Nicholas

FLAMMABILITY & DESIGN CONSIDERATIONS FOR COMMERCIAL AIRPLANE INTERIOR MATERIALS

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INTRODUCTION

The aircraft industry, like the building industry, and industries which manufacture such items as household appliances, office equipment, marine pleasure crafts and automotive products is interested in the safety of the people using their products. There is an ever increasing emphasis on the use of plastic materials in all these fields and one common major safety consideration is the flammability properties of these materials. The test methods used to best determine the fire safety provided by plastic materials creates quite a problem for the Materials Engineer. It is likewise a tremendous task for those agencies charged with establishing and enforcing the fire safety requirements and regulations for these materials used in each of the many industries. In the aircraft manufacturing industry plastic materials are used for a large variety of items in the fabrication and assembly of an airplane. They are used for structural purposes, in mechanical and electrical subsystems, electrical terminal boards and wire coatings, air ducting, water tanks and tubing, seals and sealants. The most widespread use, however, is for the interior sidewall and ceiling linings, and the many other furnishings of the areas occupied by the crew and passengers and the areas used for cargo storage. The flammability properties of the materials used for these purposes and the fire safety provided by such properties are of the greatest concern.

FLAMMABILITY TEST METHODS

At the present time there are 20 different tests listed and approved by the American Society for Testing Materials (ASTM) for use in establishing the flammability properties of plastic materials. To refresh your memories here are several of them:

(1) D568, "Test For Flammability of Plastics 0.050 Inch and Under In Thickness."

(2) D635, "Test For Flammability of Rigid Plastics Over 0.050 Inch In Thickness."

(3) D757, "Test For Flammability of Plastics, Self-Extinguishing Type."

(4) D1433, "Test For Flammability of Flexible Thin Plastic Sheeting."

(5) D1692, "Test For Flammability of Plastics Foams and Sheeting."

(6) E-84, "Surface Burning Characteristics of Building Materials."

(7) E-162, "Test For Surface Flammability of Materials Using a Radiant Heat Energy Source."

In addition, there are the various tests methods specified in Federal Test Specification 406. Still others are specified and used by such agencies as the Underwriter's Laboratory. Then the Building Code requirements of various cities throughout the United States differ from many of these. Many others have been and are likewise proposed for use in evaluating the flammability properties of materials.

To provide insight and to obtain information regarding the fire properties, the overall flame spread rates, and the temperature generated by resulting fires, there are still additional tests which can be used. Typical of these are: Differential Thermal Analysis (DTA), Thermogravometric Analysis (TGA), Specific Heat, Heat or Calorific Content, and Auto-Ignition Temperature. However, these tests are much more complex, time consuming, and therefore, are much more costly to conduct. The great number and types of materials needed and used in the construction of an airplane, therefore, preclude these tests from being used. They can be and frequently are used to gain pertinent and comparative type information in the early stages of materials evaluation and development for airplane constructional purposes.

INCREASED CONCERN & REGULATION CHANGES

A series of aircraft accidents with ensuing fires and loss of life occurred in late 1965 and early 1966. These accidents caused increased concern, not only within the governmental regulatory agencies, but among the various manufacturers of commercial transport category airplanes. As a result, in mid-1966 the Federal Aviation Agency (FAA) issued a "Notice of Proposed Rule Making," No. 66-26 (NPRM 66-26). It was the purpose of this notice to amend the Federal Aviation Regulation 25 (FAR 25). For the purpose of this discussion, we shall limit outselves to the section relating to the flammability of materials, specifically FAR 25.853, FAR 25.855, and FAR 25.857. These sections are regulations for interior materials and finishes used in the crew, passenger and cargo compartments.

TYPES OF FIRE

There are basically three types of fire ignition sources: (1) Small in-flight observed and attended fires, (2) Unobserved and unattended small ignition sources, and (3) Large fuel-ignited and fuel-fed fires associated with airplane accidents. Although materials which will prevent the rapid spread of fire are of primary concern, there are many other aspects to be considered. However, let us first concern ourselves with the FAA regulations existing at the time of the accidents and the resulting fires which created the anxiety and the proposed changes to the interior materials regulations. Then, we shall look at other aspects of materials selection and usage which must also be considered.

