisory Committee

5 Enclosures

Presented by T Horeff at the 1st Mtg of the SAFER Technical Group on Post-Crash Fire Hazard Reduction. June 28-29, 1979

ENCLOSURE I
p. 1 of 6

TOTAL SURVIVABLE/FATAL TURBINE AIRCRAFT ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1964 - 1976

ACCIDENTS		FATALITIES	
FIRE	NO FIRE	FIRE	NO FIRE
27	5	1093	50

32 ACCIDENTS - 1148 FATALITIES

95.6% OF FATALITIES IN SURVIVABLE/FATAL ACCIDENTS TO U.S. AIR CARRIERS WERE IN ACCIDENTS WHERE FIRE OCCURRED.

ENCLOSURE I
p. 206

RELATIONSHIP OF SURVIVABLE AND NON-SURVIVABLE/FATAL ACCIDENTS

U.S. AIR CARRIERS WORLD-WIDE, 1964 - 1976

FATAL ACCIDENTS

SURVIVABLE	FATALITIES	NON-SURVIVABLE	FATALITIES
32	1148	43	1468

TOTAL FATAL ACCIDENTS - 75

TOTAL FATALITIES - 2616

ESTIMATED 450 FATALITIES DUE TO FIRE IN SURVIVABLE ACCIDENTS REPRESENT 17% OF THE TOTAL FATAL ACCIDENT FATALITIES.

ENCLOSURE I
p. 3 of 6

TOTAL SURVIVABLE/FATAL AIRCRAFT FIRE ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1964 - 1976

NO.	FUEL RELEASE MODE	FATALITIES TOTAL	FATALITIES DUE TO FIRE
17 (3)	WING SEPARATION	743	270*
8 (2)	TANK DAMAGE	264	90*
1 (1)	ENGINE COMPONENT DAMAGE	48	48
1	FUEL LINE DAMAGE	43	43
27 (6)		1098	450*

ESTIMATED 450 FATALITIES DUE TO FIRE REPRESENT ABOUT 39% OF THE FATALITIES IN THE TOTAL 32 SURVIVABLE/FATAL ACCIDENTS.

Enclosure I
p. 4 of 6

IMPACT SURVIVABLE/FATAL AIRCRAFT FIRE ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1977-1978

DATE	AIRCRAFT	LOCATION	FUEL RELEASE MODE	TOB	FATALITIES TOTAL	FIRE	IMPACT	UNKNOWN
3/27/77	B-747	TENERIFE	TANK DAMAGE	396	335	118	60	157
4/4/77	DC-9	NEW HOPE, GA	WING SEP.	85	62	20	42	0
7/6/77	L-188C	ST. LOUIS, MO	UNKNOWN	3	3	3	0	0
3/1/78	DC-10	LOS ANGELES, CA	TANK DAMAGE	200	2	2	0	0
				684	402	143	102	157

ENCLOSURE I

TOTAL SURVIVABLE/FATAL AIRCRAFT FIRE ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1964-1978

NO.	FUEL RELEASE MODE	FATALITIES TOTAL	FATALITIES DUE TO FIRE
18	WING SEPARATION	805	290*
10	TANK DAMAGE	601	210*
1	ENGINE COMPONENT DAMAGE	48	48
1	FUEL FIRE DAMAGE	43	43
1	UNKNOWN	3	3
31		1500	594*

*ESTIMATED 594 FATALITIES DUE TO FIRE REPRESENT 40% OF THE TOTAL FATALITIES IN THESE 31 FATAL FIRE ACCIDENTS.

ENCLOSURE I
p. 6 of 6

FUEL TANK EXPLOSION INCIDENTS AND ACCIDENTS
CIVIL AND MILITARY TRANSPORT TYPE AIRCRAFT
1976 - 1979

DATE	AIRPLANE MODEL	LOCATION	OPERATIONAL MODE	PROBABLE CAUSE	FUEL
5/9/76	*B-747-131	HUETE, SPAIN	INFLIGHT	LIGHTNING STRIKE - FUEL TRANSFER VALVE	JP-4/JET A
5/24/77	L-382B	OAKLAND, CA	MAINT.	INTERNAL OVERTEMP. - PUMP/FILL VALVE	JP-4
12/11/77	DC-8-33	LAKE CITY, FL	MAINT.	ARCING-BOOST PUMP CONNECTOR	JET A
9/22/78	P-3B	BRUNSWICK, ME	INFLIGHT	SHORT CIRCUIT - FUEL PROBE	JP-5/JP-4
11/29/78	C-130E	COTTAGEVILLE, SC	INFLIGHT	LIGHTNING STRIKE	JP-4
4/6/79	KC-135Q	SACRAMENTO, CA	INFLIGHT	LIGHTNING STRIKE	JP-4

*NOTE: A LIGHTNING STRIKE ON 3/22/78 TO A B-747 USING JET A AFFECTED FUEL TRANSFER VALVE WITHOUT CAUSING AN EXPLOSION.

5/2/79

ENCLOSURE II

Presented by Tom Horeff at the 1st meeting of the SAFER Tech. Group on Post-Crash Fire Hazard Reduction. June 28-29, 1979

RECENT FIRE ACCIDENT STUDIES

1975 - 1979

1. NASA CR 137690, "AN ANALYSIS OF AIRCRAFT ACCIDENTS INVOLVING FIRES," MAY 1975 35
2. CRC REPORT NO. 482, "AVIATION FUEL SAFETY - 1975," NOVEMBER 1975 28
3. REPORT NO. FAA-RD-75-156, "A CRASHWORTHINESS ANALYSIS WITH EMPHASIS ON THE FIRE HAZARD: U.S. AND SELECTED FOREIGN TURBINE AIRCRAFT ACCIDENTS 1964-1974," JULY 1976
4. PAPER PREPARED BY A. F. TAYLOR, "AN EVALUATION OF WORLDWIDE TRANSPORT AIRCRAFT FIRE EXPERIENCES," SEPTEMBER 1976
5. REPORT NO NTSB-AAS-77-1, "SPECIAL STUDY -- U.S. AIR CARRIER ACCIDENTS INVOLVING FIRE 1965 THROUGH 1974 AND FACTORS AFFECTING THE STATISTICS," FEBRUARY 1977
6. PAPER PREPARED BY H. C. BLACK, "TRANSPORT CATEGORY AIRPLANE POST CRASH FUEL SYSTEMS FIRE AND EXPLOSION HAZARD REDUCTION," JUNE 1977
7. AGARD ADVISORY REPORT, "AIRCRAFT FIRE SAFETY," DRAFT DATED JUNE 1979

Presented by T. Horeff, FAA, at the 1st meeting of the SAFER Technical Group on Post-Crash Fire Hazard Reduction - June 28-29, 1979

ENCLOSURE 11

CURRENT TRANSPORT AIRCRAFT DESIGN RULES TO MINIMIZE FUEL SPILLAGE

FAR 25.721(a) & (b) FAILURE OF MAIN LANDING GEAR DURING TAKEOFF AND LANDING SHOULD NOT CAUSE THE SPILLAGE OF ENOUGH FUEL FROM THE FUEL SYSTEM TO CONSTITUTE A FIRE HAZARD. LANDING WITH ANY ONE OR MORE LANDING GEAR LEGS NOT EXTENDED SHOULD ALSO NOT RESULT IN SPILLAGE OF ENOUGH FUEL TO CONSTITUTE A FIRE HAZARD.

(AMEND. 25-15 ADOPTED 9/15/67 AND 25-32 ADOPTED 2/24/72)

FAR 25.994 - FUEL SYSTEM COMPONENTS IN NACELLES OR IN THE FUSELAGE MUST BE PROTECTED FROM DAMAGE WHICH COULD CAUSE THE RELEASE OF FUEL IN A WHEELS-UP LANDING.

(AMEND. 25-23 ADOPTED 4/8/70)

Enclosure II

CURRENT TRANSPORT AIRCRAFT DESIGN RULES TO MINIMIZE FUEL SPILLAGE

FAR 25.963(d) - FUEL TANKS IN THE FUSELAGE MUST BE ABLE TO RESIST RUPTURE AND RETAIN FUEL UNDER EMERGENCY LANDING CONDITIONS AND MUST BE LOCATED SUCH THAT SCRAPING WITH THE GROUND IS UNLIKELY.

(AMEND. 4b-6 ADOPTED 8/12/57)

FAR 25.993(f) - FUEL LINES IN THE FUSELAGE MUST BE ABLE TO DEFORM AND STRETCH WITHOUT LEAKAGE.

(AMEND. 25-15 ADOPTED 9/15/67)

Presented by Tom Horeff, FAA at the 1st Mtg. of the SAFER Tech. Group on Post-Crash Fire Hazard Reduction June 28-29, 1971

SAFETY BOARD RECOMMENDATIONS TO FAA

CAB LETTER, 11/30/65, CITING 11/11/65 B-727 SALT LAKE CITY ACCIDENT

"FUEL LINES SHOULD BE REROUTED THAT THEY PASS THROUGH THE FLOOR BEAMS NEAR THE CENTERLINE OF THE AIRCRAFT AND . . . BE MADE OF STAINLESS STEEL WITH A WALL THICKNESS OF SUFFICIENT DIMENSION TO WITHSTAND RATHER SEVERE IMPACTS."

"GENERATOR LEADS SHOULD BE ROUTED SO THAT THERE IS MAXIMUM SEPARATION BETWEEN THESE LEADS AND THE FUEL LINES. EACH LEAD SHOULD BE IN A SEPARATE, STRONG, AND FLEXIBLE PLASTIC CONDUIT."

FAA RESPONSE

AIRWORTHINESS DIRECTIVE NO. 66-30-02, EFFECTIVE 1/12/67

NEW AIRWORTHINESS REQUIREMENT ADOPTED 9/15/67

ENCLOSURE I

p. of 2

Enclosure IV
p. 2 of 2

[illegible] RECOMMENDATIONS TO FAA

N[illegible] INVOLVING [illegible] AND [illegible] 580

NEW HAVEN ACCIDENTS

"[illegible] ACTION TO INCORPORATE A PROVISION IN THE AIRWORTHINESS REQUIREMENTS FOR FUEL SYSTEM FIRE SAFETY DEVICES WHICH WILL BE EFFECTIVE IN THE PREVENTION AND CONTROL OF BOTH IN-FLIGHT AND POST-CRASH FUEL SYSTEM FIRES AND EXPLOSIONS."

FAA RESPONSE

NOTICE OF PROPOSED RULEMAKING NO. 74-16

Enclosure V

SUB-GROUP ASSIGNMENTS

(SAFER Technical Group on Post-Crash Fire Hazard Reduction)

A. Sub-group on Explosion Suppression, Fuel Tank Foam/Foil, and Fuel Tank Inerting

Chairman: A person* representing AIA
Members: B. Botteri and a person* representing ATA
Advisors**: R. Volz; L. Hebenstreit; R. Appleyard; G. Grabowski; C. C. Kimmel; S. Manatt.

B. Sub-group on Crash Resistant Fuel Tanks

Chairman: A person* representing AIA
Members: C. Pedriani and a person* representing ATA
Advisors**: H. Smith; E. Webb; G. Galloway

C. Sub-group on Anti-Misting Fuels

Chairman: T. Peacock
Members: W. Dukek; R. Mannheimer; and a person* representing ATA

D. Drafting Sub-Group

Chairman: E. Versaw
Members: Chairman of the above Sub-groups
Advisor**: I. Fagin

* These persons are to be nominated by AIA or ATA (as applicable) in the near future.

** These are volunteer advisors. The advice of other persons may be solicited at the discretion of the Sub-Group Chairman.

SUMMARY OF PROCEEDINGS

SAFER Conference of September 24-28

At The NASA/Ames Research Center

Overview. This conference consisted of three consecutive meetings of 1 1/2 days each as follows: A meeting of the Technical Group on Compartment Interior Materials headed by Mr. Martin E. Wilfert, a meeting of the Technical Group on Post-Crash Fire Hazard Reduction headed by Mr. Edward F. Versaw; and a meeting of the SAFER Committee by Mr. J. Enders.

During each of the technical group meetings, subgroup reports were discussed so that recommendations for short and long-term actions could be proposed to the main committee. At the SAFER Committee meeting, the two technical group Chairmen presented their group's suggestions for consideration by the SAFER Committee to be recommended to the Administrator by Mr. Enders, Chairman.

Each of the three meetings were taped and in addition, the main SAFER Committee meeting was recorded by a court reporter. The transcript of this recordation will be the official record of that meeting.

Technical Group on Compartment Interior Materials Meeting. This meeting was opened with welcoming remarks by Dr. Dean Chapman, Director, Astronautics Directorate NASA-Ames Research Center, after which the meeting was chaired by Mr. Martin E. Wilfert.

Subgroup reports were submitted for discussion and to provide material for the Group Chairman's presentation to the SAFER Committee. The areas encompassed by the subgroups were as follows:

1. R & D Review
2. Accident Statistics Review
3. Short-Term Action
   - Materials & Material Systems
   - Toxicology
   - Airline Operations
   - Heat Resistance of Evacuation Slides
   - Materials Evaluation & Testing

Participants in this meeting were:

M. E. Wilfert, Group Leader
J. H. Enders, SAFER Committee Chairman
E. Bara, Member
T. Batey, Authorized substitute
H. P. Branting, Member
C. R. Crane, Member
A. D. Delman, Member
J. J. Fargo, Member

R. G. E. Furlonger, Observer
J. R. Gibson, Member
R. A. Kirsch, Member
W. C. Long, Member
C. J. May, Member
R. H. Madding, Member
J. C. Martin, Member
C. W. McGuire, Member
G. L. Nelson, Member
D. G. Onderak, Member
J. A. Parker, Member
J. D. Ray, Member
C. Sarkos, Member
A. C. Schjelderup, Member
J. D. Simon, Member
D. R. Spicer, Member
G. H. Wear, Member

Technical Group on Post-Crash Fire Hazard Reduction Meeting. The welcoming remarks for this session were provided by Dr. Harold P. Klein, Director of Life Sciences, NASA-Ames Research Center. Mr. Edward Versaw, Chairman, structured this session in a similar manner to the Interior Materials meeting, operating as a working group to formulate suggestions for the SAFER Committee to consider as recommendations to be presented to the Administrator.

Subgroups within this group were as follows:

1. Explosion suppression, fuel tank foam/foil, and fuel tank inerting.
2. Crash-resistant fuel tanks.
3. Anti-misting fuels.

Two presentations were made to add to the group's information. There were:

"The Parker Liquid Nitrogen Inerting System for Post-Crash Fuel-Fire Protection," by Mr. C. Kimmel of the Parker Hannifin Corporation.

"ICI Fibrous Flame Suppressors," by Mr. A. Brown of MFS Products.

Those who participated in this meeting were:

E. F. Versaw, Group Chairman
J. H. Enders, SAFER Committee Chairman
B. P. Botteri, Member
W. G. Dukek, Member

R. G. E. Furlonger, Observer
J. D. Galloway, Member
G. J. Grabowski, Member
T. G. Horeff, Member
C. Kimmel, Member
R. A. Kirsch, Member
J. T. Leonard, Member
S. A. Manatt, Member
J. Martin, Alternate for T. Madgwick
H. C. L. Noordermeer, Member
N. R. Parmet, Member
A. T. Peacock, Member
K. Rosen, Member
R. F. Salmon, Member
H. Skavdahl, Member
H. D. Smith, Member
R. A. Volz, Member
W. D. Weatherford Jr., Member
E. P. Webb, Member
S. Weiss, Member
J. Wignot, Member
J. Wivell, Member

SAFER Committee Meeting. Mr. Clarence Syvertson, Director, NASA-Ames Research Center, presented the opening remarks after which the meeting proceeded under the chairmanship of Mr. John H. Enders.

In order to best utilize the time allotted for the main committee meeting, Mr. Enders structured the proceedings so that each technical group chairman could present the proposed recommendations of his group after which discussions could be held and decisions could be made as to those short-term and long-term recommendations which would be presented to the Administrator.

After lengthy discussions, the Committee decided on the following:

Short-Term Recommendations - Interior Materials

- Retain FAR 25, Appendix F, referenced Bunsen Burner test.
- FAA [illegible]ld request ASTM Committee F-7 to modify method F-501 to corre[illegible] method for materials that drip and melt away from the flam[illegible] d subsequently to modify FAR 25 test method for materials (Appendix F).

Short-Term Recommendations - Post-Crash Fire Hazard

- Amend FAR 25 to require fuel tank vent protection during ground fires.

- Request that the FAA examine, through an ANPRM, the feasibility of amending the regulations to require design practices which minimize the probability of failure to achieve fuel shutoff in potential fire situations.

- The FAA should request the NTSB to implement the proposals by the coordinating research council for improved accident reporting relevant to fuel fires.

Long-Term Recommendations - Interior Materials

- Expedite and coordinate C-133 and similar full-scale fire tests.

- Define a design post-crash fire scenario(s).

- Establish contribution of cabin interior materials relative to the post-crash fire hazard.

- Expedite the development of the OSU chamber and evaluate its use as a regulatory tool (within 3 years).

- Complete preliminary evaluation of the test procedure and present materials for evacuation slides by May 1980.

- Accelerate toxicity research effort to identify and understand the biological chemical and physical factors that must be integrated into comprehensive fire risk assessments for materials in specific use configuration.

- Promote open forums, documents, and presentations to make the subject of toxicology more understandable to regulatory bodies, flight crews, and to the public.

- Develop cabin interior material data bank.

- Continue development of low-smoking, fire-resistant seat foams.

- After ASTM-F7 has modified test F-501 to correct the melt and drip-away from the flame, subsequently modify the FAR 25 test method for materials (Appendix F).

- Develop for new seat designs, fire blocking layer (fire barrier) to protect present polyurethane foam cushioning material (1 year).

5

- Coordinate and accelerate development of analytical post-crash aircraft fire modeling.

Long-Term Recommendations - Post-Crash Fire Hazard

- Continue and expedite FAA/NASA research to establish a realistic airplane crash scenario with increased emphasis on post-crash fuel system failure modes and effects on cabin fire safety.

- From the crash scenario, develop fuel system design criteria which transport category aircraft must meet in order to minimize post-crash fuel fires.

- Support a transport helicopter post-crash fire study similar to the preceding recommendation.

- Expand the investigation of AMK and its properties with respect to all operational aspects of commercial transport aircraft. (The following associated recommendations are not in order of priority):

  - Develop AMK performance specification.
  - Investigate the applicability of anti-misting concepts broadened specification hydrocarbon fuels.
  - Encourage NASA to include AMK technology in its long range fuel program for advanced engine systems.
  - Investigate reduced flash point of kerosene fuels.
  - Broaden large-scale validation test.

- That FAA evaluate the use of self-contained smoke masks, gloves, clothing, or other personal protection equipment for crew members and handicapped passengers in order that they can better complete emergency evacuation under the post-crash condition.

Participants on the SAFER Committee Meeting were:

J. H. Enders, Chairman
J. E. Dougherty, Alternate for Green
J. M. Chavkin, Member (pending approval)
W. T. Edwards, Alternate for Del Balzo
M. L. Goland, Member
G. N. Goodman, Member
B. V. Hewes, Member
C. F. Hitchcock, Member
K. E. Hodge, Member
C. Huggett, Member
E. L. Hutcheson, Member
C. W. McGuire, Member
L. R. Perkins, Member
E. Podolak, Member (pending approval)
J. R. Reese, Member
S. H. Robertson, Member
E. L. Thomas, Member

General Comments

1. Since the first four long-term recommendations under Interior Materials are interrelated, it is the Committee's request that they be tied together during their long-term handling.

2. The subject of smoke hoods was discussed at length. It was decided that the subject should be referred back to the Technical Group on Compartment Interior Materials to determine, indeed, whether alleged significant improvements have been made to these devices to warrant a recommendation for their renewed study.

3. It was the specific request of the technical groups (supported by the SAFER Committee) that they receive information with regard to the FAA response to each of the recommendations.

4. The SAFER Committee charged the Chairman, Mr. Enders, with the task of presenting the contained recommendations to the Administrator at the earliest possible convenience and to reflect, in his presentation, the Committee's discussions leading to these recommendations.

5. As a matter of note, the Chairman expressed dismay that the NTSB observer did not attend this conference in view of the importance that aircraft accident investigation has in structuring a sound aircraft fire safety improvement program.

6. Details of future SAFER meetings will be announced pending the briefing of the Administrator.

Prepared By: ______________________
Executive Director, SAFER Advisory Committee

Concur: ______________________
Chairman, SAFER Advisory Committee

SUMMARY OF PROCEEDINGS
SAFER Meeting of March 4-6, 1980
At The Aerospace Corporation

The meeting was recorded on tape which will be the official record of proceedings. This document will serve as a summary of those proceedings. A final report of all SAFER activities will be made available after the termination of the committee in June 1980.

OVERVIEW. The fourth meeting of the SAFER Advisory Committee was held March 4-6 in El Segundo, California, at the conference facilities of the Aerospace Corporation. The primary purpose of this meeting was for the FAA to respond to the formal SAFER recommendations which were presented to the Administrator subsequent to the SAFER conference of September 24-28, 1979.

At the beginning of this meeting, time was allotted for updating the committee on several items of old business and to accommodate the members in an on-site inspection of the fire safety related aspects of aircraft construction at the Douglas Aircraft Company at Long Beach.

Formal responses were presented by the FAA after which open discussions took place.

The structure of the final SAFER report was considered and assignments were made for contributions of that report. The final SAFER meeting will take place at NAFEC, probably in mid-June for the purpose of reviewing the final draft SAFER report.

