An Evaluation of Thermal Acoustical Insulation Tapes and Hook and Loop

Abstract

In September of 2000, the Federal Aviation Administration (FAA) issued a Notice of Proposed Rulemaking (NPRM) that specified a new flammability standard for thermal acoustical insulation materials. Important components of the thermal acoustical system include tape and hook and loop fastening systems, which have not been studied in great detail in the past. This paper will discuss testing of these components when attached to insulation blankets and the effects of "mixing" tape with unlike film cover material. The test methodology employed for tapes and hook and loop was developed for incorporation in a planned advisory circular to support the aformentioned NPRM.

Introduction

In 1996, the International Aircraft Materials Fire Test Working Group sponsored by the Federal Aviation Administration (FAA) Technical Center formed an ad hoc task group. This group was formed for the purpose of conducting vertical flammability round robin testing on thermal acoustical insulation films and blankets, as prescribed in the Federal Aviation Regulations (FAR) 25.853. A cotton swab test, which was an internal test specified in the Boeing Commercial Airplane Company's material specifications, was also evaluated. This work and a request from the industry was prompted by a number of incidents involving flame propagation on metallized poly(ethylene terephthalate) Mylar™ thermal acoustical insulation blankets. In September of 1997, a report entitled Evaluation of Fire Test Methods for Aircraft Thermal Acoustical Insulation (DOT/FAA/AR-97/58) summarized the findings. The report included the results of the round robin testing which confirmed that metallized Mylar™ was flammable and that the vertical Bunsen burner test was not an appropriate screening test for insulation flammability.

The round robin results, the reported incidents, and the Swissair Flight 11, MD-11 crash prompted the FAA to undertake a program of intense testing, i.e., full-scale testing, intermediate testing, electrical ignition testing, and bench-scale testing in order to develop an improved flammability test method for thermal acoustical insulation. Ultimately, a flammability test, utilizing a radiant heat source and a small pilot-flame ignition source was developed, based on good correlation with full-scale testing and repeatability.

In May of 2000, the FAA issued two Airworthiness Directives (AD's) (for narrow and wide-body aircraft), calling for the removal of metallized Mylar™ insulation blankets on all affected airplanes. The AD's specified a 5 year time period for their removal. Replacement blankets were to meet the newly developed radiant panel test method specified in the documents.

In September of 2000, the FAA issued a Notice of Proposed Rulemaking (NPRM) entitled Improved Flammability Standards for Thermal/Acoustical Insulation Materials Used in Transport Category Airplanes. This new standard, Test Method to Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustical Insulation Materials, in addition to being proposed for new type designs, was also proposed for newly manufactured airplanes entering part 121 service. Additionally, the proposed flame propagation standard was also proposed for newly manufactured airplanes entering parts 91,125, and 135 service. The NPRM stated that the test method must be applied to all materials that are part of the assembly, i.e., tapes and hook and loop fastening systems.

This paper will discuss radiant panel testing of these components when attached to insulation blankets and the effects of "mixing" tape material with unlike film cover material. The test methodology employed for tapes and hook and loop was developed for incorporation in a planned advisory circular to support the aformentioned NPRM.

Discussion

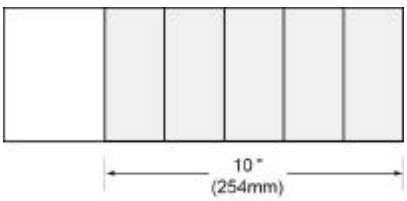
Tapes

The use of thermal acoustical insulation tape is widespread. Not only is it used for repair in the after market but also in the fabrication and installation of new blankets. In new construction, manufacturers will use the same kind of tape as film cover material such as Mylar™ tape with Mylar™ film cover and metallized poly (vinyl fluoride) Tedlar™ tape with Tedlar™ film cover. In the after market, however, it is not uncommon to see different tapes used with different film cover materials. The amount of tape, tape overlap, tape width, and the orientation are all variables depending on the application.

In order to standardize for testing purposes, one tape configuration was utilized. While there are numerous widths of tape used, 2-inch- wide tape was selected because it is one of the most commonly used in both the after market and in new construction. There was a ½ inch overlap of the tape strips on the vertical sample. The tape configuration is shown below in Figure 1.

Figure 1

Tape Configuration



The tape and film cover materials tested are listed in Table 1.

Table 1
Tape and Film Cover Materials

FILM COVER	TAPE
Polyimide	Polyimide
Metallized Tedlar™	Metallized Tedlar™
Polyimide	Metallized Tedlar™
Metallized Tedlar™	Polyimide
Plain Tedlar?	Plain Tedlar?

The test blankets were 12 ½ inches wide by 23 inches long and fabricated with two layers of 0.34 pounds per cubic foot (pcf) fiberglass. The blankets were heat-sealed around the seams.

Hook and Loop

Hook and loop strips are generally designed into a thermal acoustical insulation blanket rather than added during installation. This precludes the use of other attachment means such as clips or tapes at installation. If a blanket is intended to cover an area or a part on the airplane that needs to be accessed for maintenance or replacement at regular intervals, hook and loop would be selected in preference to tape. This is because hook and loop can be opened or removed and closed or remounted without damaging the hook and loop construction.