REGULATION COMPARISONS

Table I compares the FAA flammability regulations under which the airplanes were certified with those adopted by the FAA after considering all comments received from interested and affected individuals, airframe manufacturers, airline operators, materials suppliers and fabricators, and other related industries. Even though you may not be suppliers for the airplane industry, you will notice the proposed changes as being significant. Also, you probably will be able to recognize the significance of the changes and relate them to the impact upon similar materials common to both the airplane industry and specific product lines with which you may be familiar.

FLAMMABILITY - STATE-OF-THE-ART

Almost without exception, in each specific materials field the state-of-the-art did not exist which could provide materials meeting the proposed flammability requirements. This was true whether it be synthetic or natural occuring materials used to produce such items as: Upholstery fabrics, carpets, draperies, seat cushions or backs, light covers, compartment walls and ceilings, compartment dividers, floors, thermal-acoustical insulation, air-conditioning ducts, pulleys, gaskets and seals, or other items. The great majority of materials which did have flammability resistance usually lacked a great number of other properties required to produce a functional and profitable operating airplane. For instance:

(1) There are woven glass fabrics which are completely non-combustible, but which lack flexibility; cannot be obtained in all the weaves and colors desired; are easily abraded, fade and tear quite easily; are easily soiled and stained; and do not launder or dry clean without losing their lustre and pleasing appearance and, therefore, cause a high maintenance factor or replacement cost.

(2) There are different thermal-acoustical insulation materials, such as asbestos or other metal oxide fibers, which could be used and have the proposed flammability requirements. However, they lack the desired noise attenuation characteristics; will not resist compaction and settling under airplane vibrational characteristics; are not water repellant, fungus and mildew resistant; and of greatest concern they create a significant weight penalty since they are only available in densities of from 3 to 10 pounds per cubic foot, as compared to the 0.5 to 1.5 pounds per cubic foot densities of the materials being used.

(3) There are non-combustible aluminum sheet stocks which could be used for sidewall, ceiling, compartment dividers, interior door panels, or other interior application. However, when these items are made from aluminum they require a minimum usable gauge (.032") for attachment purposes which imposes a severe weight penalty. Aluminum needs costly operations of anodizing and dyeing, or priming and painting to obtain the desired colors; cannot be fabricated into complex multi-contoured shapes without orders of magnitude cost differences; does not possess the texture, softness and pleasantness of touch, without either a feeling of coldness or heat, as the prevailing environmental conditions may impose; and it is hard and will not absorb internally-generated noises.

These are only three examples of the many items and types of materials which may be and are commonly suggested as replacements for organic polymeric resin systems used to fabricate the many items used in passenger accommodation areas.

You may wonder what all this has to do with flammability and fire safety. It has very little to do with it; but these types of considerations have a great deal to do with the overall problem and choice of materials for the production of an efficient, operational, and functional airplane. Almost without exception, the great majority of the suggested or possible replacement materials which would satisfy the flammability requirements do not possess the low weight, ease of fabrication, decor and pleasing esthetics, and cannot be used while still providing the above factors in addition to low maintainability and operational costs which both the travelling public and the airline operators desire and have the right to expect.

CRASHWORTHINESS IMPROVEMENT PROGRAM

Now, getting back to the proposed regulation change. In response, the aircraft manufacturers, by cooperative efforts through the Aerospace Industries Association (AIA), committed themselves to a nationwide, and even some international "industry surveys" of the materials field. The objective was to assure that the most flammability-resistant and functional materials were being used for aircraft construction and to achieve, if possible, improved crash-worthiness and fire safety. The scope was to include all those materials used in significant quantities in the crew, passenger and cargo compartments. The goals were: (1) To determine the best available production materials; (2) To encourage materials' manufacturers to develop improved materials; (3) To define the most practical test methods for flammability and smoke; (4) To determine, in the case of an actual airplane fire, the significance of using improved materials; (5) To propose an upgraded regulation resulting from the total program; and (6) To recommend additional research and development efforts needed, both in the airplane industry and by the materials industry in those areas where technical deficiencies existed. Table II shows the 24 major material types and categories that were established for purposes of the survey. These are only the major categories; there were also sub-classifications within a number of these categories. In conjunction with this survey, it was necessary to:

(1) Establish a base line for desired properties - - for flammability, the FAA's Notice of Proposed Rule Making, No. 66-26 was used.