SUMMARY

March 4. Dr. A. B. Greenburg, Vice President and General Manager of Government Support Operations of the Aerospace Corporation, welcomed the group to the Aerospace facilities. The opening remarks were made by John R. Harrison, Director of the Office of Aviation Safety, who commended the group on their efforts and charged that, since an excellent network of technical exchange has been established by the committee and its technical support groups, the final SAFER report should be more than a documentation of activities, and should be constructed in such a way that it would serve as a useful reference over the next few years for those involved in aspects of improvement of aircraft cabin interior materials and in the post-crash fire hazard.

Four brief updating presentations were made resulting from assignments made during the previous SAFER meeting.

Mr. Ben Botteri, Chief of the Fire Protection Branch at the Air Force Propulsion Laboratory, presented a summary of the AGARD Report No. 132 of the Propulsion and Energetics Panel's Working Group II on Aircraft Fire Safety. This report has been recently published and will be available to the public through normal N.T.I.S. distribution channels.

Dr. Clayton Huggett, Acting Deputy Director of the National Bureau of Standards, gave the aircraft accident statistics Subgroup Report, pointing out that this report had not been reviewed in its final form by the subgroup. The conclusions stated in the report were as follows:

1. "Statistics" cannot be used as a basis for making determinations for design changes in aircraft.

   There are gaps in the data which have been collected; the state-of-the-art has not enabled some of these gaps to be filled.

3. There are insufficient resources to thoroughly investigate each accident by having all areas of expertise as part of the investigating team. At the time of investigation, it is not always possible to determine the sequence of events leading to fatalities.

   There has been a lack of pertinent data on survivability as it relates to fire, and the available data are not readily retrievable which could facilitate more thorough analysis of the incident.

   Fuel has been invariably involved in incidents in which there were fatalities.

From these conclusions, the subgroup made the following recommendations for consideration of the SAFER committee

1. There needs to be an improvement in data gathering. The AIA and FAA should be requested to work with NTSB to develop a more thorough standardized investigation report format. There should be a continuing procedures to review and update the data collection process. Concomitantly, there should be an improved data retrieval system to make the data available to more people.

2. Existing data should be more thoroughly investigated, vis-a-vis the NASA study.

3. Future changes in design and in regulations should be based on more complete data gathering and analysis.

Mr. Marty Wilfert, Senior Engineer/Scientist for the Douglas Aircraft Company, informed the committee of additional information gathered in the area of passenger smoke hoods. Conclusions reached were that there have been no new advancements which solve the concerns of the delay they might cause in passenger evacuation because of the possible confusion in the use of these devices by an untrained group and because of the risk of suffocation. Mr. Wilfert also mentioned that prospective manufacturers of these hoods are quite concerned with the product liability aspects. Mr. Ed Thomas of ATA added that the possible hampering of communication when using smoke hoods is also a problem with serious potential.

Dr. John Parker, Chief of the Chemical Research Projects Office at NASA Ames, reviewed work done in the area of cabin insulation materials as thermal barriers and proposed further study of this and of the use of reflective paints for such use.

During the afternoon of the first day, the committee members visited portions of the Douglas Aircraft Company assembly line so that they could see, first-hand, the installation of cabin interior materials and other factors pertinent to the committee's deliberations.

March 5. This day was devoted to the formal responses by the FAA to the recommendations made by the SAFER Committee.

Mr. Tom Horeff presented the responses to the long- and short-term recommendations which were of a regulatory nature. The recommendations and responses were as follows:

RECOMMENDATION. Retain the FAR 25, Appendix F, referenced bunsen burner test and request the ASTM Committee F-7 to modify method F-501 to correct the method for materials that drip and melt away from the flame and subsequently to modify the FAR 25 test method for materials (Appendix F).

RESPONSE. A letter from the FAA to the Chairman of the ASTM Committee F-7.06 has been sent (February 8, 1980) requesting that the recommendation to modify method F-501 be included as an agenda item for the next scheduled meeting of Committee F-7.06. The FAA will issue an [illegible] to amend the FAR 25 test method for materials (Appendix F) subsequent to modification of method F-501 by the ASTM.

RECOMMENDATION. Amend FAR 25 to require fuel tank vent protection during ground fires.

RESPONSE. The FAA will issue an ANPRM to seek comments concerning the effectiveness of vent flame arrestors and surge tank suppression systems in delaying the ignition of fuel vapor within the system due to external fires.

RECOMMENDATION. Examine, through an ANPRM, the feasibility of amending the regulations to require design practices which maximize the probability of engine fuel supply shut-off in potential fire situations.

RESPONSE. The FAA will issue an ANPRM to seek comments concerning the feasibility and the availability of design practices which may exist to maximize the probability of fuel shut-off in potential fire situations.

RECOMMENDATIONS. Request the NTSB to implement the proposals by the Coordinating Research Council for improved accident reporting relevant to fuel fires.

RESPONSE. An FAA letter to NTSB solicits NTSB review of CRC proposal with the objective of satisfying the need for more accident information relative to fuel, fires, and explosions. (This letter was signed by the Administrator on March 11, 1980.)

Mr. Horeff also mentioned that an R&D program to develop improved criteria for fuselage and wing crash-resistant fuel systems is planned by the FAA in FY-81 and that crash-resistant fuel system requirements were proposed at the Rotorcraft Regulatory Review in December 1979.

There were several questions following Mr. Horeff's presentation but in the interest of saving time during this day of FAA responses, they were diverted to the morning of the last day.

Mr. Tom Edwards of NAFEC responded to the remaining recommendations which concerned long-term R&D. By way of background, a general description of the management of the FAA Aircraft Safety R&D Program was given along with overviews of the cabin fire safety and the modified fuel R&D program.

The recommendations were grouped by Mr. Edwards into those which related to full-scale experiments, fire modeling, post-crash fire scenario analysis, laboratory test methodology development, survival and evacuation, standards and improvements, and those of a general nature. A thorough description of the plans for satisfying the SAFER recommendations was presented with proposed time tables for carrying out these efforts.

In addition, there was a description of work already initiated at NAFEC which relates to the SAFER goals. There was no apparent committee controversy with regard to the research and development responses presented by Mr. Edwards, except some concern over the quotable costs associated with the R&D program.

<u>March 6</u>. The questions relating to Mr. Horeff's regulatory responses, presented the previous day, were entertained. Mr. Horeff was questioned by Ed Thomas (ATA) with regard to Mr. Horeff's accident statistics which were not in agreement with those of the NTSB for the same time period. Mr. Horeff distributed information supporting his accident statistics.

There was confusion among the committee as to what was meant by the FAA response to the recommendation for requiring fuel tank vent protection during ground fires. There was concern that the FAA might again be favoring fuel-inerting systems. Mr. Horeff emphasized that this was not the case.

<u>GENERAL COMMENTS</u>:

The committee placed much emphasis on the setting of priorities on the proposed actions of the FAA in response to the SAFER recommendations. Realizing that, with budget limitations, the FAA will be able to accomplish all the SAFER tasks with equal emphasis, the committee wants a hard look to be taken where R&D money can be spent to produce the best payoff in practical increases in safety.

With regard to the recommendation alluding to fuel vent flame suppression, Dr. Huggett (NBS) proposed that basic testing should be done involving an aircraft wing, with the required lightning arrester installed, in a pool fire so that basic data can be obtained on the effectiveness of these arrestors in that situation. He also suggested that strong emphasis be placed on improved accident statistics. The lack of information in this regard had a significant effect on the committee's efforts.

Interest was expressed on the subject of paints which might delay the fire effects in certain critical areas of an aircraft and may have a side benefit of corrosion protection.

Capt. Vic Hewes (ALPA) emphasized consideration for more study of cabin windows which can shrink in elevated thermal conditions allowing the more rapid entry of heat and flame. He expressed concern for the serious problem caused by melting and dripping of ceiling panels and the need for smoke/fire detectors in lavatories. He also suggested that the committee consider recommending the requirement for low-level emergency exit lighting in addition to the existing high-level lighting already installed.

Chairman Jack Enders made the point that in accidents/incidents where fire does not occur or where fire occurs and there are no fatalities, it is important to examine "what went right," as well as what accident causal factors were present.

Mr. Guy Goodman (ATA) informed the committee that in the ICAO meet [illegible] considerations were being given to engine containment and providing protection to occupants when there is noncontainment.

Mr. Jack Wivel of British Airways stressed the importance of [illegible] impeding safety improvement by overregulating.

There was general agreement by the committee that, to maintain continuity after SAFER, Ad Hoc committees should be established.

Presentations were made by Mr. Ev Tustin of Boeing and Mr. Ed Ri[illegible] Lockheed outlining the efforts of these companies in fire safety improvement. Copies of their material is included with this summary.

The final item covered at this meeting was the structure of the final report of the committee which will reflect the committee's activities during its existence. A tentative report outline presented to the members contains 11 parts, each of which were assigned as responsibilities of specific individuals. These parts are listed below with the names of the responsible individuals. It was emphasized by the Chairman that any member of the SAFER Committee or its technical groups should feel free to contribute to any part of this report even though they may not have been named specifically, or have been asked by the person responsible for a particular part.

Part 1: Front End Matter - J. Enders and E. Wood

Part 2: Aircraft Fire Problem Definition - *C. Huggett, Ed Thoma[illegible] J. Fargo, and G. Walhout

Part 3: General Considerations of Aircraft Fire and Explosion [illegible] *M. Goland and J. Del Balzo

Part 4: Assessment of Adequacy of Current Standards and Existing Technical Basis for Near Term Upgrading of Rules - *J. R[illegible] and J. Chavkin

Part 5: Fireworthy Materials - *M. Wilfert, J. Parker, and E. [illegible]

Part 6: Toxicity and Smoke - *L. Perkins, E. Podolak, and J. Punderson

Part 7: Fuel System Fire Hazards - *J. Bert, *E. Versaw, and [illegible]

Part 8: R&D Considerations - *A. Tobiason and T. Edwards

Part 9: Crew Protection and Passenger Evacuation - *B. V. Hewes, R. Clarke, J. Searle, and C. Hitchcock

Part 10: SAFER Committee Findings and Recommendations - J. Ender[illegible] E. Wood NOTE: It has been tentatively decided that the [illegible] responses to the SAFER recommendations will be placed in t[illegible] area.

Part II: Reference and Bibliography - *A. Tobiason, [illegible]
G. Walhout, C. Huggett, and [illegible] Parker

NOTE: Asterisk indicates prime responsibility.

SAFER Committee Participants for This Section

J. H. Enders - Chairman
E. C. Wood - Executive Director
J. A. Berr
E. Podolak
T. G. Horeff (Alternate for J. Chavkin)
R. W. Clarke (Alternate for B. V. Hewes)
J. M. Del Balzo
J. E. Dougherty
M. L. Goland
G. N. Goodman
B. V. Hewes
C. E. Hitchcock
C. Huggett
L. R. Perkins
J. C. Reese
J. E. Searle
E. L. Thomas
A. R. Tobiason (Replacement for R. Hodge)

Prepared by: ______________________
Executive Director, SAFER Advisory Committee

CONCUR: ______________________
Chairman, SAFER Advisory Committee

SHORT-TERM RECOMMENDATIONS - INTERIOR MATERIALS

- RETAIN FAR 25, APPENDIX F, REFERENCED BUNSEN BURNER TEST.

- REQUEST ASTM COMMITTEE F-7 TO MODIFY METHOD F-501 TO CORRECT THE METHOD FOR MATERIALS THAT DRIP AND MELT AWAY FROM THE FLAME AND SUBSEQUENTLY TO MODIFY FAR 25 TEST METHOD FOR MATERIALS (APPENDIX F).

BASED ON CONCLUSION THAT THE BUNSEN BURNER TEST IS A VALID IGNITABILITY TEST FOR 25.? MATERIALS, EXCEPT FOR THOSE WHICH READILY MELT AWAY FROM THE BURNER FLAME DURING THE TEST.

SHORT-TERM RECOMMENDATIONS - INTERIOR MATERIALS

FAA RESPONSE

FAA LETTER TO CHAIRMAN, ASTM COMMITTEE F-7.06, REQUESTS THAT RECOMMENDATION TO MODIFY METHOD F-501 BE INCLUDED AS AN AGENDA ITEM FOR THE NEXT SCHEDULED MEETING OF COMMITTEE F-7.06.

FAA WILL ISSUE NPRM TO AMEND FAR 25 TEST METHOD FOR MATERIALS (APPENDIX F) SUBSEQUENT TO MODIFICATION OF METHOD F-501 BY ASTM.

TOTAL OF SURVIVABLE/FATAL AIRCRAFT FIRE ACCIDENTS

U. S. AIR CARRIERS WORLD-WIDE, 1964-1978

NO.	[illegible]	FATALITIES TOTAL	FATALITIES DUE TO FIRE
18	[illegible] ITION	805	[illegible]*
10	[illegible]	601	[illegible]*
1	ENGINE COMPONENT DAMAGE	46	46
1	FUEL FIRE DAMAGE	4[illegible]	[illegible]
1	UNKNOWN	[illegible]	7
31		15[illegible]	[illegible]*

*ESTIMATED [illegible]

THESE 31 [illegible]

SURVIVABLE/FATAL AIRCRAFT FIRE/EXPLOSION ACCIDENTS

U.S. AIR CARRIERS WORLD-WIDE, 1964-1978

FUEL RELEASE MODE	TOTAL	EXPLOSIONS
WING SEPARATION	18	(6)
TANK DAMAGE	10	(3)
ENGINE COMPONENT DAMAGE	1	(1)
FUEL LINE DAMAGE	1	
UNKNOWN	1	
	31	(10)

EXPLOSIONS OCCURRED DURING EVACUATION IN ABOUT 32% OF THE TOTAL SURVIVABLE/FATAL FIRE ACCIDENTS

TOTAL SURVIVABLE/FATAL AIRCRAFT EXPLOSION ACCIDENTS

U.S. AIR CARRIERS WORLD-WIDE, 1964-1978

NO	FUEL RELEASE MODE	FATALITIES TOTAL	FATALITIES DUE TO FIRE
(6)	WING SEPARATION	363	222
(3)	TANK DAMAGE	340	121
(1)	ENGINE COMPONENT DAMAGE	48	48
(10)		751	391

ESTIMATED 391 FATALITIES DUE TO FIRE IN ACCIDENTS WHERE EXPLOSIONS OCCURRED DURING EVACUATION REPRESENT ABOUT 52% OF THE FATALITIES IN THESE ACCIDENTS.

SHORT TERM RECOMMENDATIONS - POST-CRASH FIRE HAZARD

- AMEND FAR 25 TO REQUIRE FUEL TANK VENT PROTECTION DURING GROUND FIRES.

BASED ON CONCLUSION THAT VENT FLAME ARRESTORS OR SURGE TANK SUPPRESSION SYSTEMS CURRENTLY USED IN MOST COMMERCIAL PRODUCTION AIRCRAFT PROVIDE THE MAJORITY OF THE PROTECTION THAT WOULD BE PROVIDED BY INERTING, QUENCHING, AND MULTI-TANK SUPPRESSION SYSTEMS IN THEIR CURRENT STATE OF DEVELOPMENT.

RECOMMENDATION WAS MADE TO AMEND FAR 25 TO CONFORM TO THIS EXISTING TECHNOLOGY.

SHORT-TERM RECOMMENDATIONS - POST-CRASH FIRE HAZARD

FAA RESPONSE

SURGE TANK SUPPRESSION SYSTEMS ARE CURRENTLY USED IN SOME COMMERCIAL PRODUCTION AIRCRAFT TO COMPLY WITH FAR 25.954, ADOPTED 8/11/67, OR AD NO. 67-23-02, EFFECTIVE 9/10/67, WHICH REQUIRE PROTECTION AGAINST LIGHTNING-INDUCED IGNITION AT FUEL VENT OUTLETS.

VENT FLAME ARRESTORS ARE ALSO USED IN SOME AIRCRAFT TO COMPLY WITH LIGHTNING PROTECTION REQUIREMENTS AND ARE USED IN OTHER AIRCRAFT AT DESIGNERS' OPTION.

SHORT-TERM RECOMMENDATIONS - POST-CRASH FIRE HAZARD

FAA RESPONSE

VENT FLAME ARRESTORS OR SURGE TANK SUPPRESSION SYSTEMS WILL DELAY BUT NOT PREVENT PROPAGATION OF FLAMES FROM A GROUND FIRE THROUGH THE VENT INTO THE FUEL TANKS.

VENT FLAME ARRESTORS OR SURGE TANK SUPPRESSION SYSTEMS ARE NOT CAPABLE OF PROVIDING THE PROTECTION THAT WOULD BE PROVIDED BY INERTING, QUENCHING, AND MULTI-TANK SUPPRESSION SYSTEMS THROUGHOUT THE PERIOD OF TIME THAT THE FUEL TANKS REMAIN INTACT DURING A GROUND FIRE.

SHORT-TERM RECOMMENDATIONS - POST-CRASH FIRE HAZARD

FAA RESPONSE

PROPOSED REGULATORY LANGUAGE SHOULD BE OBJECTIVE IN NATURE IN SPECIFYING THE INTENDED PROTECTION, E.G., FUEL TANK VENT SYSTEMS MUST BE DESIGNED TO DELAY THE IGNITION OF FUEL VAPOR WITHIN THE SYSTEM DUE TO EXTERNAL FIRES.

FAA WILL ISSUE AN ANPRM TO SEEK COMMENTS CONCERNING THE EFFECTIVENESS OF VENT FLAME ARRESTORS AND SURGE TANK SUPPRESSION SYSTEMS IN DELAYING THE IGNITION OF FUEL VAPOR WITHIN THE SYSTEM DUE TO EXTERNAL FIRES.

FAA WILL MONITOR RESEARCH AND DEVELOPMENT PROGRAMS ON PROMISING APPROACHES TO PREVENT THE IGNITION OF FUEL VAPORS THROUGHOUT THE PERIOD OF TIME THAT THE FUEL TANKS REMAIN INTACT DURING A GROUND FIRE.

SHORT-TERM RECOMMENDATIONS - POST-CRASH FIRE HAZARD

- EXAMINE, THROUGH AN ANPRM, THE FEASIBILITY OF AMENDING THE REGULATIONS TO REQUIRE DESIGN PRACTICES WHICH MAXIMIZE THE PROBABILITY OF ENGINE FUEL SUPPLY SHUTOFF IN POTENTIAL FIRE SITUATIONS.

BASED ON DESIGN PRACTICE IN USE WHICH PROVIDES FOR CLOSURE OF BOTH TANK-TO-ENGINE AND ENGINE SHUTOFF VALVES DURING NORMAL SHUTDOWN.

RECOMMENDATION WAS MADE TO AMEND FAR 25 AND/OR FAR 121 TO CONFORM TO THIS EXISTING TECHNOLOGY.

SHORT-TERM RECOMMENDATIONS - POST-CRASH FIRE HAZARD

FAA RESPONSE

FAA WILL ISSUE AN ANPRM TO SEEK COMMENTS CONCERNING THE FEASIBILITY AND THE AVAILABILITY OF DESIGN PRACTICES WHICH MAY EXIST TO MAXIMIZE THE PROBABILITY OF FUEL SHUTOFF IN POTENTIAL FIRE SITUATIONS.

SHORT-TERM RECOMMENDATIONS - POST-CRASH FIRE HAZARD

- REQUEST THE NTSB TO IMPLEMENT THE PROPOSALS BY THE COORDINATING RESEARCH COUNCIL FOR IMPROVED ACCIDENT REPORTING RELEVANT TO FUEL FIRES.

BASED ON CONCLUSION THAT INVESTIGATIONS OF BETTER WAYS TO PROTECT AIRCRAFT AND OCCUPANTS AGAINST POST-CRASH FIRES ARE HAMPERED BY INADEQUATE DATA IN ACCIDENT REPORTS.

[illegible] RECOMMENDATIONS - POST-CRASH FIRE HAZARD

FAA RESPONSE

[illegible] ACCIDENT INVESTIGATION [illegible] FOR USE IN PREPARATION OF HUMAN FACTORS FACTUAL [illegible] FUEL AND FIRE INFORMATION PROPOSED BY THE CRC IS [illegible] DOCUMENTED BUT [illegible] FOR STORING SUCH INFORMATION IN THE COMPUTER.

[illegible] CODES FOR STORAGE AND RETRIEVAL OF FUEL AND FIRE INFORMATION.

[illegible] REVIEW OF CRC PROPOSAL WITH THE OBJECTIVE OF SATISFYING [illegible] INFORMATION RELATIVE TO FUEL, FIRES, AND EXPLOSIONS.

CRASH RESISTANT FUEL CELL SUBGROUP CONCLUSIONS

IT IS FEASIBLE TO INSTALL CRASH-RESISTANT FUEL CELLS IN FUSELAGE CARGO COMPARTMENTS.

IT MAY BE FEASIBLE TO INSTALL SOME DEGREE OF CRASH-RESISTANCE AT CRITICAL LOCATIONS IN SOME STATE-OF-THE-ART AIRCRAFT WINGS, DEPENDING UPON SPECIFIC TYPE DESIGN.

FURTHER DEFINITION OF CRITERIA FOR IMPROVED CRASH-RESISTANT FUEL CELLS SHOULD EVOLVE FROM TOTAL AIRCRAFT CRASHWORTHINESS CONSIDERATIONS IF WARRANTED BY THE RESULTS OF ADDITIONAL ACCIDENT DATA EVALUATION.

