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Practical Tests of New Materials

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Factual evidence of airline interest in and the need for development of more non-flammable and fire resistant materials is rather dramatically pictured by two recent fire loss experiences. Both incidents occurred within the last eighteen months.

The first incident occurred at Philadelphia International Airport on August 7, 1969* and involved the cabin interior of a 720 aircraft which experienced a ground fire as a result of a short circuit of a razor receptacle in an aft cabin lavatory. This was a fire originating in an unattended aircraft. The second was a 737 which experienced a fire during servicing of the oxygen supply system at Washington National Airport on December 31, 1970.** Origin of this fire was in forward part of first class cabin. With reference to time, temperatures in the order of 1300° F were present in this latter incident from the ignition point - time 0. Personnel aboard the airplane had no opportunity to

*For details, see NFPA Fire Journal Reprint FJ70-9 ($1.00 per copy) or the March 1970 issue of the Fire Journal, pages 5 to 7 and 9.

**For further information, see NFPA No. 421-T, Appendix A, page 421-19. At the time this Bulletin is being prepared, an article on this fire is being scheduled for a future issue of Fire Journal.

extinguish the flames. Ignition point of most all materials was rapidly and greatly exceeded.

You can readily see that the airline objectives are basically the same as NASA's. Namely, the preservation of the lives of human beings as well as the protection of physical property. However, the airline industry must, of necessity, make its selection from materials which combine the improved fire resistant qualities with the aesthetic requirements of interior furnishings. These materials also must have the ability to maintain physical, mechanical, and appearance qualities over a rather extended period of time under rather severe operating conditions. The time element is defined as being compatible with airframe overhaul cycles of approximately 14,000 flying hours. In terms of calendar time, this converts to an elapsed time period of 56 - 60 months. Severe operating conditions include all practical ranges of temperature and humidity, airborne contaminants, and the physical abuse hundreds of people per day can produce.

Ceiling Panels

With all this in mind, United Air Lines became interested in the materials developed by the Manned Spacecraft Center of NASA, Houston. Our contacts with Dr. Radnofsky and others at NASA resulted in our establishment of a program to service test the application of combinations of Fluorel type materials to current basic 727 ceiling panels. Panels are constructed of paper honeycomb with pre-preg fiberglass skins and with a decorative vinyl surface on the cabin side.

Modification of these ceiling panels included:

1. All four were coated on the non-decorative side with a Fluorel/40% asbestos mixture. Approximate thickness was 5 mil. (Purpose of asbestos is to add resistance to the conductive passage of heat.)

2. Two panels had their decorative vinyl surfaces removed and replaced with a Beta/Fluorel fabric material - REFSET RL-4255. A protective barrier film of KEL-F (FX-703) was then applied for improved stain resistance. Fabric thickness was 9 mil.

3. Two panels had their decorative surfaces overcoated with a Fluorel compound - REFSET L-3961-5 then overcoated with the barrier film as indicated in Item 2 above. Approximate thickness was 6 mil.

Items 1 and 3 included a primer-adhesive (EC-2216) to improve or enhance the bond. In the case of Item 2, the EC-2216 was used to bond the fabric in place.

All four panels have been in continued service since early July, 1970. The surface finish is somewhat glossy (attributed to the KEL-F) as compared to adjacent panels, but to date their appearance is considered excellent.

The non-decorative side has not yet been inspected. It is expected that the evaluation will continue until panels are removed from service.

In order to evaluate improvements in burn resistance as well as conduct the other evaluation tests, smaller duplicate panels (12 in. sq.) were prepared with identical coatings and/or fabrics. The usual tests conducted were: color stability, nicotine stain resistance, cleanability, smoke generation, and compliance with the FAR flammability requirements. It was hoped that the Fluorel materials added to these panels would improve the current burn rate classification to the level considered standard for our newer jet fleets - 747 and DC-10 airplanes. Ref. FAR 25.853 and 25.855, proposed regulations dated 8/12/69. Test results indicated non-compliance with "the time to extinguish" (less than 15 seconds) for interior components. It is believed either the current honeycomb material, decorative vinyl where retained, or the epoxy primer contributed to the flammability of the test panels. Additional test work to verify which specific item or material continues to burn after flame removal has not been conducted.