(2) Combine the various aircraft company materials specifications into one common set of requirements.

(3) Define and establish a common objective and limit of what the airplane manufacturers meant by "producibility" for their conversion of materials into end item composite parts.

(4) Establish definitions for the term "commercial availability" and the time phasing for the materials availability.

Table III, "Materials Survey Chart," shows the type of chart established and the data asked for from the material suppliers. This chart was for upholstery fabrics. Similar charts applicable to each category and sub-classification were established and distributed. Figure 1 shows the results of the survey. Response was less than 30%; and Figure 1 also includes negative responses.

DESIGN CONSIDERATIONS

Background data has been presented. It seems appropriate at this time to give design considerations which must be used in the choice of materials.

Simply stated they are:

(1) As a minimum, the materials used must meet the FAA certification requirements. Those requirements and the proposed amendments to them have been shown previously, (Table I).

(2) The materials used must provide a minimum of weight for their functional use.

(3) The materials must provide the lowest and most realistic cost, both from impact on overall airplane cost, and so that use in the airplane will provide a profit to the airline operators through low maintenance and replacement cost.

(4) The materials must provide a pleasing and acceptable decor to the travelling public.

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These design considerations have been simply stated. As you can well understand, there are many items involved in order to achieve these objectives. Let us look at some of these items.

From the standpoint of a weight consideration, Table IV lists information concerning the materials' thicknesses and weight of honeycomb sandwich panels. These constructions are typical of the constructions used for sidewall and ceiling panels, for compartment dividers and for lavatory and galley bulkheads. The construction of the Type II was possible through the adaptation of new materials which possessed a higher flammability resistance. At the same time, a weight reduction was achieved. Additional design benefits were that a greater design freedom was achieved in that more complex shapes and curvatures are also possible with the Type II construction. Although switching from the existing to the new construction posed additional design and fabrication problems, most of these have been largely overcome.

The flammability characteristics when checked by conventional methods, such as the Bunsen Burner, Radiant Panel (ASTM E-162) and the 25-foot Tunnel Test (ASTM E-84), were also lower for the Type II construction. Flammability testing of these constructions in airplane mock-up fires also correlated these laboratory test results. Marked improvement in the flammability resistance was noted. By using the Type II construction, the temperature rise rate over a 3-minute interval was reduced by 30 percent and the maximum temperature was reduced by 800F. It is also significant that the maximum temperature resulting from the use of the improved materials occurred at a somewhat later time.

MATERIAL SPECIFICATIONS NEEDED

When we talk of materials and their usage we are talking about use as single materials and use in providing multi-component composites. To ensure that the materials used are uniform, have consistent properties and will perform the same when they are used singularily or in such composites, material specifications are required. For instance, at The Boeing Company we have 290 different non-metallic material specifications. A breakdown showing the different types is given in Table V. Other companies have a comparable number. Most of these are for organic or combinations of organic and inorganic materials. In most instances, the specifications have wide variations in flammability properties. It would be a simple task if each material for which there is a specification had only one specific use or application. If such were the case, specifying properties, particularly flammability properties, would be relatively easy. As an example, referring again to Table IV, if these materials were only going to be used in such a composite, only the flammability of the end item composite would have to be determined. As long as the composite performed and met the regulatory requirements, the individual materials' properties would be inconsequential. However, this is also an over-simplification. Without determing or comparing the individual materials' properties, their effect on the overall composite could not be compared with other materials which might be used. Likewise, to ensure repetitive performance, the quality of the individual materials must be established, and the specifications prepared stating the receiving inspection and acceptance requirements.