[illegible] FOR [illegible] CONCLUSIONS

[illegible]

[illegible]

[illegible]

FAA RESPONSE

SPECIAL AVIATION FIRE AND EXPLOSION REDUCTION ADVISORY COMMITTEE

LONG-TERM RECOMMENDATIONS ON AIRCRAFT

CABIN INTERIOR MATERIALS

AND

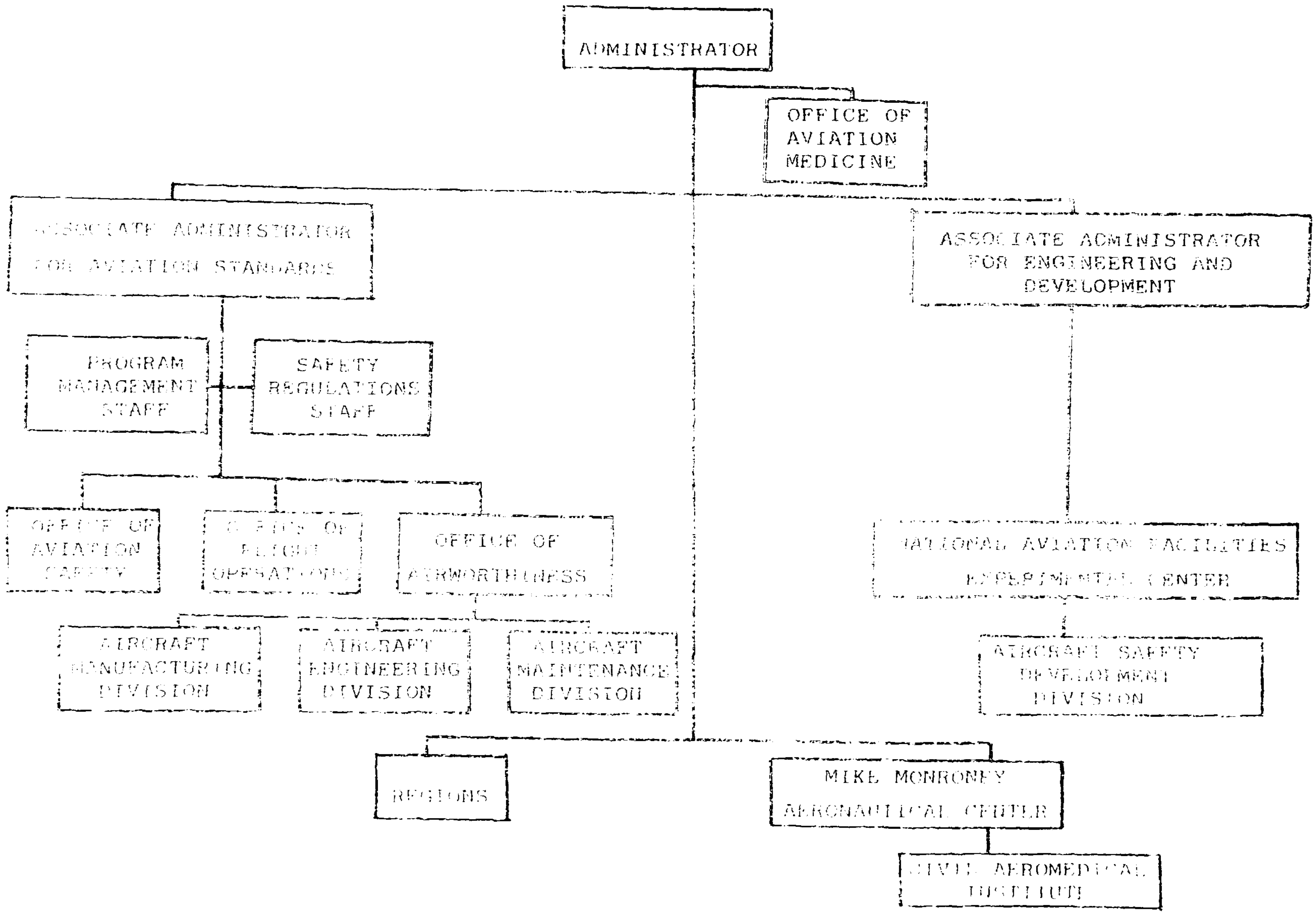
POST-CRASH FIRE HAZARD

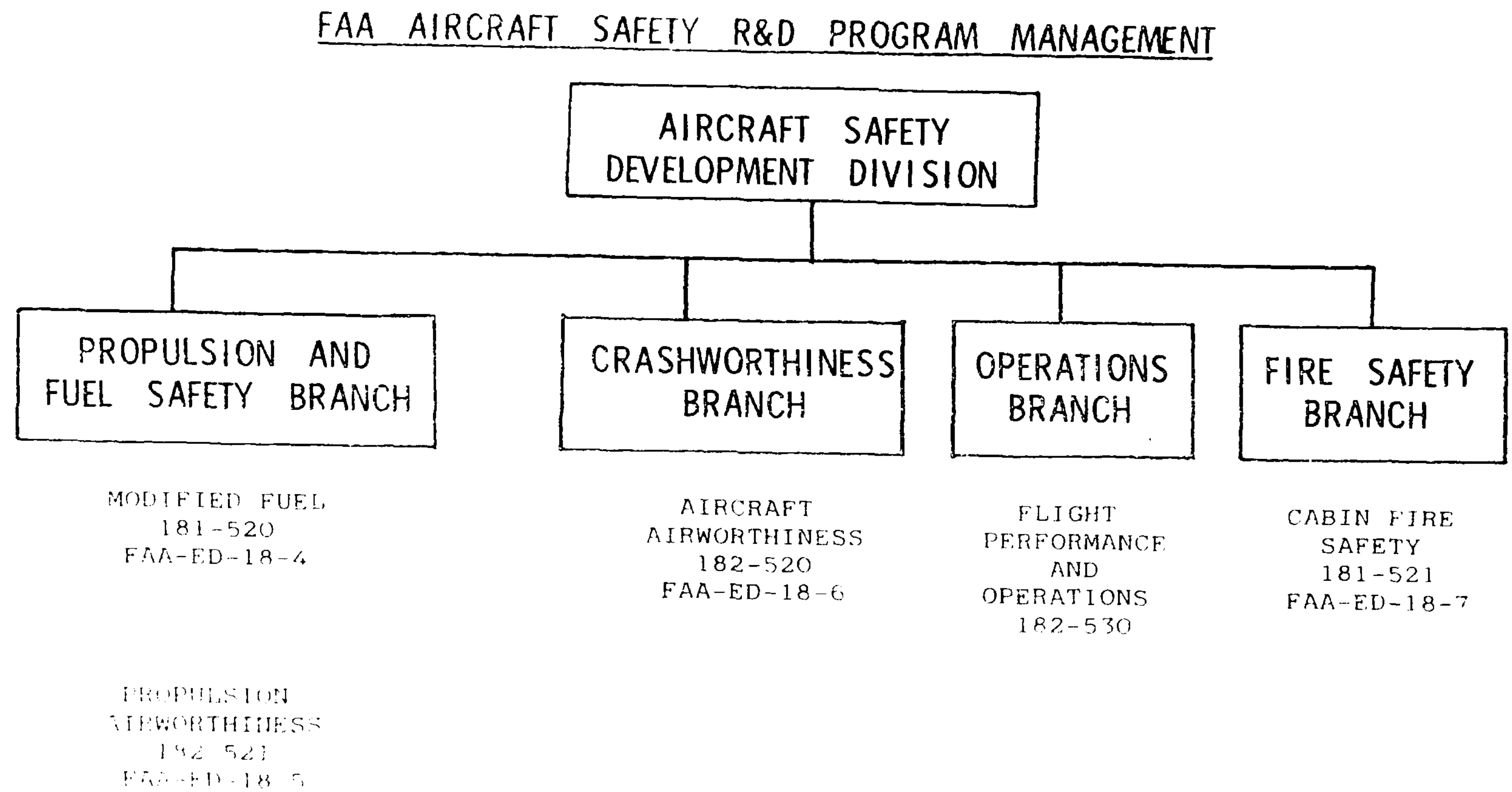
MARCH 5, 1980

PRESENTATION OUTLINE

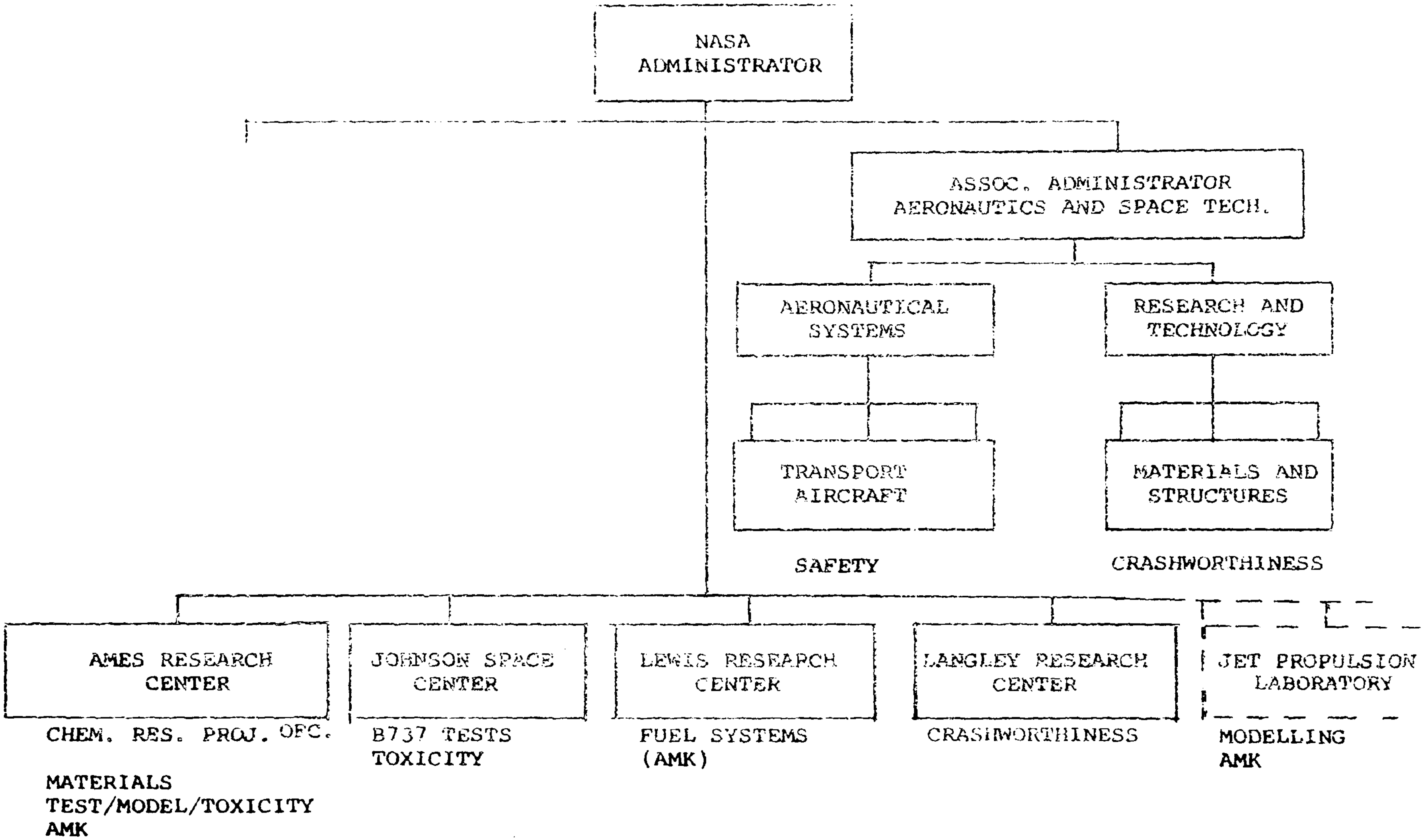
- GENERAL
  - FAA AIRCRAFT SAFETY R&D PROGRAM MANAGEMENT
- INTERIOR MATERIALS
  - OVERVIEW OF CABIN FIRE SAFETY R&D PROGRAM
  - SAFER RECOMMENDATIONS
    - o PLANNED R&D
    - o RESULTS
- POST-CRASH FIRE HAZARD
  - OVERVIEW OF MODIFIED FUEL R&D PROGRAM
  - SAFER RECOMMENDATIONS
    - o PLANNED R&D
    - o RESULTS

FAA AIRCRAFT SAFETY R&D PROGRAM MANAGEMENT




FAA AIRCRAFT SAFETY R&D PROGRAM MANAGEMENT
AIRCRAFT SAFETY DEVELOPMENT DIVISION
PROPULSION AND FUEL SAFETY BRANCH
CRASHWORTHINESS BRANCH
OPERATIONS BRANCH
FIRE SAFETY BRANCH
MODIFIED FUEL 181-520 FAA-ED-18-4
AIRCRAFT AIRWORTHINESS 182-520 FAA-ED-18-6
FLIGHT PERFORMANCE AND OPERATIONS 182-530
CABIN FIRE SAFETY 181-521 FAA-ED-18-7
PROPULSION AIRWORTHINESS

NASA ORGANIZATION



INTERIOR MATERIALS

AIRCRAFT CABIN FIRE SAFETY

PROGRAM PLAN

ARB... 3/80

CABIN FIRE PROBLEM

HIGH DENSITY PEOPLE/COMBUSTIBLES

ACCIDENT ANALYSIS

- .FIRE FATALITIES OCCUR IN CRASH ACCIDENTS
- .FIRE/TOTAL ACCIDENT FATALITIES 15 PERCENT
- .FIRE/SURVIVABLE ACCIDENT FATALITIES 40 PERCENT

IN-FLIGHT FIRE

- .U.S. AIRLINES RECORD FLAWLESS

FAA FIRE REGULATIONS

- .FLAMMABILITY HISTORY, 1947 - 1972
- .BUNSEN BURNER TEST
  - -GOOD IGNITABILITY: LIMITED TEST CONDITIONS AND MEASUREMENTS
- .PROPOSED RULEMAKING
  - -FLAMMABILITY, SMOKE, AND TOXICITY
  - "PIECEMEAL" CRITICISM

OVERALL PROGRAM OBJECTIVES

CHARACTERIZE POSTCRASH TRANSPORT CABIN FIRE HAZARDS

- .ROLE OF INTERIOR MATERIALS

INCREASE THE SURVIVABILITY OF OCCUPANTS

- .DEVELOP TEST METHODS AND CRITERIA FOR INTERIOR MATERIALS
- .EXAMINE AND RECOMMEND
    - -FIRE MANAGEMENT/SUPPRESSION SYSTEMS
    - -EVACUATION AIDS
- .EXAMINE AND FOSTER THE USE OF IMPROVED MATERIALS

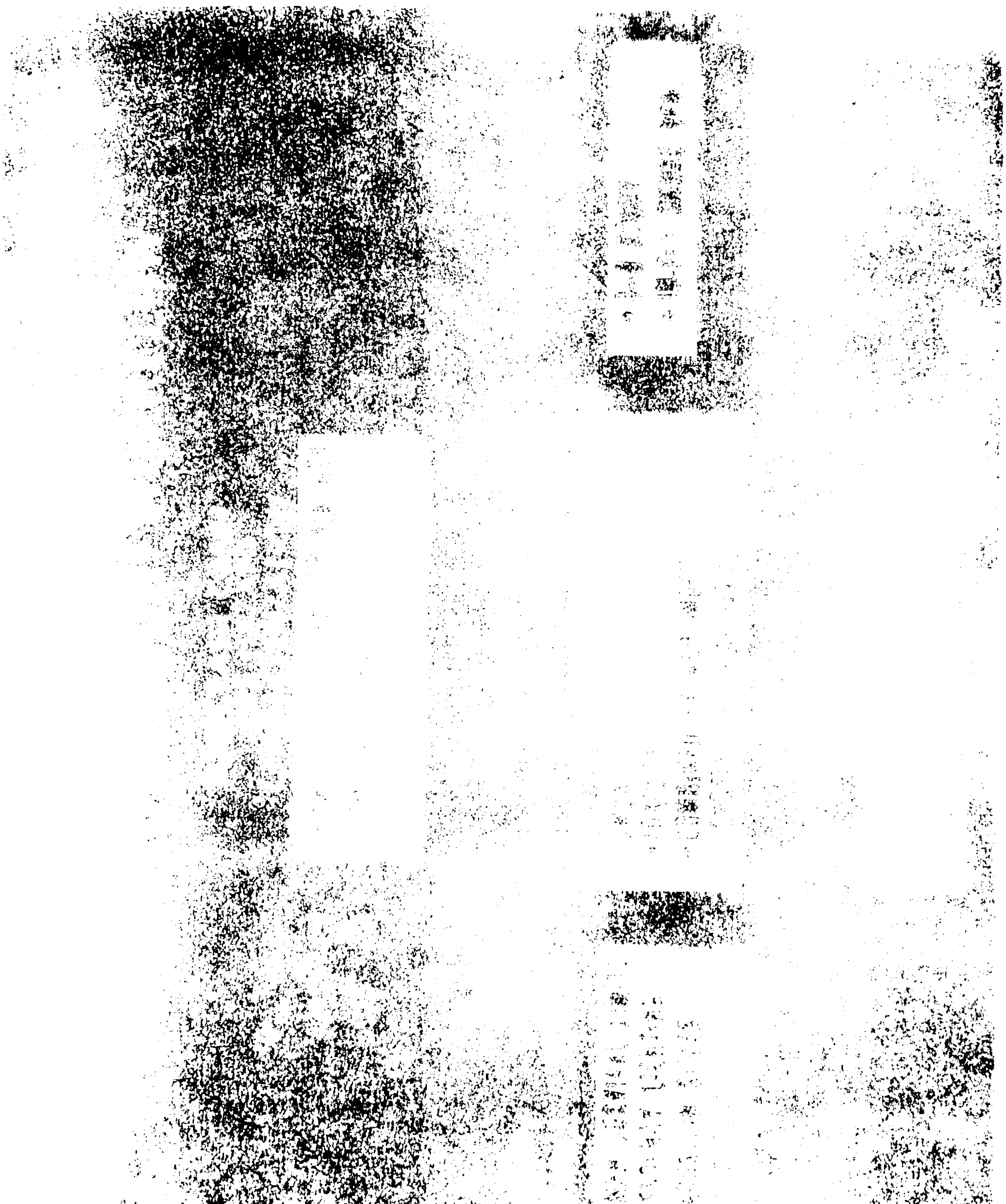

IMPROVEMENT IN POSTCRASH
CABIN FIRE SAFETY
FIRE
MATERIALS

MAJOR PROGRAM TASKS

1. POSTCRASH CABIN FIRE HAZARDS CHARACTERIZATION
2. LABORATORY TEST METHODOLOGY DEVELOPMENT
3. SURVIVAL AND EVACUATION
4. FIRE MANAGEMENT AND SUPPRESSION
5. STANDARDS AND IMPROVEMENTS

PLANNED C-133 PROJECTS

1. CABIN HAZARDS WITHIN A BARE INTERIOR
2. CABIN HAZARDS WITHIN AN INTERIOR FURNISHED WITH "TYPICAL" WIDEBODY MATERIALS
3. CHARACTERIZATION OF A DESIGN FIRE
4. CABIN HAZARDS WITHIN AN INTERIOR FURNISHED WITH ADVANCED NASA MATERIALS
5. STUDIES TO CORRELATE SMALL-SCALE AND LARGE-SCALE TEST RESULTS



C-133

FULL-SCALE FIRE TEST FACILITY

UNIQUE DESIGN AND DIMENSIONS

SCHEDULED COMPLETION - MAY 1980

BEGIN TESTING - JULY 1980

SIGNIFICANT ACCELERATION IN TESTING

- ISOLATION FROM WINDS WHICH DESTROY TEST REPEATABILITY
- REGULARLY SCHEDULED TESTING INDEPENDENT OF WEATHER
- TESTING POSSIBLE IN WINTER

-MODELING-

INTRODUCTION

FULL-SCALE TESTS

.MOST DEFINITIVE SOURCES OF DATA, BUT COSTLY, TIME-CONSUMING AND RELATIVELY INFLEXIBLE

MODELING

.LESS ACCURATE DATA, BUT MORE FLEXIBLE AND LESS TIME-CONSUMING

FAA SPONSORSHIP

.PHYSICAL FIRE MODELING...SCALED MODELS

-FROUDE..ATMOSPHERIC PRESSURE...NAFEC

-PRESSURE...30 ATMOSPHERES...FMRC NOW BUT LATER AT NAFEC

.MATHEMATICAL FIRE MODELING...SEMIEMPIRICAL COMPUTER PROGRAM FOR PREDICTING FLAME SPREAD AND HAZARD DEVELOPMENT...UDRI...DAYTON AIRCRAFT FIRE (DACFIR) MODEL

AD-A099 176 FEDERAL AVIATION ADMINISTRATION WASHINGTON DC OFFICE--ETC F/G 1/2
SPECIAL AVIATION FIRE AND EXPLOSION REDUCTION (SAFER) ADVISORY --ETC(U)
JUN 80 J H ENDERS, E C WOOD
UNCLASSIFIED FAA-ASF-80-4-VOL-2B NL

2 OF 3
AD A
099176

-MODELING-

GENERAL OBJECTIVES

DEVELOP RELIABLE PHYSICAL FIRE MODELING TECHNIQUES

- .BROADLY EVALUATE EFFECTS OF DIFFERENT MATERIALS AND MATERIAL SYSTEMS
- .EXAMINE DIFFERENT FIRE SCENARIOS, AMBIENT CONDITIONS, AND CONFIGURATIONAL FACTORS
- .ASSIST IN DETERMINING FULL-SCALE CONDITIONS

DEVELOP A RELIABLE MATHEMATICAL MODEL OF POSTCRASH CABIN FIRE (COMPUTER PROGRAM)

- .PREDICT EFFECTS OF CHANGES IN CABIN DESIGN AND INTERIOR MATERIALS

-MODELING-

<u>EXTRAMURAL EFFORTS</u>

UDRI	-FURTHER DEVELOPMENT AND VALIDATION DACFIR
FMRC	-PRESSURE MODELING
	-SMOKE LAYER RADIATION
NASA (JSC)	-DACFIR VALIDATION TESTING
NASA (ARC)	-ADVANCED WINDOWS
	-CMA PROGRAM
NASA (JPL)	-THERMOCHEMICAL MODELING
NBS	-FIELD MODEL SOLUTIONS TO ASSIST UDRI DACFIR DEVELOPMENT
	.SMOKE LAYER GAS DYNAMICS
	.FUEL FIRE PENETRATION INTO FUSELAGE
	.FUSELAGE PRESSURE DISTRIBUTION
CAMI	-EVACUATION MODELING

-LABORATORY TEST METHODOLOGY DEVELOPMENT-

<u>INTRODUCTION</u>

.CABIN MATERIALS SCREENED USING SMALL-SCALE TESTS

.FLAMMABILITY-IGNITABILITY, FLAME SPREAD, HEAT, FLASHOVER

.SMOKE-OBSCURATION

.TOXICITY-INCAPACITATING OR LETHAL NATURE OF COMBUSTION PRODUCTS

<u>OBJECTIVE</u>

.TO DETERMINE WHAT TEST(S), TEST CONDITIONS, DATA OR SCIENTIFIC TREATMENT OF DATA BEST RELATE TO THE

FIRE HAZARDS

OF BURNING CABIN MATERIALS IN A POSTCRASH EXTERNAL FUEL FIRE ENVIRONMENT

-LABORATORY TEST METHODOLOGY DEVELOPMENT-

MAJOR ACTIVITIES

1. FLAMMABILITY

2. SMOKE

3. TOXICITY

4. COMBINED HAZARD INDEX OR CHI

5. CORRELATION STUDY OF SMALL-SCALE TESTS WITH LARGE-SCALE TESTS

-SURVIVAL AND EVACUATION-

<u>INTRODUCTION</u>

.FAA 90-SECOND EVACUATION DEMONSTRATION REQUIREMENT

.MUST QUANTIFY HUMAN TOLERANCE TO MAJOR PHYSICAL FIRE-RELATED HAZARDS

- -SMOKE AND IRRITANT GASES: IMPAIRMENT OF VISIBILITY
- -HEAT: THERMAL STRESS
- -OXYGEN DEPLETION: LIFE HAZARD

.SURVIVAL AND EVACUATION CLOSELY LINKED

.RAPID EVACUATION RATE IS <u>OVERRIDING</u> SAFETY CONSIDERATION

- -EMERGENCY LIGHTING FOR SMOKE-FILLED CABIN
- -HEAT RESISTANT EVACUATION SLIDES
- -SMOKE HOODS FOR PASSENGER/CREW PROTECTION

-SURVIVAL AND EVACUATION-

<u>MAJOR ACTIVITIES</u>

1. HUMAN SURVIVAL LIMITATIONS

2. EMERGENCY LIGHTING

3. EVACUATION SLIDES

4. SMOKE HOODS

-FIRE MANAGEMENT AND SUPPRESSION-

INTRODUCTION

.BUILDING FIRE PROTECTION PRIMARILY FIRE DETECTION, MANAGEMENT AND SUPPRESSION

.SIMILAR CONCEPTS AIRCRAFT IN-FLIGHT FIRE PROTECTION

.CAN THESE OR OTHER CONCEPTS BE ADAPTED IMPROVEMENT POSTCRASH CABIN FIRE SAFETY?