It is our opinion that components and materials which comply with current FAR requirements are difficult to upgrade to the higher FAR standards by adding protective coatings, fabrics, etc., and yet remain within reasonable weight and cost guidelines. It would seem more practical to design and fabricate such components with the higher burn rate classification as one of the design objectives. We hope that development work now under way and data made available from full scale testing will prove beneficial in this area.

The Boeing Company has closely followed our program and also accomplished additional evaluations of "Fluorel" coatings. They have, likewise, expressed an opinion that using a protective coating to upgrade present interior materials is not the ultimate solution for improved flammability.

To supplement the above mentioned program, we have likewise conducted service testing and/or "in house" evaluation of other materials.

Carpets

Starting in early 1968, we have run two service tests of Nomex carpet. The first material tested was of a modified Wilton construction, but pile fiber was not of carpet quality thus the surface was very soft. Estimated retail value of carpet tests, incidentally, was approximately $30.00 per square yard.

This carpet was installed in high traffic aisle area on one of our Los Angeles - San Francisco 727 Commuter aircraft. Total time of service test was 487 flight hours. Crushing of the soft yarn was very noticeable. Stain resistance was on a par with other carpeting in similar service.

A second test was subsequently conducted on a 737 aircraft. The entire aisle was carpeted with a revised material incorporating a heavier and coarser yarn construction. The carpet was removed after 30 days (approximately 150 hours) for inspection. Crushing was not so pronounced as in the original material tested. Unfortunately, the carpeting was not reinstalled because it was "lost" in house with other carpet materials.

Also, Nomex carpets were installed in the airplane "burned" during the joint ALPA-NASA-UAL fire tests held at Cleveland in July, 1968. This test simulated burn through into the cabin from an exterior fuel-fed fire source. After the fire was extinguished, a great variety of burning debris was noted to have fallen on the carpet and charred it badly. However, there was no evidence that the carpet had contributed to the fire. Interestingly, the condition of the polypropylene carpet in our two recent fire incidents displayed charring by molten metal, etc., but not otherwise affected by the cabin fire.

Upholstery

A service test also has been conducted of Beta Glass/Verel upholstery material. This test ran for approximately 1,000 flight hours. We tried to match existing wool upholstery in color, but did not get a good match as the clear glass fibers gave the material a faded look. In brief, this test determined that Beta/Verel fabric is reasonably serviceable, but improvements must be made in color matching for it to compete with treated wool fabrics.

We have evaluated Durette fabrics, but have accomplished no service testing because of the construction and color limitations in upholstery applications and the extremely high cost (from $23.00 to $30.00 per square yard) in quantities we might require. Here again, we currently see no advantage over the treated wool fabric which we are using in our newer generation fleets.

Insulation

Another development which we are following is that of the fire suppressing foam. To date, our evaluation has been limited to discussions with NASA and AVCO personnel. Presently, our main concern is that the chemicals added to provide fire suppressing characteristics also provide outgassing which would not be beneficial to passenger survivability. However, we continue to be interested in this product since one example of a practical application could be the core of a composite material class divider which could act as a fire barrier in passenger cabins.

From this report, you can see that our actual "in service" testing of the materials has been done only to evaluate certain mechanical properties, and not to evaluate flammability control properties.

An actual aircraft fire is synergistic; that is, the whole is greater than the sum of its parts. Given that a fire propagates undetected and unchecked, the following occurs. The material in the area of flame ignition bursts into flames and gives off heat of combustion. This heat reinforces the original ignition source and raises the temperature of the substrates of the surrounding area to the ignition point. Usually a draft or natural ventilation condition is present which helps supply the oxygen necessary to continue combustion. The flame not being removed, as in a lab test, continues to grow in intensity and is fueled by materials in adjacent areas. Thus, all the materials are continuously exposed to flame and continue to burn. Some burning materials separate from their original position within the aircraft, igniting other areas. In short, the heat source is propagating instead of being stationary.

It is our philosophy to only install proven materials. We feel the validity of flammability and contribution to the overall problem can only be verified by full scale testing programs such as currently planned by NASA. These burn tests will be conducted in a 737 fuselage made available and furnished to NASA, Houston, by United Air Lines. Only by such testing can the gulf be closed between the safety provided by existing laboratory burn tests and the safety we require under actual fire conditions.