Parallel with the above usage, and using the sandwich panel materials as an example once a specification is established, even though the original materials usage is in an end-item composite, there is no method to prevent such a material from being used in many other ways: To be used singularily, or in combinations with other materials differing widely from the original composite ingredients. It is easy to understand the many combinations possible and the desired individual properties, or the individual effects on the overall property. Such widespread usage creates a never ending job of checking, adjusting, and modifying by both the materials' user and by the supplier. Added to the above are also the requirements to determine the effects of various process parameters or the effect of a single material on the properties of the end item products. One specific example is the use of an elastomeric coated glass fabric. After many attempt, trials, and modifications by the basic materials' suppliers, and the intermediate compounder and coating applicator, the fabric met the desired properties, including the resistance to burning. Another usage of this fabric required an additional modification through the application of a low emittance coating, such as aluminum. The process used by the coater in this instance was to vapor plate a separate film with aluminum, sensitize the coated fabric with a very minute layer of adhesive, and bring the fabric and plated film together. The adhesive was then cured and the aluminum stripped from the original film. The statement made by the coater was that in comparison to the end-item such a minute amount of adhesive was used that its influence on the overall flammability would be nil. However, upon testing, the coated and aluminized fabric showed a very high burning rate compared to the self-extinguishing and practically non-burning properties of the original coated fabric. Many other similar instances have been encountered in our search for materials. This example points out the necessity of establishing and continuously monitoring the materials properties. When suppliers modify basic materials to achieve a higher degree of flammability resistance, any significant change in other properties must also be established by retesting. A balance between desired properties can then be achieved but many times leads to a compromise in many of them.

MULTIPLE FLAMMABILITY REQUIREMENTS

Another consideration which complicates materials usage is the varying levels of flammability requirements. As shown in Table I, the regulations of the past and the interim regulations have requirements which are dependent upon where materials are used in the airplane interior. Use of many materials in areas different from those for which they were originally specified and certified often occurs. For many instances where this does occur, the specification requirements established originally may be far in excess of those required for many such subsequently different uses. In still other applications, the same

Specification of flammability properties must therefore be established with requirements imposed by the original use criteria. Likewise the specification requirements must be such that they can be referenced on purchase orders, checked for conformance by the materials suppliers, and tested and verified by the receiving inspection department of the purchaser.

Some materials are never used alone, but are always combined with others. The most typical of these are paints, adhesives and honeycomb core materials. Such materials may drastically affect the resulting flammability properties and the tests on the individual materials are not meaningful from the standpoint of end-item usage. However, we still need testing of the individual materials to provide a screening method to reduce the number of tests conducted, to reduce the test effort expanded and to reduce the cost required for the fabrication of the composite test specimens.

ZONES OF USAGE

Does it make sense to have these different regulation requirements, or wouldn't it be better to have only one requirement? Yes, multiple requirements do make sense, and no, one requirement would not be the better approach. Figure 2 shows the cross-section of an airplane body with indications typical of the various levels of flammability requirements, based upon the zones of materials usage. These zones, although not specifically stated in the original FAA regulations or the interim and presently effective regulations, have since been proposed. Figure 2 also lists the specific requirements as recommended to the FAA following extensive and numerous flammability tests on aircraft materials. Many airplane mock-up fire tests, both small and large, and fires occurring in unattended airplanes substantiate the technical basis of a regulation with the multiple zone concept and multiple requirements.

FUTURE OUTLOOK-FLAMMABILITY AND SMOKE

We have primarily concerned ourselves with only the aspect of material flammability in this discussion. We would be remiss if we did not touch on the property associated with the burning of almost all materials, that of the resulting smoke emission.