RECENT EXPERIMENTAL STUDIES

.FAA/NAFEC

-COMPARTMENTATION: QUESTIONABLE BENEFIT: UNKNOWN EFFECT ON EVACUATION

-HALON 1301: EFFECTIVE FIRES WHOLLY WITHIN CABIN; COUNTERPRODUCTIVE EXTERNAL FUEL FIRE

-C-133: EFFECT OF GALLEY BLOCKAGE

.NASA/MCDONNEL/BOEING

-GALLEY AND CARGO COMPARTMENT HARDENING

-FIRE MANAGEMENT AND SUPPRESSION-

COMMENCING IN FY-80

PHASE I (CONTRACT)

- .DETERMINE FEASIBILITY AND ESTIMATE COST/BENEFIT
- .IDENTIFY PROMISING CONCEPTS REQUIRING EXPERIMENTATION

PHASE II (CONTRACT OR IN-HOUSE)

- .EXPERIMENTAL STUDY PROMISING CONCEPTS

PHASE III (CONTRACT)

- .DESIGN STUDY OF BEST RATED SYSTEM
- .DERIVE HARD DATA INITIAL AND RECURRING COSTS
- .CALCULATE ACCURATE COST/BENEFIT FOR COMPARISON ADVANCED MATERIALS SYSTEMS

-STANDARDS AND IMPROVEMENTS-

<u>MAJOR ACTIVITIES</u>

1. ACCEPTABILITY CRITERIA ANALYSIS

2. DATA BANK

3. IMPROVEMENTS IN SPECIFIC USAGE CATEGORIES

AIRCRAFT CABIN FIRE SAFETY PROGRAM

FUNDING REQUIREMENTS ($000)

MAJOR TASKS	FY-80	FY-81 (EST)	FY-82 (EST)	FY-83 (EST)	FY-84 (EST)
1. POSTCRASH CABIN FIRE HAZARDS CHARACTERIZATION	886	800	400	100	0
2. LABORATORY TEST METHODOLOGY DEVELOPMENT	665	400	250	50	0
3. SURVIVAL & EVACUATION	485	600	200	50	0
4. FIRE MANAGEMENT AND SUPPRESSION	170	200	150	0	0
5. STANDARDS & IMPROVEMENTS	80	300	300	150	0
6. LONG TERM STUDIES	0	0	0	650	1000
TOTAL	2286	2300	1300	1000	1000

NASA PLANNING

AIRCRAFT INTERIOR FIRE TECHNOLOGY

- NASA PROGRAM SHIFTING FROM EMPHASIS ON MATERIALS RESEARCH TO MORE SYSTEMS ORIENTED APPROACH:

  THREAT SCENARIO, FUEL SYSTEMS, TESTING, MODELLING, TOXICOLOGY, MATERIALS DEVELOPMENT

- NASA CURRENTLY ENGAGED IN LONG TERM PLANNING --

  COORDINATED AND CONSISTENT WITH SAFER CABIN INTERIOR R&D

- PLANNING COORDINATED WITH FAA AND NBS

- PLAN AND IMPLEMENTATION BEFORE SUMMER, 1980 TO IMPACT FY 82 FUNDING PLANS

- NASA HAS FUNDING PLACE HOLDER (FIREMEN II) -- NOT APPROVED FUNDING

82	83	84	85	86	87	TOTAL
$1.2M	2.5	2.8	4.0	4.0	5.5	$20M

NASA

CABIN INTERIOR TECHNOLOGY

- FIREMEN -- $450K, R&T BASE - $400K
- MATERIALS, MODELLING, FULL SCALE TESTING, TOXICITY
  - INTERIOR PANELS - FILMS, INKS
  - SEATS - NEOPRENE AND POLYIMIDE FOAM
    - BLOCKING LAYER
    - WOOL/NYLON AND KERMEL/WOOL FABRICS
    - FULL SCALE TESTING
  - MODELLING - GLOBAL ENCLOSURE
  - TESTING -

    BOEING 737

    CABIN FIRE SIMULATOR (DOUGLAS)

SAFER RECOMMENDATIONS

INTERIOR MATERIALS

POST-CRASH CABIN FIRE HAZARDS CHARACTERIZATION

FULL-SCALE EXPERIMENTS

- EXPEDITE AND COORDINATE C-133 AND SIMILAR FULL-SCALE FIRE TESTS
- ESTABLISH CONTRIBUTION OF CABIN INTERIOR MATERIALS RELATIVE TO THE POST-CRASH FIRE HAZARD

FIRE MODELING

- COORDINATE AND ACCELERATE DEVELOPMENT OF ANALYTICAL POST-CRASH AIRCRAFT FIRE MODELING

SCENARIO ANALYSIS

- DEFINE A DESIGN POST-CRASH FIRE SCENARIO(S)

SAFER RECOMMENDATIONS

LABORATORY TEST METHODOLOGY DEVELOPMENT

- EXPEDITE THE DEVELOPMENT OF THE OSU CHAMBER AND EVALUATE ITS USE AS A REGULATORY TOOL (WITHIN 3 YEARS)

- ACCELERATE TOXICITY RESEARCH EFFORT TO IDENTIFY AND UNDERSTAND THE BIOLOGICAL CHEMICAL AND PHYSICAL FACTORS THAT MUST BE INTEGRATED INTO COMPREHENSIVE FIRE RISK ASSESSMENTS FOR MATERIALS IN SPECIFIC USE CONFIGURATION

SAFER RECOMMENDATIONS

SURVIVAL AND EVACUATION

- THAT FAA EVALUATE THE USE OF SELF-CONTAINED SMOKE MASKS, GLOVES, CLOTHING, OR OTHER PERSONAL PROTECTION EQUIPMENT FOR CREWMEMBERS IN ORDER THAT THEY CAN BETTER COMPLETE EMERGENCY EVACUATION UNDER THE POST-CRASH CONDITION

- COMPLETE PRELIMINARY EVALUATION OF THE TEST PROCEDURE AND PRESENT MATERIALS FOR EVACUATION SLIDES BY MAY 1980

SAFER RECOMMENDATIONS

STANDARDS AND IMPROVEMENTS

- DEVELOP CABIN INTERIOR MATERIAL DATA BANK
- CONTINUE DEVELOPMENT OF LOW-SMOKING FIRE-RESISTANT SEAT FOAMS
- DEVELOP FOR NEW SEAT DESIGNS, FIRE BLOCKING LAYER (FIRE BARRIER) TO PROTECT PRESENT POLYURETHANE FOAM CUSHIONING MATERIAL (1 YEAR)
-

SAFER RECOMMENDATIONS

GENERAL

- PROMOTE OPEN FORUMS, DOCUMENTS, AND PRESENTATIONS TO MAKE THE SUBJECT OF TOXICOLOGY MORE UNDERSTANDABLE TO REGULATORY BODIES FLIGHT CREWS, AND TO THE PUBLIC

POST-CRASH CABIN FIRE HAZARDS CHARACTERIZATION

FULL SCALE EXPERIMENTS -

SAFER RECOMMENDATIONS

[illegible] AND [illegible] AND [illegible] FULL-SCALE FIRE TESTS

[illegible] CABIN INTERIOR MATERIALS RELATIVE TO THE POST-CRASH FIRE HAZARD

- C-133 -

PROJECT: CABIN HAZARDS WITH UNFURNISHED INTERIOR

OBJECTIVE

- DEFINE INTERIOR HAZARD DEVELOPMENT AS CAUSED BY EXTERNAL FUEL FIRE WITH NO CABIN MATERIAL CONTRIBUTION

BACKGROUND

- LITTLE DATA IN EXISTENCE ON PENETRATION OF FIRE INTO FUSELAGE OPENING
- MOST PREVIOUS WORK ON FUSELAGE BURN-THROUGH AND IN-FLIGHT TYPE FIRES

TECHNICAL APPROACH

- DEVELOP POOL FIRE SCENARIO FOR C-133 WHICH WOULD REPRESENT A MAJOR FUEL FIRE
- CHARACTERIZE RESULTANT INTERIOR HAZARD DEVELOPMENT

- C-133 -

PROJECT: CABIN HAZARDS/"TYPICAL" MATERIALS

OBJECT ·

- HAZARD BURNING MATERIALS VIS-A-VIS FUEL FIRE
- RELATIVE IMPORTANCE HEAT, SMOKE, AND TOXIC GASES

BACKGROUND

- IMPORTANCE AND ROLE OF MATERIALS CONTROVERSIAL
- SAFER RECOMMENDATION

TECHNICAL APPROACH

- "TYPICAL" WIDE BODY MATERIALS
- 3 TEST CONDITIONS: "O" WIND, "O" WIND PLUS GUST, AND STEADY WIND
- COMPARE HAZARDS/SURVIVABILITY WITH AND WITHOUT INTERIOR MATERIALS

- C-133 -

PROJECT: CHARACTERIZATION OF A DESIGN FIRE

OBJECTIVE

- DEFINE DESIGN FIRE STANDARD FOR LARGE-SCALE TESTS

BACKGROUND

- RELATIVELY FEW DIVERGENT LARGE-SCALE TESTS
- SAFER RECOMMENDATION. ADVANTAGES
- C-133 BEST MEETS SAFER DESIGN FIRE CRITERIA

TECHNICAL APPROACH

- DETERMINE FIRE THAT PRODUCES DESIRED SURVIVAL TIME (E. G., 5 MINUTES)
- BARE INTERIOR
- DESCRIBE EXTERNAL AND INTERNAL CONDITIONS

- C-133 -

PROJECT: CABIN HAZARDS/NASA ADVANCED MATERIALS

OBJECTIVE

- SAFETY Δ IN-SERVICE VERSUS ADVANCED NASA MATERIALS

BACKGROUND

- ARE IN-SERVICE MATERIALS BEST AVAILABLE?
- WHAT IS SAFEST ENVIRONMENT POSSIBLE?
- SAFER RECOMMENDATION

TECHNICAL APPROACH

- SIMILAR TO "TYPICAL" MATERIALS TESTS
- RELY ON NASA EXPERTISE FOR ADVANCED MATERIALS
- EXAMINE AT LEAST 3 MATERIAL SYSTEMS UNDER DESIGN FIRE CONDITIONS

- C-133 -

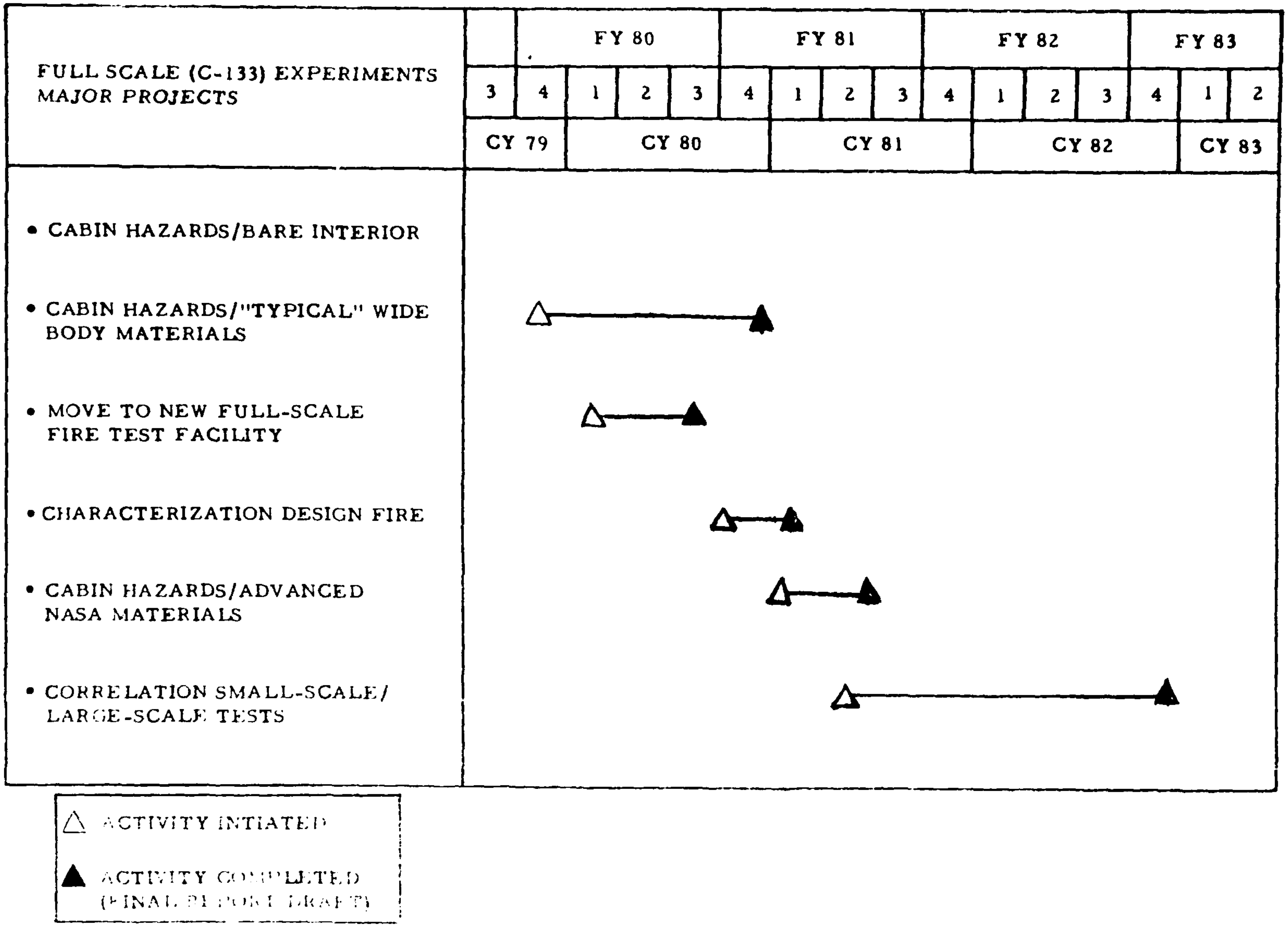
PROJECT: CORRELATE LARGE AND SMALL SCALE TESTS

C-133 BEST TEST ARTICLE NEW AVAILABLE

OTHER DEVELOPMENTS AND RECOMMENDATIONS MAY IMPACT ITS USE; E. G.,

- SAFER RECOMMENDATIONS
- GUIDANCE/DIRECTION CORRELATION STUDIES REVIEW
- DEVELOPMENTS IN FIRE MANAGEMENT AND SUPPRESSION STUDY