In order to subject joined hook and loop strips to radiant panel testing, two small test blankets were assembled. Each blanket was fabricated with one layer of 0.34 pcf fiberglass and encapsulated with film cover. The film covers used in this testing were plain Mylar™ Class 1, metallized Tedlar™, and polyimide. Figure 2a depicts the open test sample with a 1-inch-wide hook strip on one blanket and a 1-inch-wide loop strip on the other. The two blankets were then brought together forming the closed test sample as seen in Figure 2b. This figure also shows the flame placement during the test differs from the flame placement for insulation blankets and tapes. The heat flux and the time of flame application, however, are the same as those specified in the test standard.

Figure 2a
Open Test Sample

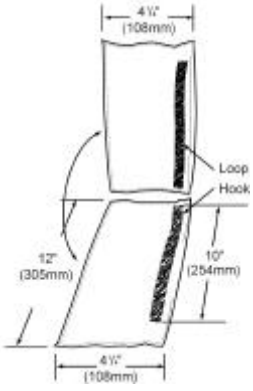
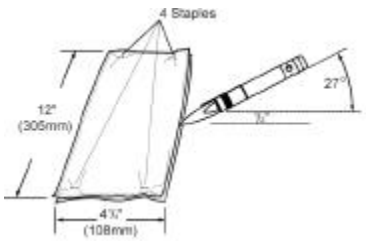


Figure 2b
Closed Test Sample



Test Program

Tape Testing

The taped test blankets were prepared in the configurations shown in Figure 1. They were given a 24-hour lay up time in order to achieve proper tape adhesion. Testing was accomplished in accordance to Part VI-Test Method to Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustical Insulation Materials, specified in the NPRM. The following are the requirements of the test method: (1) No flaming allowed beyond 2 inches to the left of the centerline of the point of pilot flame application, and (2) Of the three specimens tested, only one may have an after flame, not to exceed 3 seconds.

Hook and Loop Testing

In order to show that the configuration of the hook and loop strips on the small blankets would appropriately characterize the flammability of the hook and loop, radiant panel tests were first run on small blankets without the hook and loop strips. This was done in order to assess any "oven effect" that would cause ignition of the film cover between the two small blankets. If this had occurred, it would have compromised the test results when hook and loops strips were attached. Figure 2 b. depicts the point of flame application for samples with and without hook and loop strips.

Results

Tapes

Table 2. shows the results of radiant panel tests performed on the vertical tape construction.

Table 2
Vertical Tape Strips
(average of three tests)

FILM COVER	**TAPE**	**AFTER FLAME** (seconds)	**FLAME PROPAGATION** (pass/fail)*
Polyimide	Polyimide	43	fail
Metallized Tedlar?	Polyimide	0	pass
Polyimide	Metallized Tedlar?	70	fail
Metallized Tedlar?	Metallized Tedlar?	0	pass
Plain Tedlar?	Plain Tedlar?	0	pass

* fail - denotes flame propagation beyond 2 inches to the left of the point of flame application

The data shows that the polyimide film and polyimide tape construction fails both the after flame and flame propagation requirements in this series of testing. Because polyimide tape does not melt or shrink away, enough radiant heat is generated to lift the tape strips resulting in a “ripple” or “accordion” effect. This effect results in direct exposure of the tape adhesive to the flame with subsequent flash fires down and perpendicular to the length of the sample. The metallized Tedlar? film and tape construction passed both the after flame and flame propagation requirements as did the plain Tedlar? film and tape construction. The polyimide tape on metallized Tedlar? film also passed the test requirements. The metallized Tedlar? tape on polyimide film cover failed with an after flame of 70 seconds and flaming to the end of the tape strips.

Hook and Loop

The polyimide and metallized Tedlar? test blankets without the hook and loop strips did not propagate flame or continue burning upon removal of the flame source. The Mylar? Class 1 sample without hook and loop strips had an after flame of 12 seconds. All samples with hook and loop strips failed due to flaming along the full 10 inches of the hook and loop strips.

Conclusions

1. Polyimide tape strips over polyimide film cover samples fail the radiant panel test criteria.
2. Metallized Tedlar? tape strips over metallized Tedlar? film cover samples pass the radiant panel test requirements.
3. Plain Tedlar? tape strips over plain Tedlar? film cover samples pass the radiant panel test requirements.
4. Metallized Tedlar? tape strips over polyimide film cover samples fail the radiant panel test criteria, but polyimide tape strips over metallized Tedlar? film cover samples pass the radiant panel requirements.
5. The small test blankets with the hook and loop strips attached are an acceptable sample configuration that can characterize the flammability of the hook and loop strips.
6. The polyimide, metallized Tedlar? , and Mylar? Class 1 samples with the hook and loop strips fail the radiant panel test requirements.
7. Tapes and hook and loop used in the installation of aircraft insulation blankets may contribute significantly to blanket flammability.