It is commonly known that the flammability of most organic materials can be greatly reduced by the incorporation of chlorine or bromine into the basic polymer structure and through the addition of inert fillers. The net result is to decrease the flame spread, but by doing so, greatly increase the resultant smoke. This has been of great concern to the FAA, Underwriter Laboratories (U.L.), the American Society for Testing Materials (ASTM), various building code regulatory agencies, as well as the airplane manufacturers. The optimum achievement would be to decrease the flammability of materials while at the same time greatly reducing the quantity of generated smoke. Figure 5 shows that such an ideal has been achieved by a few products. There may be like improvement in others.

It is not the intent at this time to discuss whether or not the possibility or the probability that enough of these and similar types of materials exist so that an airplane interior could be produced. It should suffice to say that: To date the airplane industry has not been overwhelmed by materials producers or suppliers with products exhibiting such a combination of properties. However, it is our desire that in the very near future such a situation will occur. Like desires are prevalent and have been strongly expressed by such other groups as previously mentioned.

A detailed discussion on the parameters effecting the burning and resulting smoke emission properties of the many materials used in airplane construction is beyond the scope of this presentation. Such information should be presented in detail by itself since there are many technical aspects to be considered.

Presently, along with the many details which are lacking and which have not been fully evaluated, test procedures are yet to be investigated, established, and agreed upon by industry users, suppliers, regulator agencies and others. When these items have been defined and established it is predicted that the airplane industry, materials suppliers, building industry, and regulatory agencies will prepare and institute smoke test procedures and requirements for the various types of materials.

It is our firm belief that with enough emphasis the problems of obtaining the materials with both a higher degree of flame retardancy and low smoke emission will be resolved. Product research directed at such goals is strongly recommended.

DIFFERENT REGULATION REQUIREMENTS		
SUBJECT	CAR 4b	CURRENT FAR PART 25
Materials Burn Test - Materials in Areas Occupied by Crew and Passengers	(a) All Materials at Least Flash Resistant (b) Walls, Ceilings, Coverings of Upholstery, Floors, and Interior Furnishings - Shall be Flame Resistant (4"/min. Burn Rate - Horizontal Test)	Cabin Lining Materials: Vertical & Horizontal 12 Sec. Ignition: (a) Self Extinguishing (b) Char Length 8 inch vertical 4 inch horizontal Other Materials: Horizontal Test; 15 Sec. Ignition 4 in./min. Burn Rate
Materials Used in Cargo Areas	All Materials Including Tie Downs Shall be at Least Flame Resistant	For Class A Compartment - Same as for Crew and Passenger Areas. For Class B, C, D and E Compartments, Fire Resistant

INTERIOR MATERIALS FLAMMABILITY REQUIREMENTS

TABLE I

CATEGORY [1]	TITLE
1	Decorative Fabrics
2	Non-Decorative Fabrics
3	Industrial Coated Fabrics
4	Decorative Coated Fabrics & Leathers (Natural & Artifical)
5	Floor Coverings
6	Fiberglass Insulation
8	Flexible Coupling Air Ducts
9	Plastic Transparencies (Window & Windscreen)
10	Vinyl-Aluminum Laminates
11	Rigid Melamine Laminates
12	Potting Compounds
13	Adhesives & Pressure Sensitive Tapes
14	Cellular Plastics
15	Thermoplastics
17	Glass Reinforced Plastic Laminated Ducting
18	Glass Reinforced Plastic Sheet Items
19	Glass Reinforced Plastic Configurated Parts
20	Decorative Elastomeric Seal Materials
21	General Elastomeric Material
22	Organic Finishes
23	Electrical Conductors
24	Wood (Edgings and Veneers)