FULL SCALE (C-133) PROJECTS MILESTONES

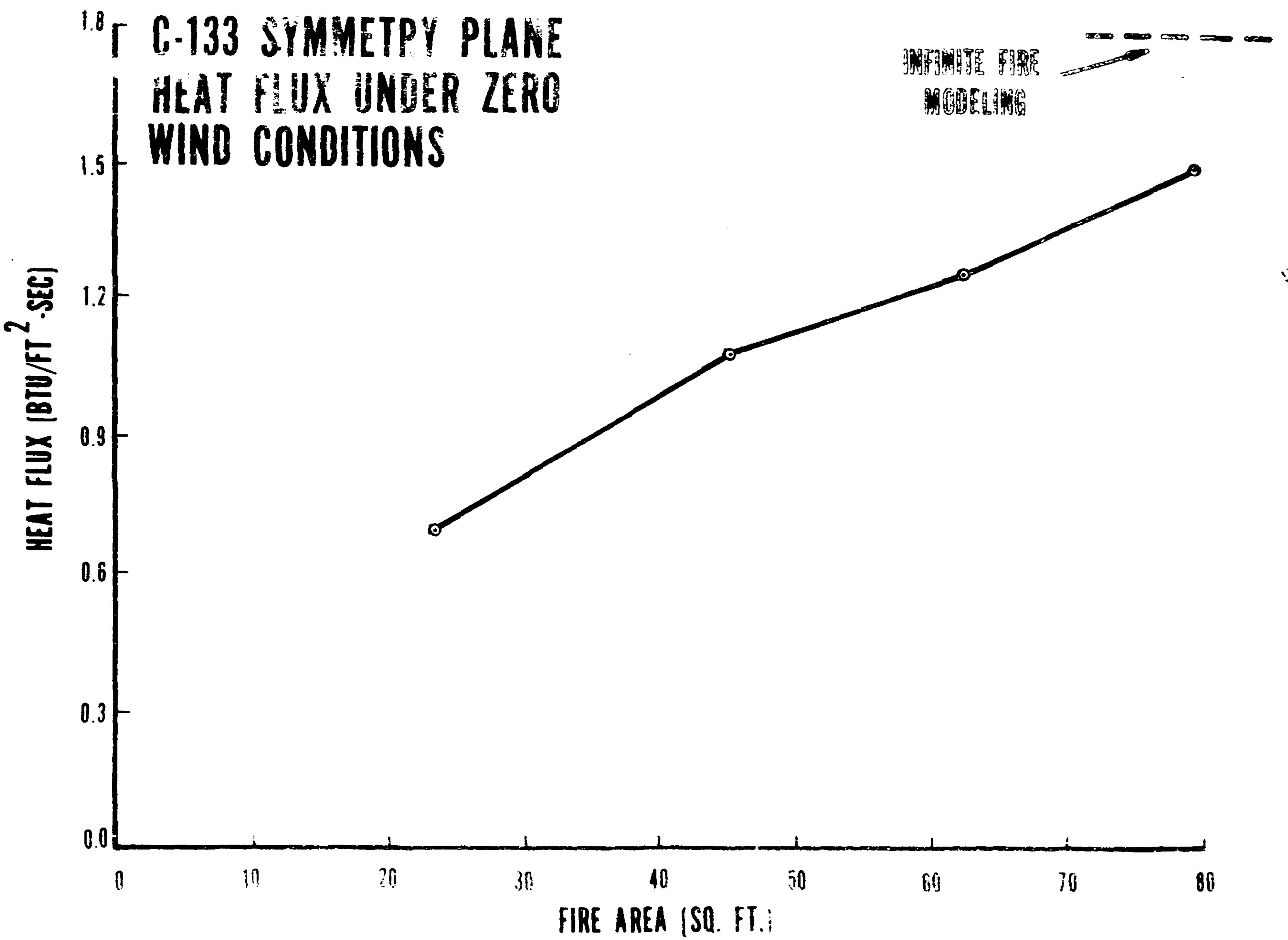


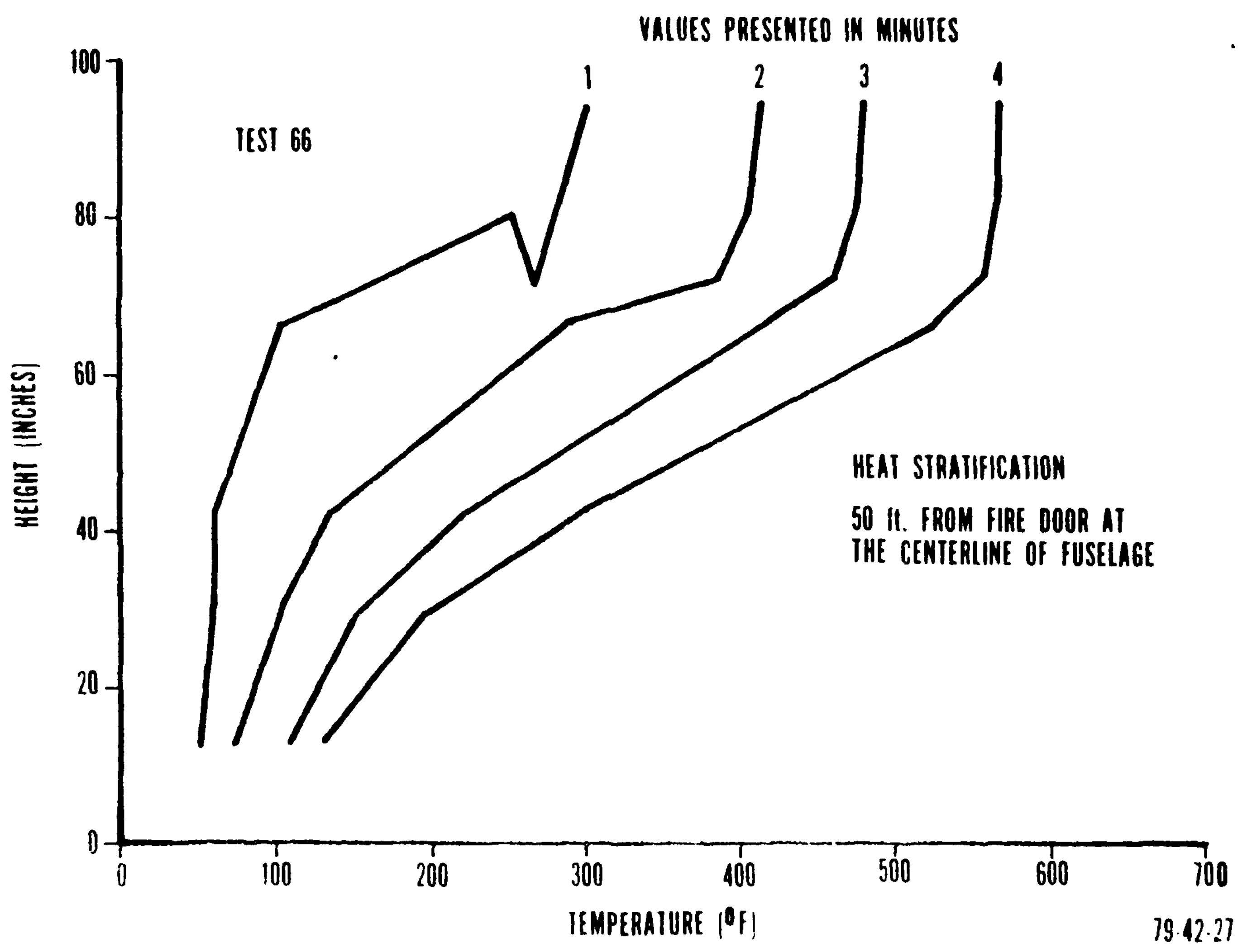
SUMMARY OF PRELIMINARY FINDINGS FOR FUEL FIRES

1. SIGNIFICANT STRATIFICATION OF HEAT, SMOKE AND GASES

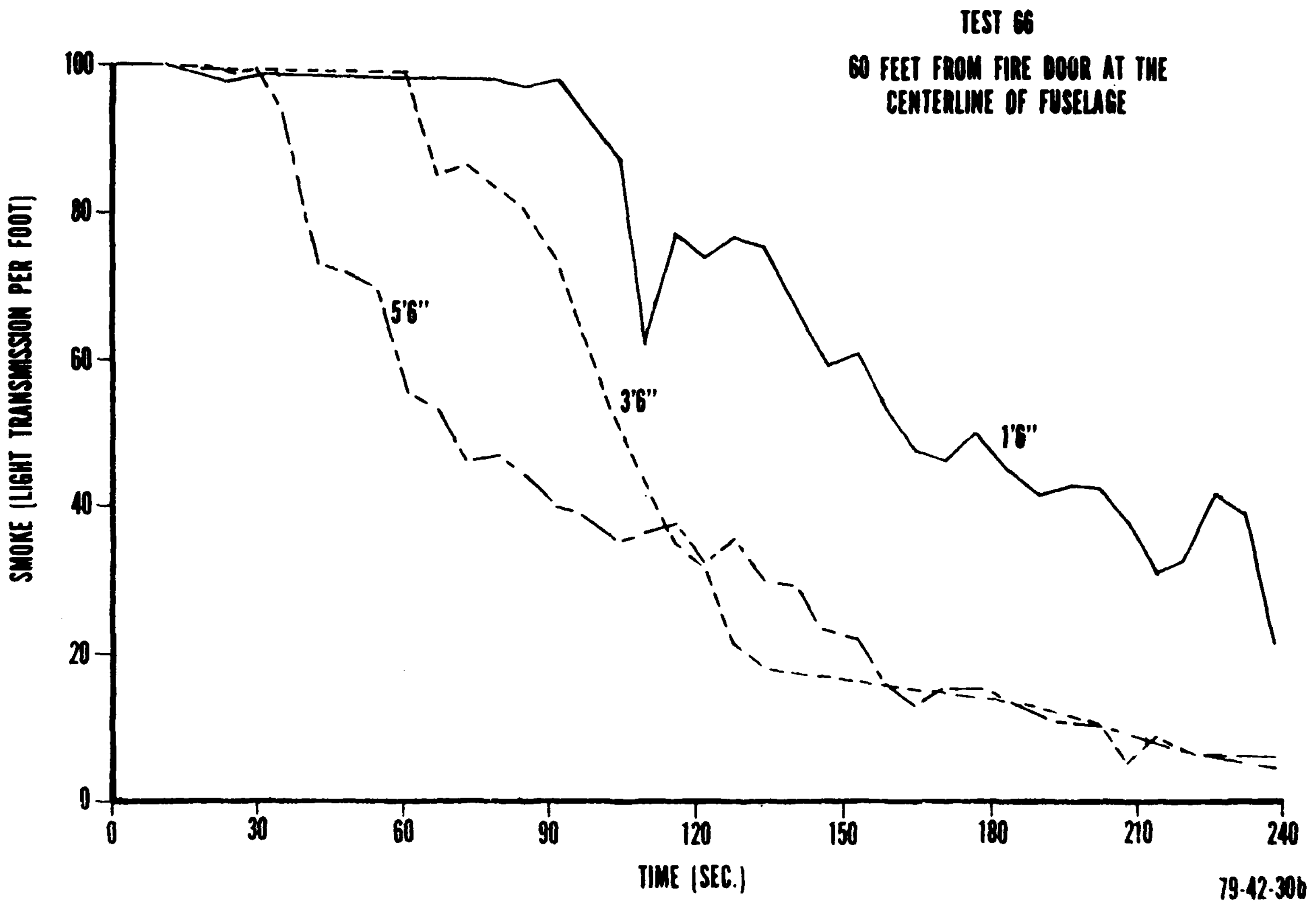
2. HEAT AND SMOKE MORE HAZARDOUS THAN CARBON MONOXIDE

3. INSIGNIFICANT OXYGEN DEPLETION

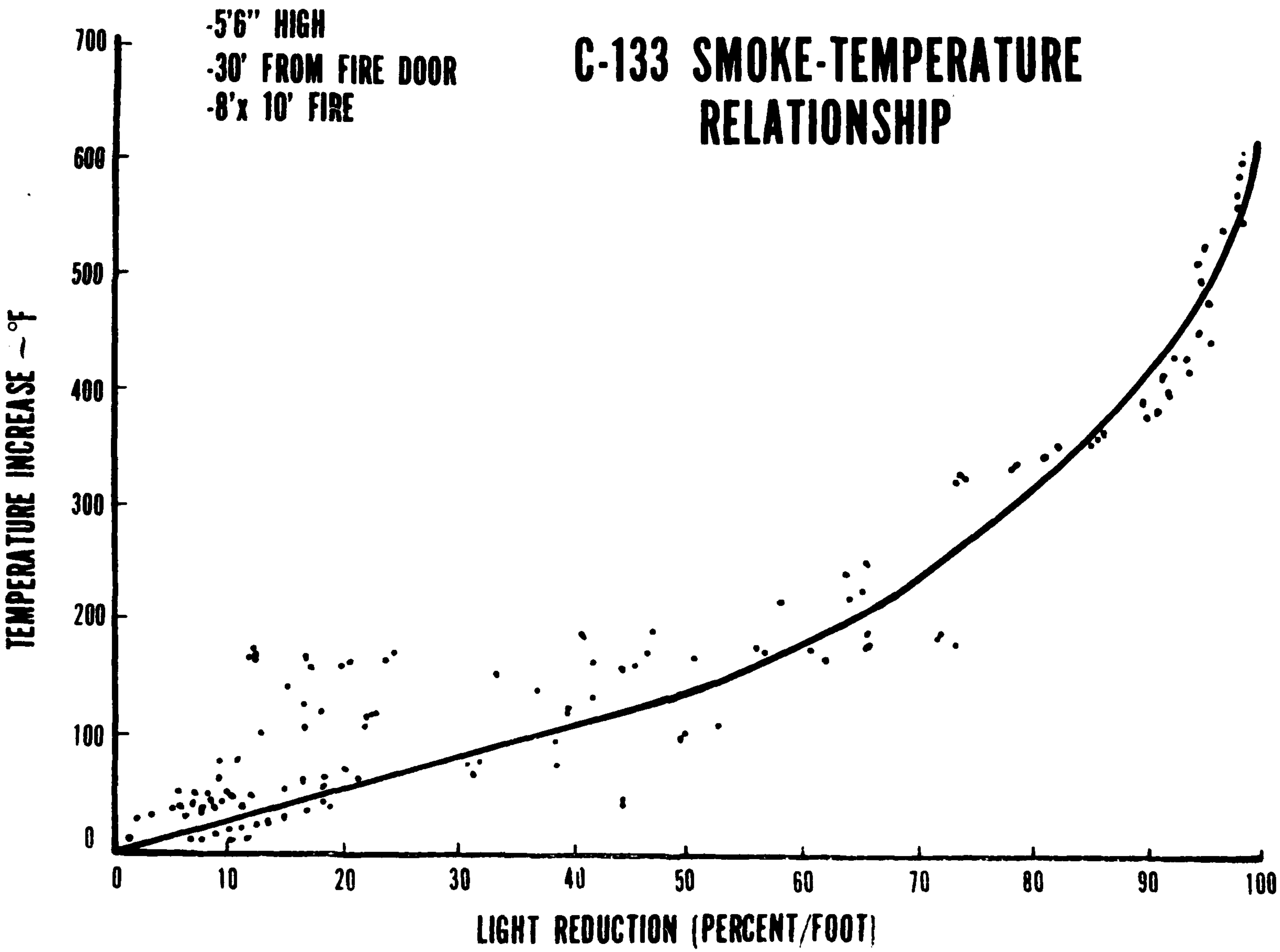

C-133 SYMMETPY PLANE
HEAT FLUX UNDER ZERO
WIND CONDITIONS
INFINITE FIRE
MODELING
HEAT FLUX (BTU/FT^2-SEC)
1.8
1.5
1.2
0.9
0.6
0.3
0.0
0
10
20
30
40
50
60
70
80
FIRE AREA (SQ. FT.)



C-133 CABIN AIR TEMPERATURE STRATIFICATION



C-133 CABIN AIR SMOKE HISTORY


C-133 SMOKE-TEMPERATURE
RELATIONSHIP
-5'6" HIGH
-30' FROM FIRE DOOR
-8'x 10' FIRE
TEMPERATURE INCREASE ~ °F
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
90
100
LIGHT REDUCTION (PERCENT/FOOT)

- DC-7 -

FULL-SCALE TESTS

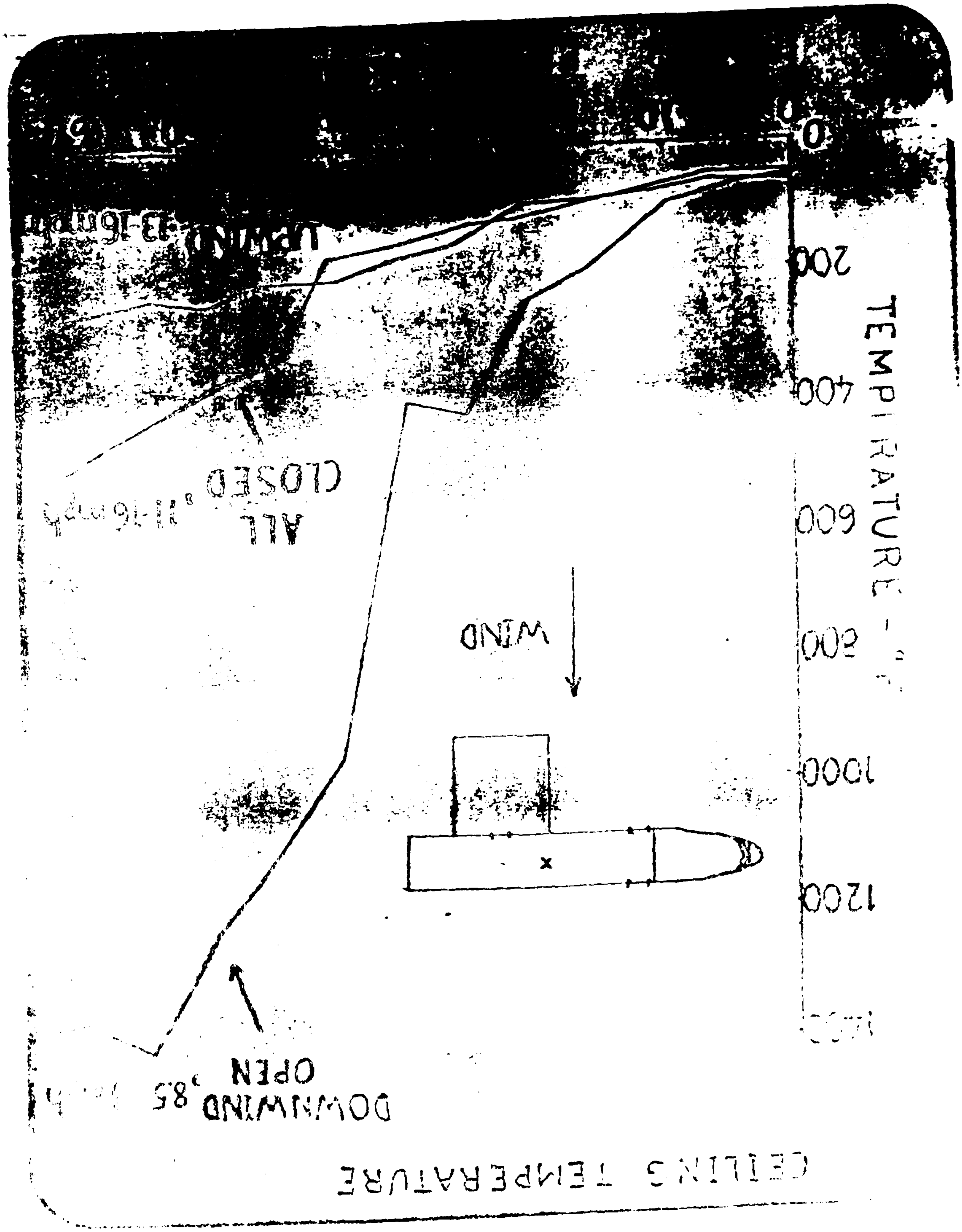
(NO INTERIOR)

OBJECTIVE

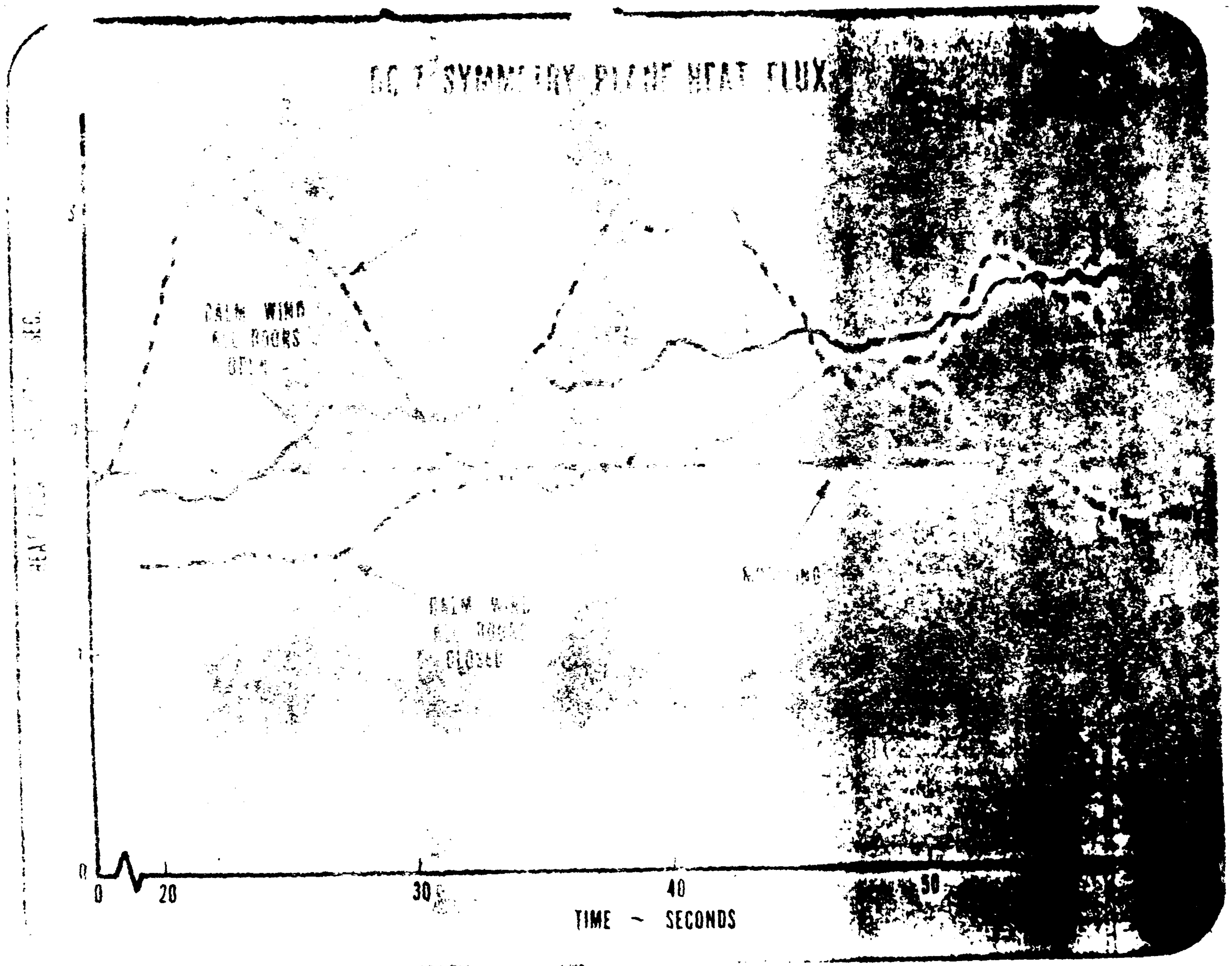
- TO DETERMINE CABIN HAZARDS FROM INFINITE POOL FIRE WITH VARYING EXIT OPENINGS

TECHNICAL APPROACH

- POOL FIRE - 20' X 20'
- VARYING WINDS
- VARYING EXIT STATUS



CEILING TEMPERATURE
TEMPERATURE - °F
0
200
400
600
800
1000
1200
WIND
ALL CLOSED
DOWNWIND OPEN
UPWIND


CALM WIND
CALM WIND
0
20
30
40
50
TIME ~ SECONDS

INTERIOR MATERIAL

SEATS

A. FLAME RETARDANT POLYURETHANE FOAM (COMFORT SECTION)

B. FLAME FLAME RETARDANT EXPANDED PLOYURETHANE FOAM (FLOATATION SECTION)

C. SEAT FABRIC = WOOL/VINYL BLENDS

CEILING PANELS

½" PVF/FIBERGLASS - EPOXY AND NOMEX - HONEYCOMB/FIBERGLASS - EPOXY

HATRACK

½" PVF/FIBERGLASS - EPOXY AND NOMEX - HONEYCOMB/FIBERGLASS - EPOXY

SIDEWALL PANEL - HONEYCOMB

½" PVF/FIBERGLASS - EPOXY AND NOMEX - HONEYCOMB/FIBERGLASS - EPOXY

WINDOW REVEAL

THERMOFORMED PART (POLYCARBONATE)