[1] Categories 7 & 16 were combined into 4 & 15 respectively

MATERIAL CATEGORIES

TABLE II

A.I.A. INPUTS			MATERIAL MANUFACTURER TO COMPLETE	
			FIRM NAME & ADDRESS	
PROPERTY	TEST METHOD	VALUE	PRODUCT DESIG. 1. ______ VALUE	PRODUCT DESIG. 2. ______ VALUE
FLAMMABILITY TARGET	CCC-T-191, METHOD 5902	ZERO FLAME, 1 INCH CHAR A. AFTER 3 LAUNDERINGS B. AFTER 3 DRY CLEANINGS		
PRESENTLY AVAILABLE	CCC-T-191, METHOD 5902	0-3 SEC FLAME, 3 INCH CHAR.		
COLORFASTNESS LIGHT	CCC-T-191, METHOD 5660	NO APPRECIABLE CHANGE AFTER 40 S.F. HOURS.		
CROCKING	CCC-T-191, METHOD 5650	"GOOD" WET OR DRY.		
PERSPIRATION	CCC-T-191, METHOD 5862	"GOOD" RATING.		
WEIGHT	CCC-T-191, METHOD 5041 WITH 18 x 18 INCH SQUARE	16 OZ. MAXIMUM/SQ. YD.		
TENSILE STRENGTH	CCC-T-191, METHOD 5100	100 LB MINIMUM		
TEAR STRENGTH	CCC-T-191, METHOD 5132	WARP 5 LB MINIMUM FILL 2.5 LB MINIMUM		
BURST	CCC-T-191, METHOD 5122	125 LB MINIMUM		
STIFFNESS	CCC-T-191, METHOD 5200	2 TO 3 INCH LOOP		
ABRASION RESISTANCE	CCC-T-191, METHOD 5306 CS-10 WHEEL, 1000 gm. LOAD.	NO APPREICABLE WEAR OR COLOR COLOR CHANGE AFTER 750 CYCLES.		
SHRINKAGE RESISTANCE	A. COMMERCIAL DRY CLEANER B. COMMERCIAL LAUNDERER C. AGE 7 DAYS AT 160 ± 5°F THEN CCC-T-191, METHOD 5550.	18 x 18 INCH SQUARE MARKED ON 22 x 22 INCH PIECES OF MATERIAL SHALL NOT SHRINK MORE THAN 3% IN EACH CASE.		
CLEANABILITY	1-1/2 INCH DIAMETER STAIN A. COMMERCIAL DRY CLEANER B. COMMERCIAL LAUNDERER	NO DETERIORATION OR APPRECIABLE STAINING WHEN TESTED WITH SOUP, BUTTER, MAYONNAISE, COFFEE WITH CREAM, CHOCOLATE, FRUIT JUICE, HAIR OIL AND PERSPIRATION.		
AGING	CCC-T-191, METHOD 5850 A. AGE 2 WEEKS AT 125 ± 5°F B. AGE 1 WEEK AT 160 ± 5°F	NO APPRECIABLE COLOR CHANGE AND NO MORE THAN 10% LOSS TENSILE STRENGTH.		
CORROSION	PLACE MATERIAL BETWEEN CHROMODIZED 2024-T3 ALCLAD AND 7075-T6 ALCLAD.	NO CORROSION EFFECT AFTER 72 HR AT 100 ± 2°F AND 98 TO 100% R.H.		

1. THIS COLUMN ONLY FOR MATERIALS AVAILABLE FOR EVALUATION PRIOR TO JAN. 1, 1968, AND IN PRODUCTION QUANTITIES PRIOR TO JUNE 15, 1968. IT IS PERMISSIBLE TO OMIT VALUE(S), WHERE IT CANNOT BE OBTAINED IN ACCORDANCE WITH THE INDICATED TEST METHOD IN TIME FOR SUBMITTAL.
2. THIS COLUMN FOR MATERIAL AVAILABLE IN PRODUCTION QUANTITIES AFTER JUNE 15, 1968. GIVE PROBABLE PROPERTIES OR OBJECTIVES.