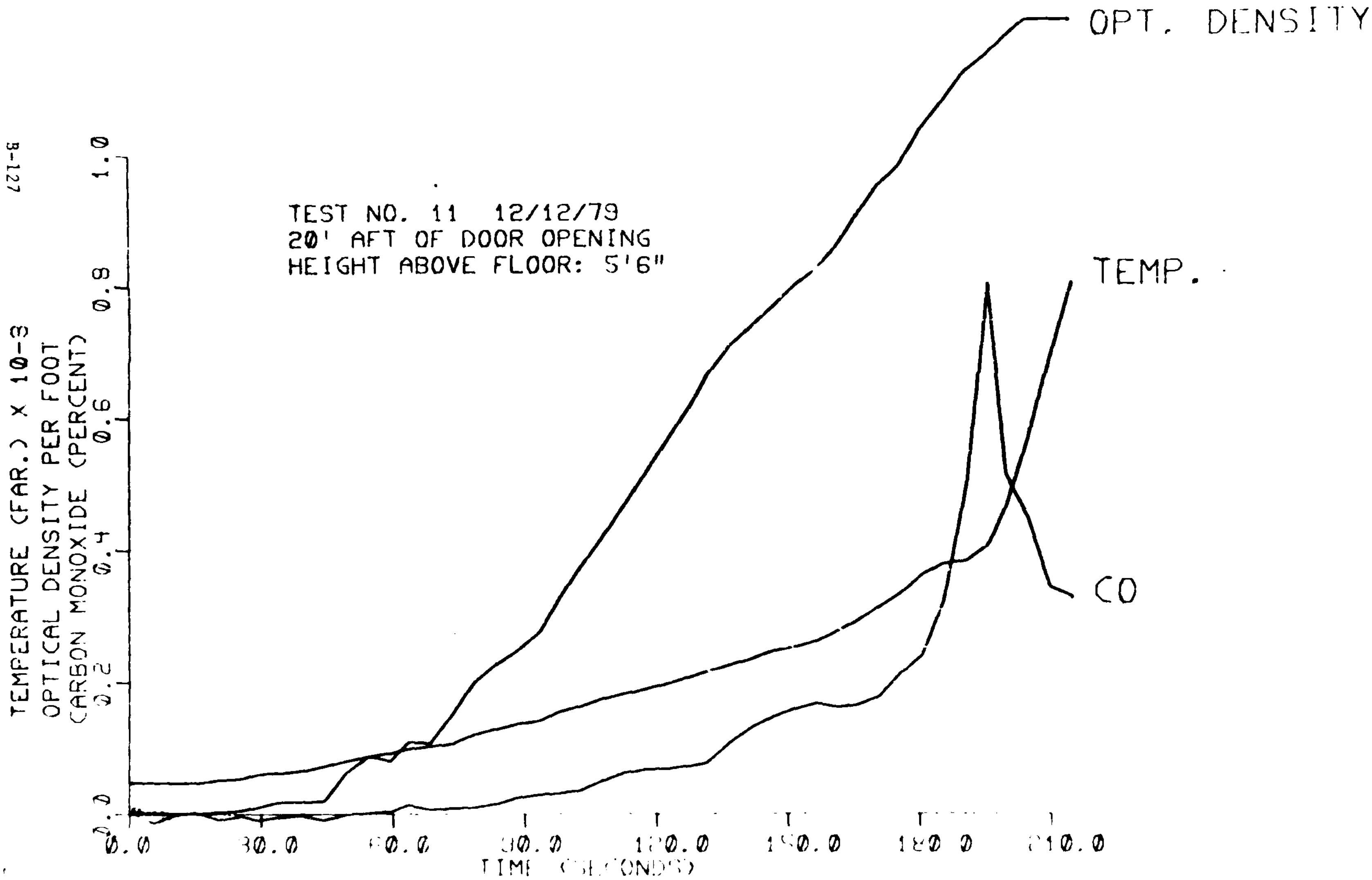
WINDOW SHADE

THERMOFORMED PART (POLYCARBONATE)

[illegible]

[illegible]

CABIN HAZARDS FROM C133 WITH INTERIOR MATERIALS



[illegible] IN-USE MATERIAL TEST RESULTS

PRELIMINARY

- BURNING MATERIAL CAN SIGNIFICANTLY CONTRIBUTE TO THE INTERNAL CABIN HAZARD DURING A POST-CRASH FIRE
- MAJOR STRATIFICATION OF HAZARDS EXIST
- INITIAL FIRE SPREAD IN THE CABIN WAS SLOW (CONFINED TO AREA AROUND DOORWAY)
- BURNING AND DETERIORATION OF CEILING CONTRIBUTED TO RAPID SPREAD OF THE FIRE LATER IN THE TEST (3 MINUTES)

POST-CRASH CABIN FIRE HAZARDS CHARACTERIZATION

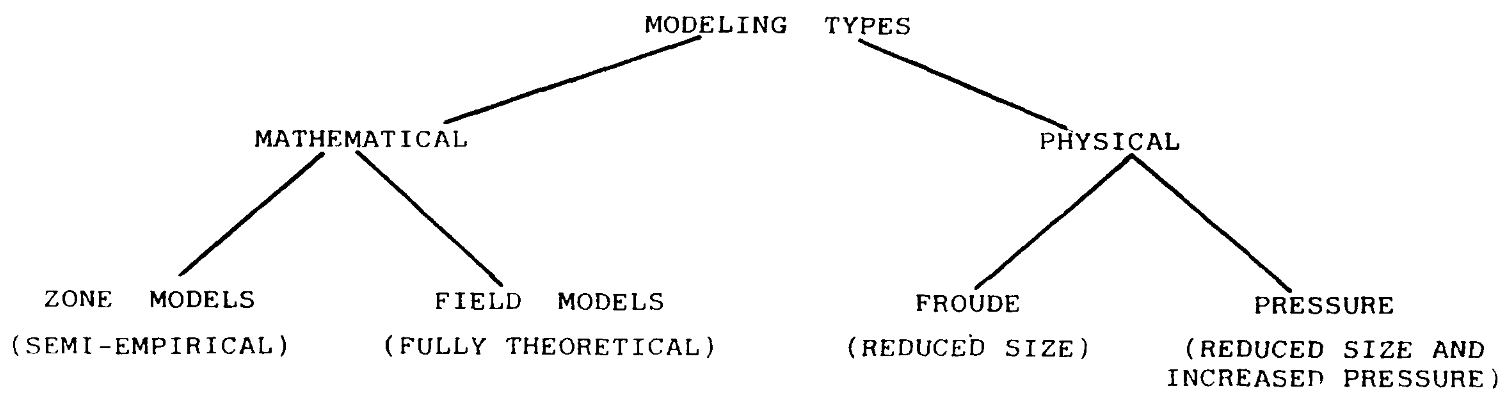
- FIRE MODELING -

SAFER RECOMMENDATION

- COORDINATE AND ACCELERATE DEVELOPMENT OF ANALYTICAL POST-CRASH AIRCRAFT FIRE MODELING

- FIRE MODELING -

PLANNED RESEARCH AND DEVELOPMENT



SAFER RECOMMENDATIONS

MATHEMATICAL MODELING

ZONE MODELS

- REDIRECT AND COMPLETE DEVELOPMENT OF DACFIR MODEL (UDRI)
- APPLY SMOKE LAYER RADIATION TECHNOLOGY TO AIRCRAFT CABIN FIRE (FACTORY MUTUAL)

FIELD MODELS

- APPLY THERMOCHEMICAL MODELING TO SEATS AND CARPETS (NASA/JPL)
- PERFORM 2-D FIELD MODEL EVALUATION OF SPREADING SMOKE LAYER IN AIRCRAFT CABIN (NBS)
- DEVELOP 3-D FIELD MODEL FOR FIRE PENETRATION IN A FUSELAGE OPENING (NBS)
- DETERMINE PRESSURE DISTRIBUTION AROUND FUSELAGE UNDER FIRE PLUME (NBS)

SAFER RECOMMENDATIONS

PHYSICAL MODELING

FROUDE MODELING (NAFEC)

- $\frac{1}{2}$ SCALE WORK: SCENARIO ANALYSIS
- $\frac{1}{2}$ SCALE WORK: C-133 CORRELATION; DESIGN FIRE; COMPARTMENTATION; SMOKE AND GASES
- MODEL OF FULL-SCALE FIRE TEST FACILITY

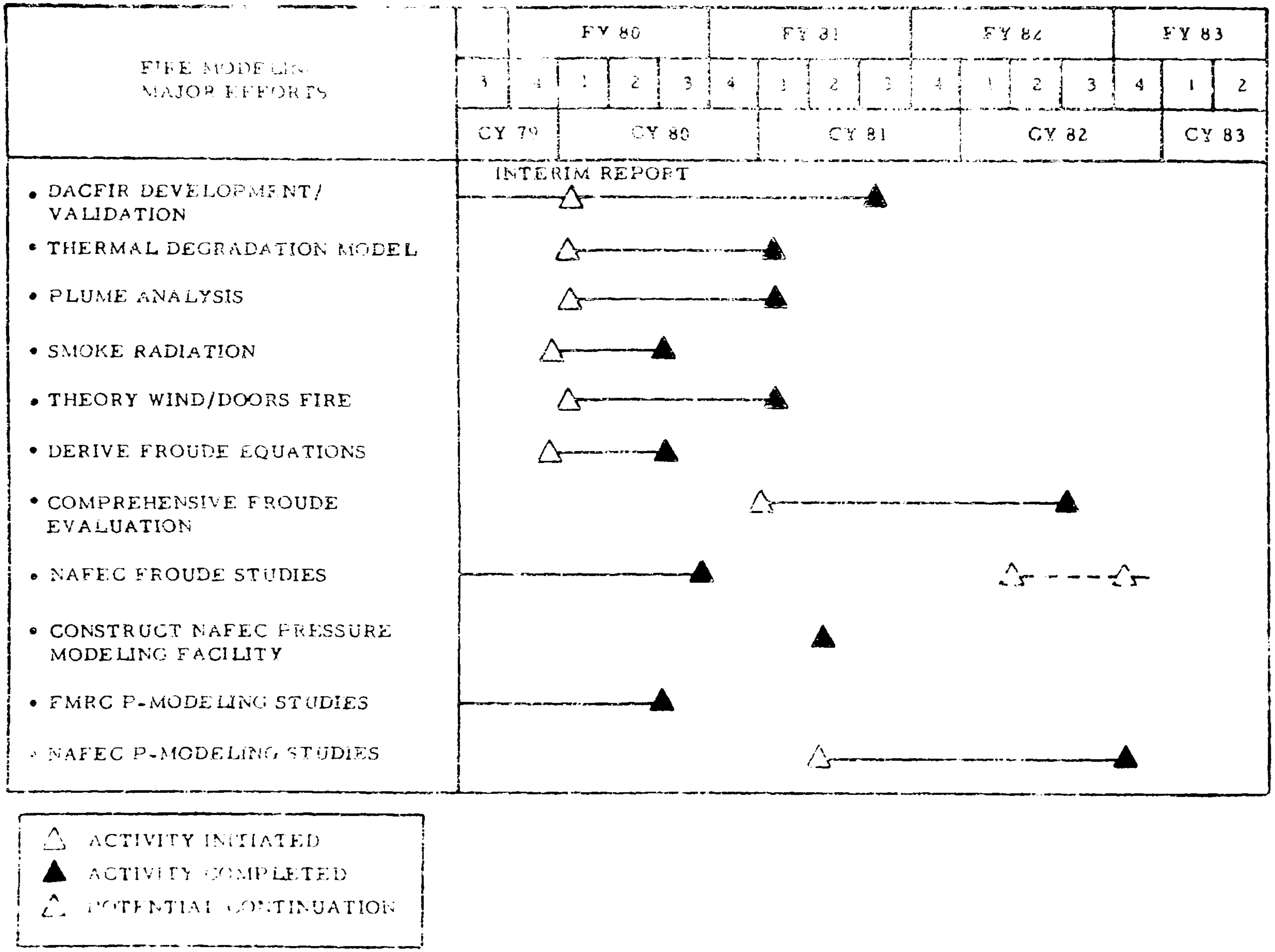
PRESSURE MODELING

- CEILING FIRE VALIDATION (FACTORY MUTUAL)
- COMPLETE AIRCRAFT FUSELAGE MODEL (NAFEC FACILITY)

PHYSICAL MODELING ACCOMPLISHMENTS

- REDESIGN OF C-133 TEST FIRE
- EXPERIMENTAL AND THEORETICAL CHARACTERIZATION OF POOL FIRE RADIATION THROUGH A DOORWAY
- DISCOVERY OF EFFECTS OF WIND AND DOOR OPENING CONFIGURATION
- CHARACTERIZATION OF TEMPERATURE STRATIFICATION EFFECTS
- NEW FLAMMABILITY RANKING SYSTEM
- VERIFICATION OF VALIDITY OF PRESSURE MODELING OF VERTICALLY BURNING MATERIALS

MODELING MILESTONES



NASA

FIRE MODELLING

- JPL
- GLOBAL MODEL - CABIN ENCLOSURE - VENTILATED
- LIMITED ENERGY RELEASE CRITERIA
- TRANSIENT, TWO-DIMENSIONAL
- CONSERVATION EQUATIONS FOR:
    - MASS
    - MOMENTUM
    - SPECIES
    - ENERGY
- BOUNDRY CONDITIONS
    - POOL OF FUEL
    - WALLS
    - OPENINGS

POST-CRASH CABIN FIRE HAZARDS CHARACTERIZATION

- SCENARIO ANALYSIS -

SAFER RECOMMENDATION

- DEFINE A DESIGN POST-CRASH FIRE SCENARIO(S)

LABORATORY TEST METHODOLOGY DEVELOPMENT

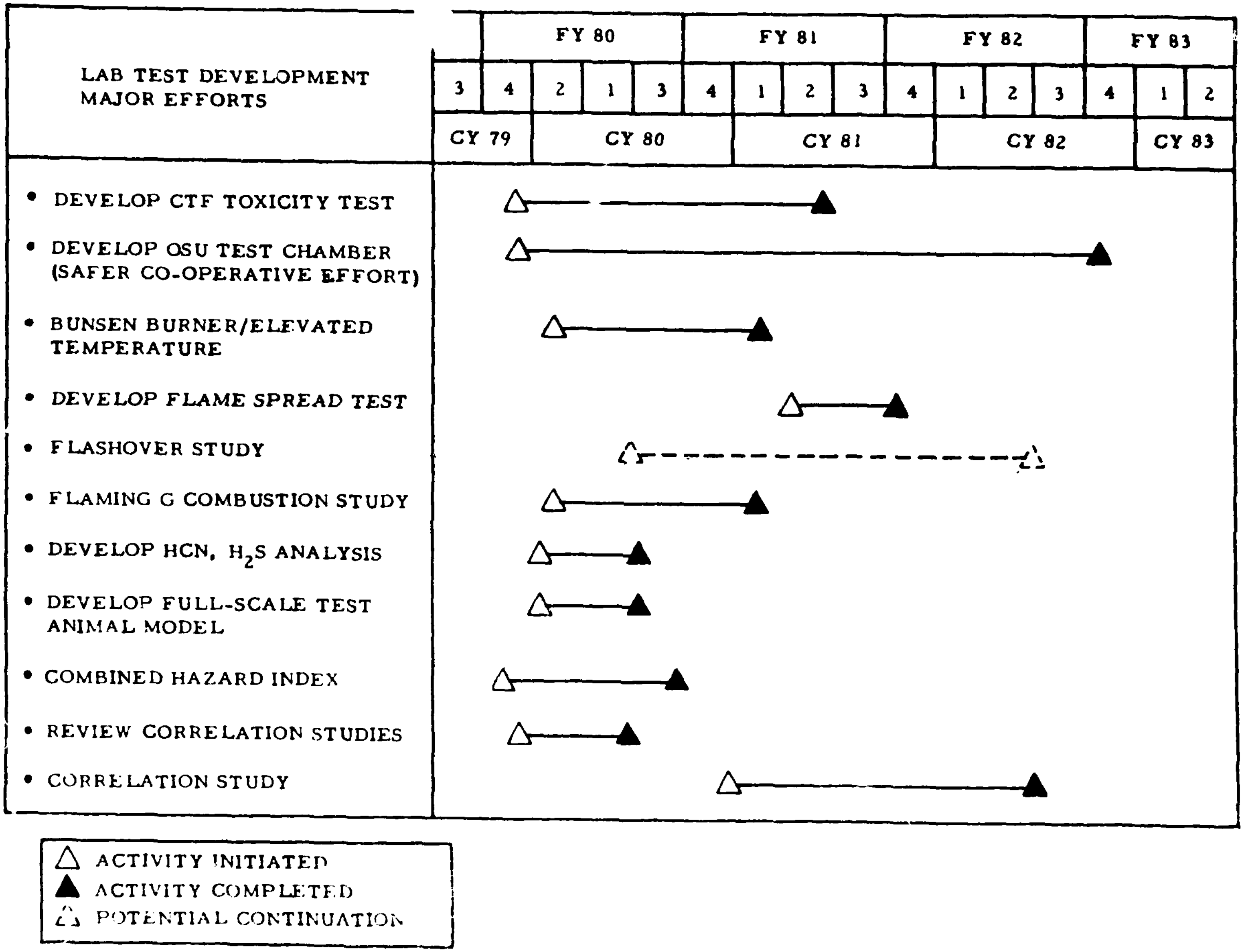
SAFER RECOMMENDATION

- EXPEDITE THE DEVELOPMENT OF THE OSU CHAMBER AND EVALUATE ITS USE AS A REGULATORY TOOL (WITHIN 3 YEARS)

OSU TEST CHAMBER PLANNED RESEARCH AND DEVELOPMENT

- WORK WITH ASTM TO STANDARDIZE AND ADOPT
- CONTINUE CHI PROGRAM
- USE FOR MATERIAL EVALUATION AT NAFEC
- ATTEMPT CORRELATION WITH REALISTIC FIRE BEHAVIOR IN FULL-SCALE AND MODEL SCALE TESTING
- PARTICIPATE IN SAFER RECOMMENDED GROUP FOR EVALUATION AS A REGULATORY TOOL

LABORATORY TEST DEVELOPMENT MILESTONES



LABORATORY TEST METHODOLOGY DEVELOPMENT

SAFER RECOMMENDATION

- ACCELERATE TOXICITY RESEARCH EFFORT TO IDENTIFY AND UNDERSTAND THE BIOLOGICAL, CHEMICAL, AND PHYSICAL FACTORS THAT MUST BE INTEGRATED INTO COMPREHENSIVE FIRE RISK ASSESSMENTS FOR MATERIALS IN SPECIFIC USE CONFIGURATION

-TOXICITY-

PLANNED FUTURE STUDIES

.C-133 MATERIALS GAS EMISSIONS AND TOXICITY MEASUREMENTS

LABORATORY TEST METHODOLOGY DEVELOPMENT

.FURTHER DEVELOPMENT OF COMBUSTION TUBE FURNACE

-UNIDIRECTIONAL HEATING

-FLAMING COMBUSTION

-IRRITANT GASES EFFECTS

.DEVELOPMENT OSU CHAMBER HEAT/SMOKE/GASES

.CONTINUED PARTICIPATION NBS TOXICITY PROTOCOL (CAMI)

SURVIVAL AND EVACUATION

.STUDY ESCAPE IMPAIRMENT IRRITANT GASES

-PRIMATES (ESCAPE)

-RATS (INCAPACITATION)

.STUDY TOXICITY OF HEAT AND GASES IN COMBINATION

.DEVELOP "STATE-OF-ART" HUMAN SURVIVAL MODEL

-TOXICITY-

CURRENT STATUS

NO STANDARDIZED COMBUSTION TOXICITY TESTS EXIST

SAFER AD HOC COMMITTEE ON TOXICOLOGY

.MANY FUNDAMENTAL PROBLEMS STILL EXIST

RECENT FAA WORK

.COOPERATIVE PROGRAM BETWEEN CAMI AND NAFEC

.DEVELOPMENT OF COMBUSTION TUBE FURNACE

.EVALUATED 75 CABIN MATERIALS

-ANIMAL TOXICITY AT CAMI

-TOXIC GASES YIELDS AT NAFEC

.CORRELATION ANIMAL/TOXIC GASES DATA

-TOXICITY DESCRIBED BY SYSTEMIC POISONS

-IRRITANT GASES HAD NO DIRECT EFFECT ON TOXICITY

CURRENT FAA WORK

-CAMI - NBS PROTOCOL

-NAFEC C-133 SUPPORT

GENERAL

SAFER RECOMMENDATION

- PROMOTE OPEN FORUMS, DOCUMENTS, AND PRESENTATIONS TO MAKE THE SUBJECT OF TOXICOLOGY MORE UNDERSTANDABLE TO REGULATORY BODIES, FLIGHT CREWS, AND TO THE PUBLIC

COMMUNICATION OF TOXICOLOGY PROBLEM

(CAMI LEADERSHIP)

1. SPONSOR ANNUAL WORKING CONFERENCES OF PRINCIPAL INVESTIGATORS

2. PROMOTE GREATER COORDINATION OF FAA COMBUSTION TOXICOLOGY PROGRAMS WITH OTHER AGENCIES OF THE GOVERNMENT

3. BRING TO THE ATTENTION OF CREWS, AIRCRAFT OWNERS, AND OPERATORS, PASSENGERS, AND THE GENERAL PUBLIC THE COMPLEX NATURE OF THE HAZARDS OF FIRE IN AVIATION

SURVIVAL AND EVACUATION

SAFER RECOMMENDATION

- THAT FAA EVALUATE THE USE OF SELF-CONTAINED SMOKE MASKS, GLOVES, CLOTHING, OR OTHER PERSONAL PROTECTION EQUIPMENT FOR CREWMEMBERS IN ORDER THAT THEY CAN BETTER COMPLETE EMERGENCY EVACUATION UNDER THE POST-CRASH CONDITION

CREW CLOTHING STATUS

- FAA RECEPTIVE TO FORMAL AND INFORMAL SAFER COMMENTS

- FAA WAITING FOR RESULTS OF UPCOMING PUBLIC HEARINGS

- WHILE ENHANCING TIME OF INCAPACITATION IS MOST IMPORTANT FOR PASSENGERS, ENHANCING WORKING CAPACITY OF CREW MAY BE IMPORTANT (SHOES, GLOVES, HEADGEAR)

PROTECTIVE BREATHING/VISION DEVICES - STATUS

CURRENT

- OXYGEN MASKS STANDARDS - PAX CONTINUOUS FLOW TSO C64, CREW DEMAND TSO C78
- RESEARCH AND DEVELOPMENT CAMI PROGRAM
- SAE STANDARDS, A10 COMMITTEE - AIRCRAFT OXYGEN EQUIPMENT DRAFT AS 831 (1980)
- FAA STANDARDS, TSO - PROTECTIVE BREATHING EQUIPMENT (PORTABLE/NONPORTABLE (1980))
- FAA OPERATIONAL EQUIPMENT REQUIREMENTS - NPRM (1980)

[illegible] BREATHING DEVICES
[illegible] PROGRAMS*

SUBJECTS	TYPE	NO. TYPES TESTED	NO. PASSED (DEMAND WITH POSITIVE PRESSURE)	NO. PASSED (DEMAND ONLY)
PHASE I MALE	MASK/GOGGLES	118	14	0
	FULLFACE	17	6	0
	HOODS	2	2	NOT TESTED
PHASE II MALE	MASK/GOGGLES	25	2[illegible]	NOT TESTED
	HOODS	2	2	NOT TESTED
PHASE III MALE/FEMALE	FULLFACE	10	10	0
	HOODS	2	2	NOT TESTED
PHASE IV MALE/FEMALE	USE OF FULLFACE MASKS DURING DECOMPRESSIONS			
	64 TESTS COMPLETED, DATA BEING PROCESSED			
PHASE V MALE	EFFECT OF BEARDS ON CREW OXYGEN MASKS			
	54 TESTS COMPLETED BEARDS CAUSED DECREMENT			
PHASE VI FEMALE	SAME AS PHASE I FOR FEMALE FACES, IN PROCESS			

*APPROXIMATELY 2,850 TESTS

SURVIVAL AND EVACUATION

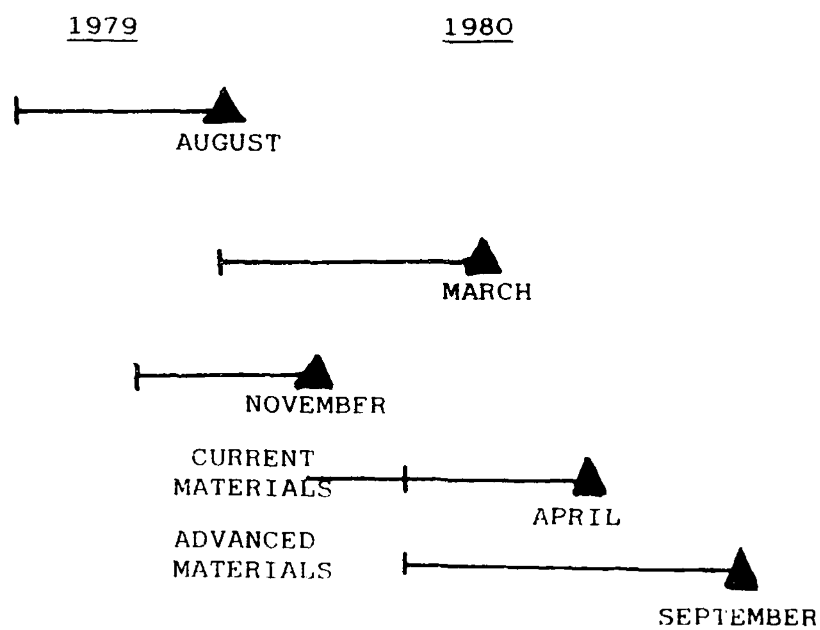
SAFER RECOMMENDATION

- COMPLETE PRELIMINARY EVALUATION OF THE TEST PROCEDURE AND PRESENT MATERIALS FOR EVACUATION SLIDES BY MAY 1980

HEAT RESISTANCE OF EVACUATION SLIDE MATERIALS

PLANNED RESEARCH AND DEVELOPMENT AND SCHEDULE

- DEVELOP A LABORATORY TEST APPARATUS
- EXAMINE AND SELECT AN OPTIMUM REFLECTIVE COATING
- EVALUATE ADVANCE MATERIALS
- CONDUCT FULL-SCALE SLIDE POOL FIRE TESTS



STANDARDS AND IMPROVEMENTS

SAFER RECOMMENDATION

- DEVELOP CABIN INTERIOR MATERIAL DATA BANK

OVERVIEW OF STUDY TASKS

TASK 1

1.1 SURVEY OF POTENTIAL DATA BASE USERS

1.2 SURVEY OF POTENTIAL DATA SUPPLIERS

1.3 PERFORM PRELIMINARY DATA GATHERING

TASK 2

2.1 SURVEY OF COMMERCIALLY AVAILABLE SOFTWARE PACKAGES WHICH MAY BE APPLICABLE

2.2 SURVEY HARDWARE SYSTEMS WHICH MAY BE SUITABLE TO SUPPORT DATA BASE REQUIREMENTS

2.3 ESTIMATE ADMINISTRATIVE SUPPORT AND COSTS TO OPERATE MOST LIKELY COMBINATIONS

2.4 SYNTHESIS AND ANALYSIS TO MAKE DATA SYSTEM RECOMMENDATIONS

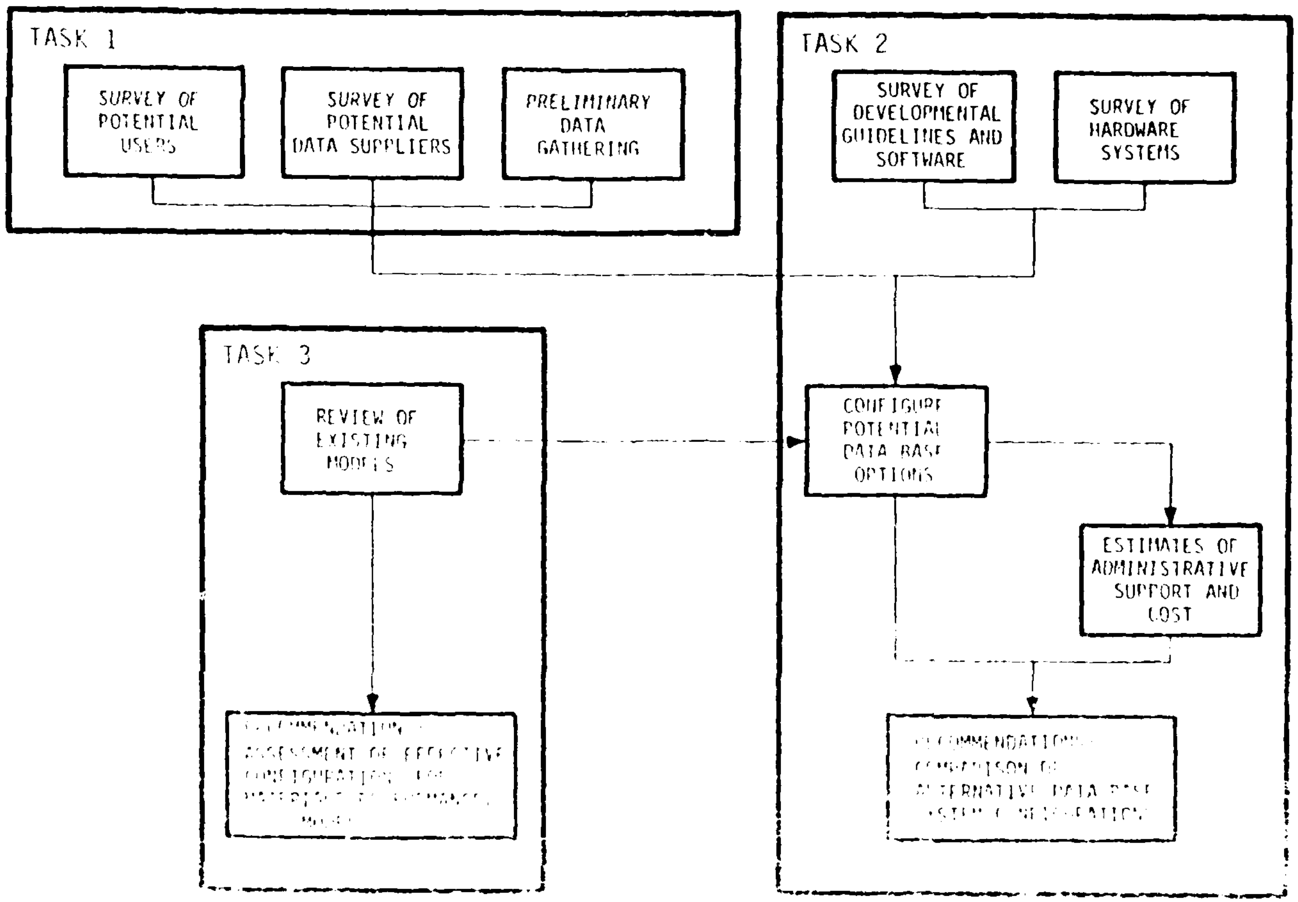
TASK 3

3.1 PRELIMINARY REVIEW OF MODELLING APPLICATIONS OF DATA BASE TO SCOPE DATA BASE HARDWARE AND SOFTWARE REQUIREMENTS

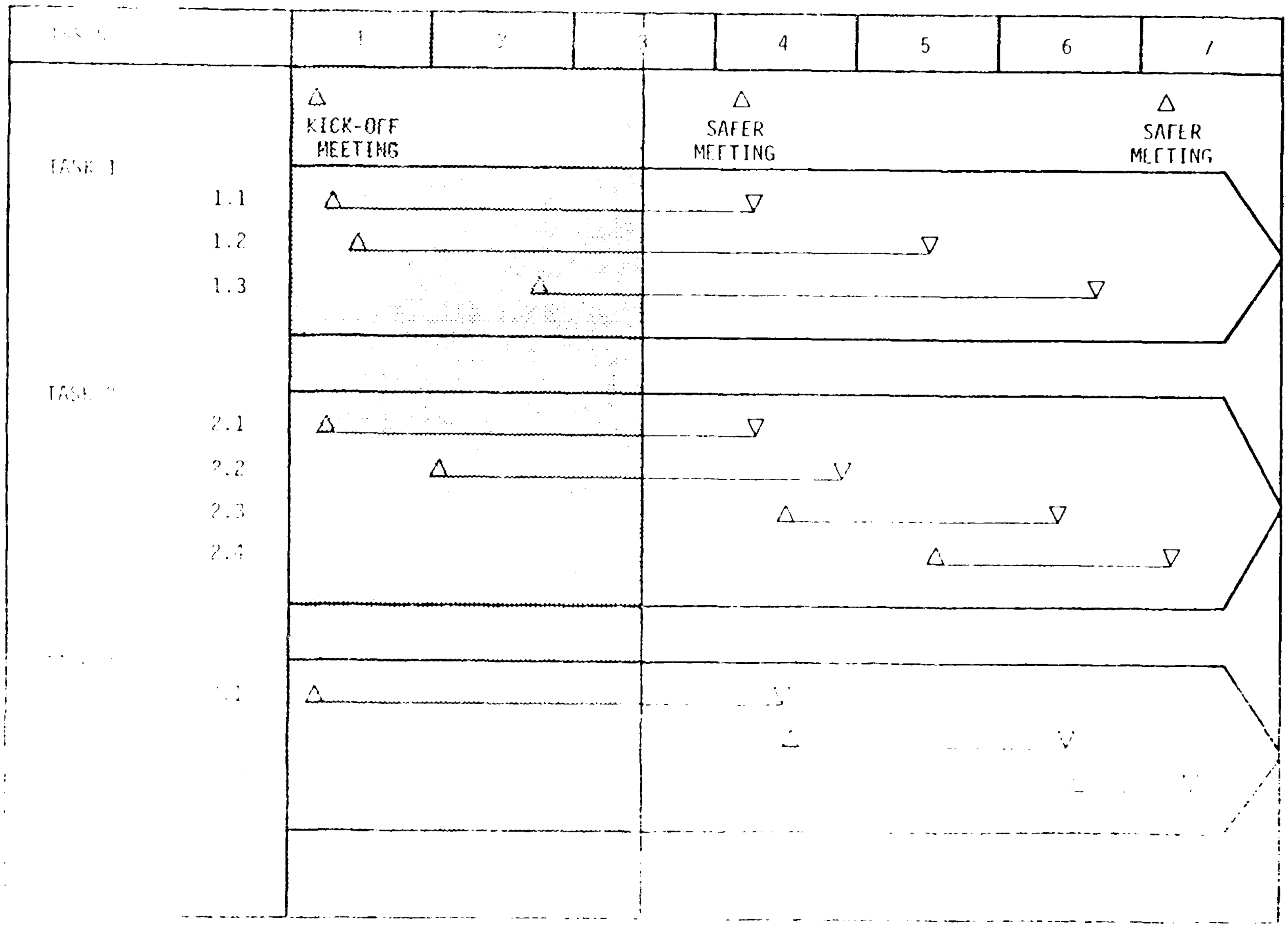
3.2 REVIEW OF EXISTING, RELATED MODELS FOR THEIR SCIENTIFIC CONTRIBUTION TO MATERIAL RESEARCH AND TESTING PROGRAMS

3.3 [illegible] RECOMMENDATIONS TO FAA NASA [illegible] TOTAL SYSTEM APPROACH TO AIRCRAFT MATERIALS RESEARCH AND [illegible] ANALYSIS

OVERVIEW OF STUDY TASKS



... MILESTONES OF STUDY



TASK 1.2

SPECTRUM OF DATA BASE CONTENTS AND SCOPE
- MATERIAL ATTRIBUTES -

THE DATA BASE CONTENTS AND SCOPE ALSO VARIES WITH THE MATERIAL ATTRIBUTES INCLUDED. EACH MATERIAL MAY BE DESCRIBED WITH THE FOLLOWING SPECTRUM OF ATTRIBUTES:

- MATERIAL NAME
- MATERIAL MANUFACTURER
- DESCRIPTION
- FIRE TEST DATA
  - FAR TEST RESULTS
  - FLAME SPREAD
  - FIRE CONTAINMENT/BURN THROUGH
  - HEAT RELEASE, ETC.
- SMOKE AND TOXICITY DATA
- PHYSICAL PROPERTIES
- COST DATA

STANDARDS AND IMPROVEMENTS

SAFER RECOMMENDATIONS

- CONTINUE DEVELOPMENT OF LOW-SMOKING FIRE-RESISTANT SEAT FOAMS
- DEVELOP FOR NEW SEAT DESIGNS, FIRE BLOCKING LAYER (FIRE BARRIER) TO PROTECT PRESENT POLYURETHANE FOAM CUSHIONING MATERIAL (1 YEAR)

- IMPROVEMENTS IN SPECIFIC USAGE CATEGORIES -

SEAT CUSHIONS

- OBJECTIVE:
  - CONDUCT STUDIES SUPPORT PROTECTION/REPLACEMENT URETHANES
- BACKGROUND:
  - URETHANE FOAMS MOST FLAMMABLE CABIN MATERIALS USED
  - SAFER RECOMMENDATION
- TECHNICAL APROACH:
  - JOINT NASA/NAFEC EFFORT
  - NASA: SCREEN MATERIALS, CONDUCT INITIAL EVALUATION, FABRICATE SEAT ASSEMBLIES
  - NAFEC: CONDUCT DESIGN FIRE EXPERIMENTS IN C-133

NASA

SEAT TECHNOLOGY

- 1979 - MATERIAL SCREENING

  MATERIALS SELECTED

  FABRIC - KERMEL/WOOL, WOOL/NYLON

  BLOCKING LAYER - VONAR 3, DURRETTE, KYNOL

  ADHESIVE - R 2332 NF

  CUSHION - POLYIMIDE, NEOPRENE

  1980 - FABRICATE FULL SCALE COMPONENTS

  - TEST SEATS AND BACKS - SEPT. 1980

    CABIN FIRE SIMULATOR (DOUGLAS)

  - TEST FULL SCALE SEATS - MARCH 1981

    B737 CABIN (JOHNSON SPACE CENTER)

POST-CRASH FIRE HAZARD

SAFER RECOMMENDATIONS

POST-CRASH FIRE HAZARD

- CONTINUE AND EXPEDITE FAA/NASA RESEARCH TO ESTABLISH A REALISTIC AIRPLANE CRASH SCENARIO WITH INCREASED EMPHASIS ON POST-CRASH FUEL SYSTEM FAILURE MODES AND EFFECTS ON CABIN FIRE SAFETY

- FROM THE CRASH SCENARIO, DEVELOP FUEL SYSTEM DESIGN CRITERIA WHICH TRANSPORT CATEGORY AIRCRAFT MUST MEET IN ORDER TO MINIMIZE POST-CRASH FUEL FIRES

FAA PLANNED RESEARCH AND DEVELOPMENT

TRANSPORT CRASH SCENARIOS

	ESTIMATED COMPLETION
TASK I	
– DEVELOPMENT OF CRASH SCENARIOS	
• REVIEW AND EVALUATION OF ACCIDENT DATA	5/80
• CRASH DESIGN REQUIREMENTS AND PROCEDURES	7/80
• HUMAN TOLERANCE AND OCCUPANT PROTECTION	8/80
• CATEGORIZATION OF CRASH IMPACT CONDITIONS	9/80
• ANALYSIS OF SELECTED AIRPLANE ACCIDENT CONDITIONS	10/80
• FINALIZATION OF CRASH SCENARIOS	11/80
TASK II	
– IDENTIFICATION OF STRUCTURAL AND SUBSYSTEMS FAILURES	
• STRUCTURAL SYSTEMS	11/80
• PROPULSION AND FUEL SYSTEM	12/80
• FIRE	12/80
• MATRIX CATEGORIZATION	1/81
• ASSESSMENT OF ADVANCED MATERIAL USAGE	2/81

FAA PLANNED RESEARCH AND DEVELOPMENT

TRANSPORT CRASH SCENARIOS (CONTINUED)

	ESTIMATED COMPLETION
TASK III	
– CRITERIA AND DESIGN PHILOSOPHY	
• US ARMY CRASH SURVIVAL DESIGN GUIDE (REVISED)	10/80
• DYNAMIC RESPONSE INDEX MODEL	12/80
• MERIT FUNCTIONS	2/81
TASK IV	
– AVAILABLE TEST DATA, TEST TECHNIQUES, AND ANALYTICAL METHODS	
• TEST DATA AND TECHNIQUES	1/81
• *IDENTIFICATION OF FUTURE TEST PROGRAM REQUIREMENTS*	4/81
• REVIEW OF AVAILABLE ANALYTICAL TECHNIQUES	3/81
• RECOMMENDATION OF FUTURE ANALYTICAL EFFORTS	5/81

NASA PLANNED RESEARCH AND DEVELOPMENT

TRANSPORT POST-CRASH FIRE HAZARDS

	MONTHS FROM CONTRACT
TASK I	3
– CRASH FIRE PROBLEM	
• REVIEW DATA - IN-HOUSE, INDUSTRY, AND LITERATURE	
• CATEGORIZATION OF DATA - FIRE FATALITIES AND CRASH CHARACTERISTICS	
• ANALYZE USE OF COMPOSITE MATERIALS	
TASK II	5
– CRASH FIRE SAFETY CONCEPTS	
• REVIEW DATA - IN-HOUSE, INDUSTRY, AND LITERATURE	
• IDENTIFY NEW AND/OR EXISTING CRASH FIRE SAFETY CONCEPTS	
TASK III	7
– CONCEPT CHARACTERIZATION	
• COST/BENEFIT ANALYSIS OF IDENTIFIED CONCEPTS - TASK II	

FAA PLANNED RESEARCH AND DEVELOPMENT

HELICOPTER CRASH SCENARIO

MONTHS FROM CONTRACT

PHASE I — 14

- OBTAIN AND/OR REVIEW EXISTING ACCIDENT DATA
  - MANUFACTURERS, NTSB, FAA
- CATEGORIZATION OF CRASH IMPACT CONDITIONS
  - WEIGHT CONFIGURATION, CRASH ENVIRIONMENT, TERRAIN/WATER
  - STRUCTURAL, PROPULSION, AND FUEL SYSTEM DAMAGE
  - STABILITY AND CONTROL FAILURES
  - POST-CRASH CONDITION, SURVIVABILITY
  - FUEL SPILLAGE, FIRE
- DEVELOP MATRIX OF POTENTIALLY SURVIVABLE CRASH CONDITIONS
  - STRUCTURAL CRASH IMPACT DYNAMICS ANALYSES OF ACCIDENT - AIRFRAMES, FUEL SYSTEMS, INTERIORS, EGRESS, FIRE

POST-CRASH FIRE HAZARD

SAFER RECOMMENDATIONS

- SUPPORT A TRANSPORT HELICOPTER POST-CRASH FIRE STUDY SIMILAR TO THE PRECEDING RECOMMENDATION

FAA PLANNED RESEARCH AND DEVELOPMENT

HELICOPTER CRASH SCENARIO (CONTINUED)

	MONTHS FROM CONTRACT
PHASE II	19
– IDENTIFICATION OF INJURY/FATALITY CAUSATIVE FEATURES	
• IDENTIFICATION OF STRUCTURAL AND SUBSYSTEM FAILURES – AIRFRAMES, CABIN, FUEL SYSTEM, EGRESS, FIRE, ETC.	
• FREQUENCIES OF OCCURRANCE/SEVERITY	
• INTERRELATIONSHIP OF CAUSATION FACTORS	
PHASE III	21
– IDENTIFICATION OF TEST TECHNIQUES AND ANALYTICAL METHODS APPLICABLE TO ROTORCRAFT	
• CURRENT TEST TECHNIQUES	
• REVIEW OF AVAILABLE ANALYTICAL TECHNIQUES	
• IDENTIFICATION OF FUTURE ANALYTICAL EFFORTS	
PHASE IV	24
– DEFINE AREAS OF RESEARCH AND DEVELOPMENT FOR IMPROVING ROTORCRAFT CRASHWORTHINESS	
• EVALUATE US ARMY EFFORTS	
• IDENTIFICATION OF FUTURE TEST PROGRAMS	