MATERIAL TYPE: UPHOLSTERY FABRIC

CATEGORY NO. 1

AIA MATERIAL SURVEY CHART

TABLE III

TYPE I EXISTING AIRPLANE CONSTRUCTION			TYPE II NEW CONSTRUCTION WITH DECREASED FLAMMABILITY		
Material and Construction Detail	Thickness (inches)	Weight (Lbs/Ft^2)	Material and Construction Detail	Thickness (inches)	Weight (Lbs/Ft^2)
Tedlar Film [1]	.001 }	.008	Tedlar Film [1]	.001 }	.008
Adhesive			Decorative Ink		.004
0.020 Vinyl Laminates	.020	.140	Tedlar Film [1]	.002	.016
Adhesive	.004	.027	Epoxy-Fiber-glass Laminate	.010	.105
Polyester Fiber-glass Laminate	.013	.120	Epoxy-Fiber-glass Laminate	.004	.042
Adhesive	.004	.026	Nomex Honeycomb Core	.250	.041
Paper Honeycomb Core	.250	.076	Epoxy-Fiber-glass Laminate	.004	.042
Adhesive	.004	.026	[1] Includes Thickness & Weight of Adhesive		
Polyester Fiber-glass Laminate	.013	.120			
Total Weight		.543	Total Weight		.258