SAFER RECOMMENDATIONS

POST-CRASH FIRE HAZARD

MODIFIED FUEL

- o EXPAND THE INVESTIGATION OF AMK AND ITS PROPERTIES WITH RESPECT TO ALL OPERATIONAL ASPECTS OF COMMERCIAL TRANSPORT AIRCRAFT.
  - DEVELOP AMK PERFORMANCE SPECIFICATION.
  - INVESTIGATE THE APPLICABILITY OF ANTIMISTING CONCEPTS OF BROADENED SPECIFICATION HYDROCARBON FUELS.
  - INVESTIGATE REDUCED FLASH POINTS OF KEROSENE FUELS.
  - ENCOURAGE NASA TO INCLUDE AMK TECHNOLOGY IN ITS LONG-RANGE FUEL PROGRAM FOR ADVANCED ENGINE SYSTEMS

  BROADEN LARGE-SCALE VALIDATION TEST

ANTIMISTING FUEL PROGRAM

5-PHASE PROGRAM

- FEASIBILITY/SCOPE
- PROTOTYPE SCREENING
- PROTOTYPE DEVELOPMENT
- PROTOTYPE DEMONSTRATION
- RECOMMENDATIONS/INTRODUCTION SCHEDULE

ANTIMISTING FUEL PROGRAM

PROGRAM MANAGEMENT

PHASE I - FEASIBILITY/SCOPE

- o IN ACCORDANCE WITH THE APRIL 1978 MEMORANDUM OF UNDERSTANDING BETWEEN U.S. AND U.K. (NASA AS THIRD PARTY).
- o RESPONSIBILTIES
  - DOT/FAA
    - AIRCRAFT FUEL SYSTEM COMPATIBILITY
    - LARGE-SCALE CRASH FLAMMABILITY RESISTANCE
    - FLAMMABILITY CHARACTERISTICS
    - RHEOLOGICAL PROPERTIES
  - U.K./RAE
    - PRODUCTION
    - BLENDING
    - FLAMMABILITY CHARACTERISTICS
    - RHEOLOGY
    - FUEL SYSTEM COMPATIBILITY

PROGRAM MANAGEMENT (CONTINUED)

- U.S./NASA

  ENGINE FUEL SYSTEM COMPATIBILITIES

  BASIC RHEOLOGY

PHASES II, III, IV, AND V

o IN ACCORDANCE WITH ED-79-

  - U.S./DOT/FAA, ALL TECHNICAL/BUDGETARY RESPONSIBILITIES

NASA

ANTIMISTING KEROSENE (AMK)

- COMPATIBILITY WITH GAS TURBINE ENGINE COMPONENTS
  - LEWIS RESEARCH CENTER/PRATT AND WHITNEY A.C. - $700K, 1 YR
  - FUEL INJECTOR, CONTROLLER, FILTER, COMBUSTOR, PUMP
  - PHYSICAL AND CHEMICAL CHARACTERIZATION - EFFECT ON MATERIALS

- RHEOLOGY AND FLUID PROPERTIES
  - JPL AND AMES RESEARCH CENTER - $300K/YEAR
  - GELLATION
  - SOLVENT EFFECTS
  - DROPLET PHYSICS
  - DRAG MEASUREMENTS

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- o BASIC CHARACTERISTICS
- o LARGE-SCALE EVALUATIONS
- o PRELIMINARY COST/BENEFIT
- o FEASIBILITY DECISION

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- o BASIC CHARACTERISTICS
  - FLAMMABILITY LIMITS/EQUIPMENT PROJECTS
  - RHEOLOGY/QUALITY CONTROL PROJECTS
  - COMPATIBILITY PROJECTS
  - SPECIFICATION OUTLINE PROJECTS
  - PRODUCTION PROBLEMS PROJECTS

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- o BASIC CHARACTERISTICS
  - \- FLAMMABILITY LIMITS/EQUIPMENT PROJECTS
    - o LABORATORY SCALE FLAMMABILITY RIG
    - o EFFECT OF OTHER FLAMMABLES
    - o P.M.F. DEFINITION DEVELOPMENT
    - o IGNITION INTENSITY REQUIREMENTS
    - o DROPLET CHARACTERIZATION
    - o FLAME PROPAGATION RATE
    - o POOL FIRE IGNITION SUSCEPTIBILITY

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- BASIC CHARACTERISTICS
  - RHEOLOGY/QUALITY CONTROL PROJECTS
    - VISCOSITY MANAGEMENT DEVELOPMENT
    - FLAMMABILITY VERSUS VISCOSITY
    - EFFECT OF SHEAR RATE ON VISCOSITY
    - HEAT TRANSFER CHARACTERISTICS
    - SPRAY/VAPORIZATION TECHNIQUES
    - ASTM FUELS METHODS APPLICABILITY
    - DEGRADATION TECHNIQUES
    - BLENDING TECHNIQUES
    - EFFECT OF STORAGE TIME
    - WATER PROPENSITY
    - PIPE FLOW CHARACTERISTICS

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- BASIC CHARACTERISTICS
  - COMPATIBILITY PROJECTS
    - SURVEY OF AIRCRAFT FUEL SYSTEMS
    - SURVEY OF ENGINE FUEL SYSTEMS
    - SURVEY OF AIRPORT FUEL MANAGEMENT SYSTEMS
    - FUEL SIMULATOR INVESTIGATIONS
    - ENGINE COMPONENT BENCH TESTING
    - ENGINE STARTING INVESTIGATION
    - IMPACT ON TURBINE COOLING SYSTEMS
    - ENVIRONMENTAL CONSIDERATIONS
    - HEAT EXCHANGER/FUEL HEATER EFFECTIVITY

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- o BASIC CHARACTERISTICS
  - \- SPECIFICATION OUTLINE PROJECTS
    - o EVALUATION OF SPECIFICATION CRITICAL SECTIONS
    - o GEOGRAPHICAL CONSIDERATIONS
    - o ALTERNATIVE FUELS COMPOSITION EFFECTS
    - o BACTERIOLOGICAL CONSIDERATIONS
    - o IMPACT OF OTHER ADDITIVES
    - o ANTIMISTING QUALITY DETECTOR/INDICATOR

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- BASIC CHARACTERISTICS
  - PRODUCTION PROBLEMS PROJECTS
    - BLENDING LOCATION
    - BLENDING TECHNIQUES
    - BLENDING QUALITY CONTROL CONSIDERATIONS
    - STORAGE TANK/MATERIALS EFFECTS
    - STORAGE STABILITY
    - BLENDING VERSUS ALTERNATIVE FUELS
    - POSSIBLE STORAGE FACILITY REVISION REQUIREMENTS
    - IMPACT ON AIRPORT TRANSPORT SYSTEMS
    - DEGRADATION LOCATION/TECHNIQUES
    - INTERNATIONAL CONSIDERATIONS
    - BLEND MIXING

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

- o LARGE-SCALE EVALUATIONS, PROJECTS
  - LABORATORY TO FULL-SCALE RELATABILITY
  - CRASH SCENARIO PARAMETRIC RANGE
  - INSTRUMENTATION REQUIREMENTS
  - CRASH SITE ANALYSIS
  - CRASH VEHICLE(S) ACQUISITION/PREPARATION

PHASE I - FEASIBILITY/SCOPE

- o PRELIMINARY COST/BENEFIT CONSIDERATIONS
  - ANALYSIS OF COST/BENEFIT FACTORS TO BE CONSIDERED
  - FLEET OR GEO-SEGMENTAL INTRODUCTION
  - MAXIMUM COST PROJECTIONS

PHASE I - FEASIBILITY/SCOPE

- o DECISION ON FEASIBILITY

<u>ANTIMISTING FUEL PROGRAM</u>

PHASE II - PROTOTYPE SCREENING

- BASIC CHARACTERISTICS
- LARGE-SCALE EVALUATIONS
- COST/BENEFIT COMPARISON
- PROTOTYPE SELECTION

ANTIMISTING FUEL PROGRAM

PHASE III - PROTOTYPE DEVELOPMENT

- COMPATIBILITY RESOLUTION
- QUALITY CONTROL/SPECIFICATION DEFINITION
- PRODUCTION/SUPPLY ESTABLISHED
- UTILIZATION/ECONOMICS
- CRASH PREPARATION

ANTIMISTING FUEL PROGRAM

PHASE IV - PROTOTYPE DEMONSTRATION

- o FLIGHT TEST
- o FULL-SCALE CRASH TEST
- o FINAL COST/BENEFIT ANALYSIS

PHASE V

- o REGULATORY RECOMMENDATION/PROCESS

ANTIMISTING FUEL PROGRAM

PHASE I - FEASIBILITY/SCOPE

BASIC TESTS/CHARACTERISTICS
LARGE-SCALE EVALUATION
PRELIMINARY COST/BENEFIT
FEASIBILITY DECISION

PHASE II - PROTOTYPE SCREENING

BASIC TESTS/CHARACTERISTICS
LARGE-SCALE EVALUATION

PHASE III - PROTOTYPE DEVELOPMENT

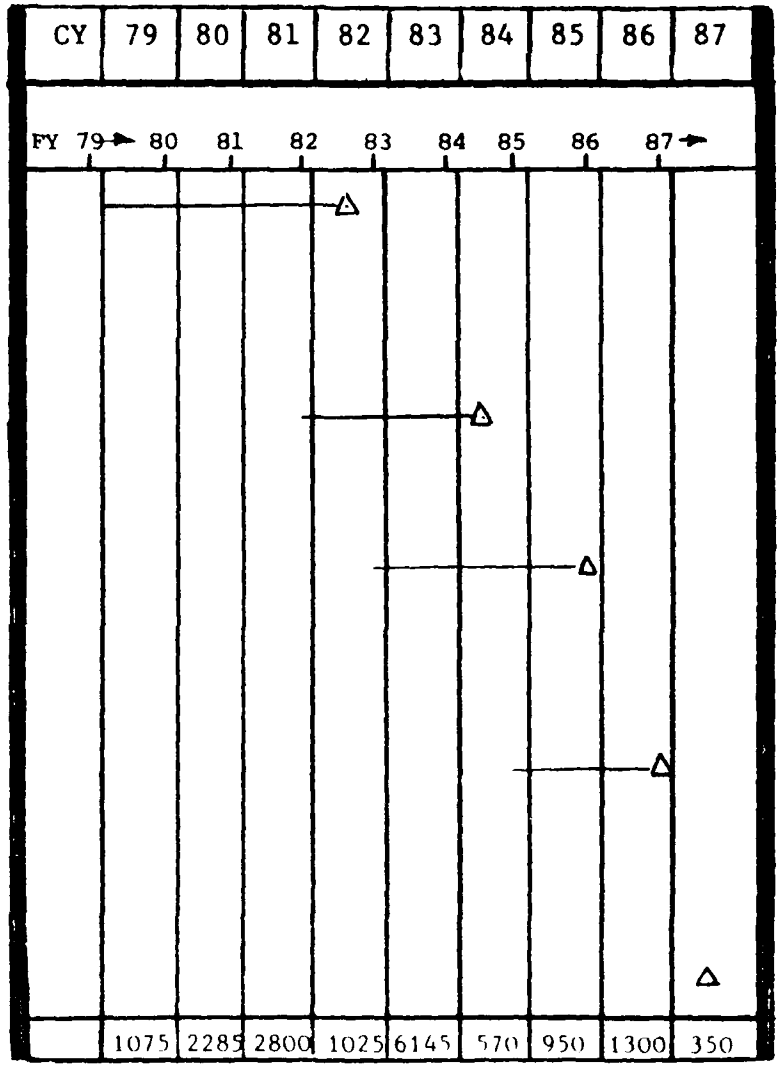
COMPATIBILITY RESOLUTION
SPECIFICATION/Q.C. REQUIREMENTS
PRODUCTION/SUPPLY TECHNIQUES
LARGE-SCALE FLAMMABILITY DEMO.

PHASE IV - PROTOTYPE DEMO.

FULL-SCALE FLIGHT TESTING
FULL-SCALE CRASH TEST
FINAL COST/BENEFIT ANALYSIS

PHASE V - RECOMMENDATIONS/
INTRODUCTION SCHEDULE

TOTAL CONTRACT COST
(THOUSANDS OF $)



FY

Honorable James B. King
Chairman, National Transportation Safety Board
800 Independence Avenue, S.W.
Washington, D.C. 20594

Dear Mr. Chairman:

Based on suggestions during public hearings held by the Federal Aviation Administration (FAA) in 1977 on the hazards of interior materials and fuel system fires and explosions associated with survivable transport category airplane accidents, the Special Aviation Fire and Explosion Reduction (SAFER) Advisory Committee was formed to recommend ways to improve cabin occupant survivability in the post-crash environment. On November 27, 1979, Mr. John H. Enders, Chairman of the SAFER Advisory Committee, reported to me on the action that could contribute significantly to safety which the Committee recommended can be taken on the basis of present-day technical knowledge. One of these recommendations was that the FAA should request the National Transportation Safety Board (NTSB) to implement the proposals by the Coordinating Research Council (CRC) for improved accident reporting relevant to fuel fires.

This CRC proposal is presented on page 41 of CRC Report No. 482, "Aviation Fuel Safety -1975," a copy of which is enclosed. You will note it is recommended that NTSB Aircraft Accident Report Form 6120.2 be revised to focus attention on the need for more information relative to fuel and fires in reporting on transport category aircraft accidents.

The CRC review of aircraft accident fire experience revealed that vital information relevant to aircraft fires and explosions was lacking from most accident reports and files. Information on the cause and nature of aircraft fires/explosions would be of considerable assistance in designing preventive measures and in research and development efforts directed towards reducing these hazards. Factors which would be of interest concerning an impact-survivable accident post-crash fire/explosion environment would include ambient air temperature, wind direction, impact speed, deceleration distance, fuel system damage, fuel type, fuel temperature, ignition sources, time of ignition, location, form, rate, amount, and area of fuel spill, crash site conditions, types of interior materials involved, and cause of fatalities. While it may

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not be possible to establish some of these factors in certain accidents, it appears that reporting and storing as much meaningful fire and explosion information as can be obtained would prove valuable in efforts to reduce aircraft fire and explosion hazards.

Your Mr. R. H. McCormick, observer of SAFER Technical Group activities, indicated in a recent discussion with a member of our staff that Human Factors Groups are responsible in transport airplane accident investigations for documenting most of the above fire-related factors and that an effort is underway to establish computer storage codes for retrieval of such information. It is acknowledged that most of the CKC suggested additions to Form 61... are being covered in Human Factors Group reports, however, we solicit your review of the SAFER Advisory Committee recommendation with the objective of satisfying the need for more information relative to fuel, fires, and explosions.

Sincerely,

... signed by
... M. Bond
Administrator

Enclosure

cc: AVS-1/A..-1/ASF-1/ASF-300(WOOD)/A..-100/140/TGR/AI-1/P-20/...
AOA-1/APA-1/ASF-100/AVS-20
A..-140:TGMorell:dmn:2/12/80

CRC Report No. 482

AVIATION FUEL SAFETY - 1975

November 1975

COORDINATING RESEARCH COUNCIL, INC.
30 ROCKEFELLER PLAZA, NEW YORK, N.Y. 10020

Very few accident reports specify that the occupants were killed due to fire because in many cases it is difficult, even with autopsies, to separate impact from post-crash fire effects. Reports like the 1/30/74 B707 accident at Samoa are relatively rare. For most survivable fatal accidents, the investigators conclude that a combination of factors was responsible for fatalities.

r. Recommendations on Improved Accident Reporting

Aircraft accidents are reported using standardized forms. In the case of General Aviation, either NTSB Form 6120.1 is completed by the pilot/operator or NTSB Form 6120.4 is completed by the Investigator. Both ask for data on fuel by volume and grade but do not seek information on mode of fuel release.

In the case of Air Carrier accidents, NTSB Form 6120.2 is used in reporting all civil aircraft accidents involving aircraft exceeding 12,500 pounds takeoff weight, helicopters and Alaskan air carriers. Usually this form is supported by attached statements as well as the report of the Investigation Team. Complete though this form is, it still lacks certain vital information relevant to fuel fires; unfortunately the usual attachments to this form in an Accident File also lack the information. A revision of the Form should focus attention on the need for information relative to fuel and fires.

The suggested additions to Form 6120.2 cover the following items:

Section V - Cause of fatalities, Fire, Asphyxiation or Trauma.

Section VII - Exit Time. Exits Used.
Location of Exits and Fatalities.

Section VIII - Fuel Aboard by Volume and Grade.
Source of Fuel Release.
Fire Extinguishing System.

Section X - Site Conditions, e.g., Surface.

National Transportation
Safety Board

Washington, D.C. 20594

Office of
Chairman

April 9, 198

Honorable Langhorne Bond
Administrator
Federal Aviation Administration
800 Independence Avenue, S. W.
Washington, D. C. 20591

ASF-1
AVS-1/AVS-
AOA-1/ADA-1

Dear Mr. Bond:

This is in reply to your letter request of March 11, 198 , for Safety Board review of a recommendation by the Special Aviation Fire and Explosion Reduction (SAFER) Advisory Committee concerning the collection of more information relative to fuels, fires, and explosions associated with aircraft accidents.

As you may know, our staff has initiated a major project to develop an improved aircraft accident data management system. This effort will include a review of the accident information requirements of the Safety Board and of other organizations, with a view toward improving the kinds and amount of data collected during accident investigations. Particular emphasis is being directed toward improving the quality and quantity of human performance and crash-survivability data. Obviously, the changes in accident requirements which result will necessitate revision of the Safety Board's Aircraft Accident Report Forms.

Because of the Federal Aviation Administration's (FAA) extensive involvement in the investigation of selected aircraft accidents and the use of accident data, the Safety Board's data project staff is working closely with representatives of FAA's Office of Aviation Safety to ensure that consideration is given to the needs of both organizations. In addition to the day-to-day informal interaction between FAA and Safety Board staffs, bi-weekly progress meetings of the two groups are held.

Therefore, please be assured that your staff will be kept informed of our progress on this project and that the recommendations of the SAFER Committee and the Coordinating Research Council will be given full consideration for inclusion in the new aircraft accident data system.

Sincerely yours,

James B. King
Chairman

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FEDERAL AVIATION ADMINISTRATION

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ADDITIONAL DISCUSSIONS

CREW PROTECTION AND PASSENGER EVACUATION

The scope and expertise of the SAFER Advisory Committee was limited to transport category aircraft and the design aspects of such aircraft as they relate to fire and explosion reduction. Because of the relatively short time involved for the Committee's efforts, attention was focussed primarily on impact survivable accidents where control of fire and explosions would enhance occupant survival. Certain of the discussions of the Committee were beyond this scope; however, since they did affect occupant survivability they are reflected here so they can be kept in view for regulatory activities outside SAFER.

1. Seating Density

If aircraft occupants are to evacuate the aircraft rapidly in an emergency, they must first of all be able to get out of their seats quickly. Yet airlines have been adding seats, thus reducing the space between the seat backs and passengers in the seat behind. If seats are too densely spaced, swift evacuation may be hampered in an emergency situation.

2. Protective Equipment

Any special protective equipment provided for crewmembers must be located at their stations and be readily accessible. Crew ability to aid passengers in evacuating an aircraft during a fire may be enhanced by protective breathing devices and gloves; however, tests should be conducted similar to earlier

AD-A099 176 FEDERAL AVIATION ADMINISTRATION WASHINGTON DC OFFICE--ETC F/G 1/2
SPECIAL AVIATION FIRE AND EXPLOSION REDUCTION (SAFER) ADVISORY --ETC(U)
JUN 80 J H ENDERS, E C WOOD
UNCLASSIFIED FAA-ASF-80-4-VOL-2B NL

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tests carried out for passenger hoods which address the specific problems of time required to don the equipment, ability to direct passengers be understood, and freedom of movement.

3. Public Address System

With reference to passenger egress, consideration should be given to the effective "passenger address system." It should be mandatory that all PA systems be independently powered and be capable of operating in a situation where all other systems have failed.

4. Flight Attendant Stations

A review should be conducted of the location, distribution, and structural integrity of flight attendant stations (jumpseats) in relation to:

a. visibility of cabin interiors and occupants (assessments of the cabin in a smoke and fire situation as well as ability to see areas in the cabin where passengers may need to be rescued by crash fire rescue (CFR) personnel after an evacuation is required).

b. having trained crewmembers dispersed throughout the entire aircraft, especially at exit areas, to provide more effective leadership, immediate opening of correct exits, and effective management of passenger flow to usable exits.

5. New Training Initiatives

Passenger education has been called "the missing link in air safety." (Ref. 11) Seat cards, oral briefings, and demonstrations before takeoff provide passengers with essential information in case of an emergency (Ref. 12) and this area has been the focus of attention by government and industry over the years. Nonetheless, passengers continue to "tune out" this information, and there is very little data readily available to the general public on the hazards present in an aircraft fire, not to mention the related issue of toxicity. The SAFER Committee believes there is a need for continued emphasis on improved passenger education and recommends that the FAA promote open forums, documents, presentations, and other methods to make these subjects more readily understandable by the public. For example, the FAA could collaborate with the National Fire Prevention Association on such fire education issues as what to do if a fire breaks out in flight or after a crash, potential hazards from wearing readily flammable clothing, or smoking in the lavatory. These subjects could be incorporated into public service announcements.

LMED

-8