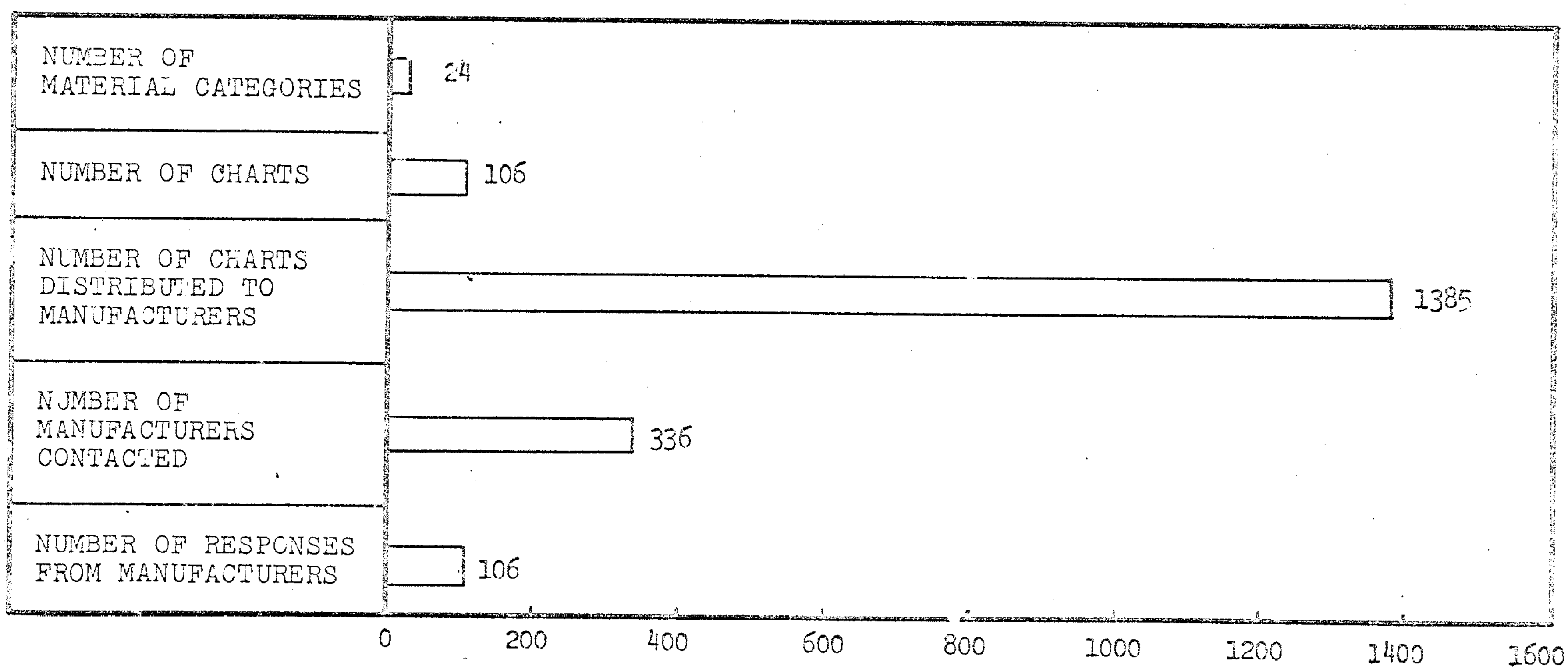
TYPICAL COMPOSITE HONEYCOMB SANDWICH PANELS

TABLE IV

SPECIFICATION TYPE	SPECIFICATION BREAKDOWN		
	Total No.	Total No. Used Comm'l Airplanes	No. Controlled by Commercial A/P Div.
Total	290	167	117
Rubbers and Elastomers	52	21	7
Wood	1	1	1
Lubricants and Solvents	9	4	2
Complete Sandwich Panels or Honeycomb Cores	9	5	5
Resins and Adhesives	60	36	29
Plastics	115	80	57
Thermal Acoustical Insulation and Glass Fabric	9	7	5
Finishes	35	13	9

NON-METALLIC MATERIAL SPECIFICATIONS

TABLE V



AIA SURVEY RESULTS

FIGURE 1.

CRITICAL AREA

- INTERIOR PANELING AND SURFACING ABOVE WINDOW

  60-Second Ignition, Vertical
  15-Second Self Extinguishing Time
  6-Inch Burn Length
  3-Seconds Self Ext. of Drippings

GENERAL

- INTERIOR FURNISHINGS AND OTHER MATERIALS

  12-Second Ignition, Vertical
  15-Second Self Extinguishing Time
  8-Inch Burn Length
  5-Seconds Self Ext. of Drippings

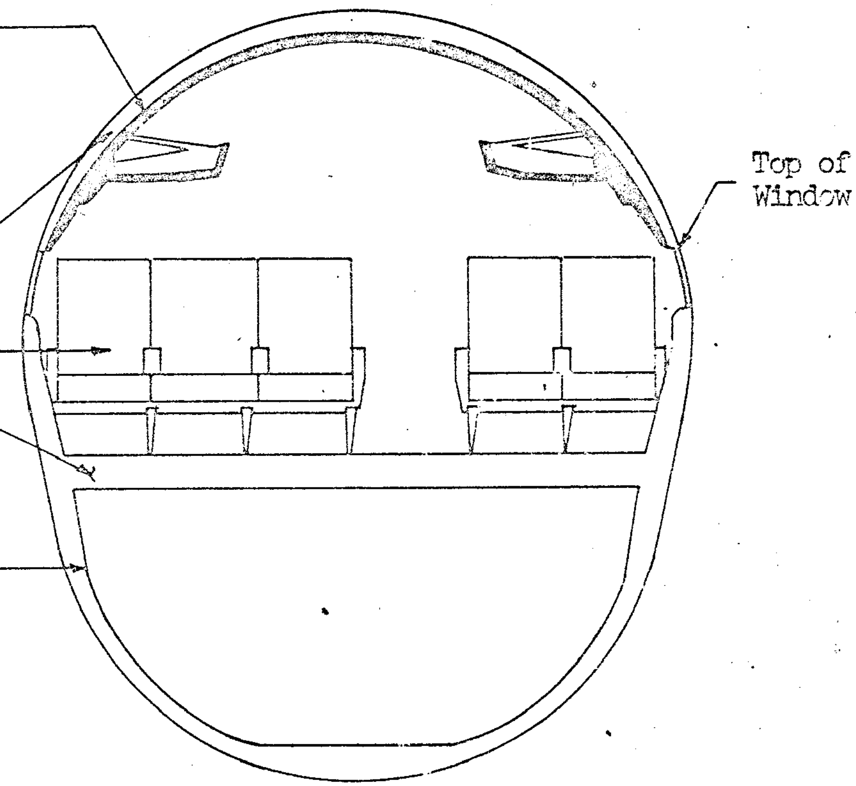
- CARGO LINING

  Existing Requirement and
  12-Second Ignition, Vertical
  15-Second Self Extinguishing Time
  8-Inch Burn Length
  No Flame Penetration

- EXCEPTIONS:

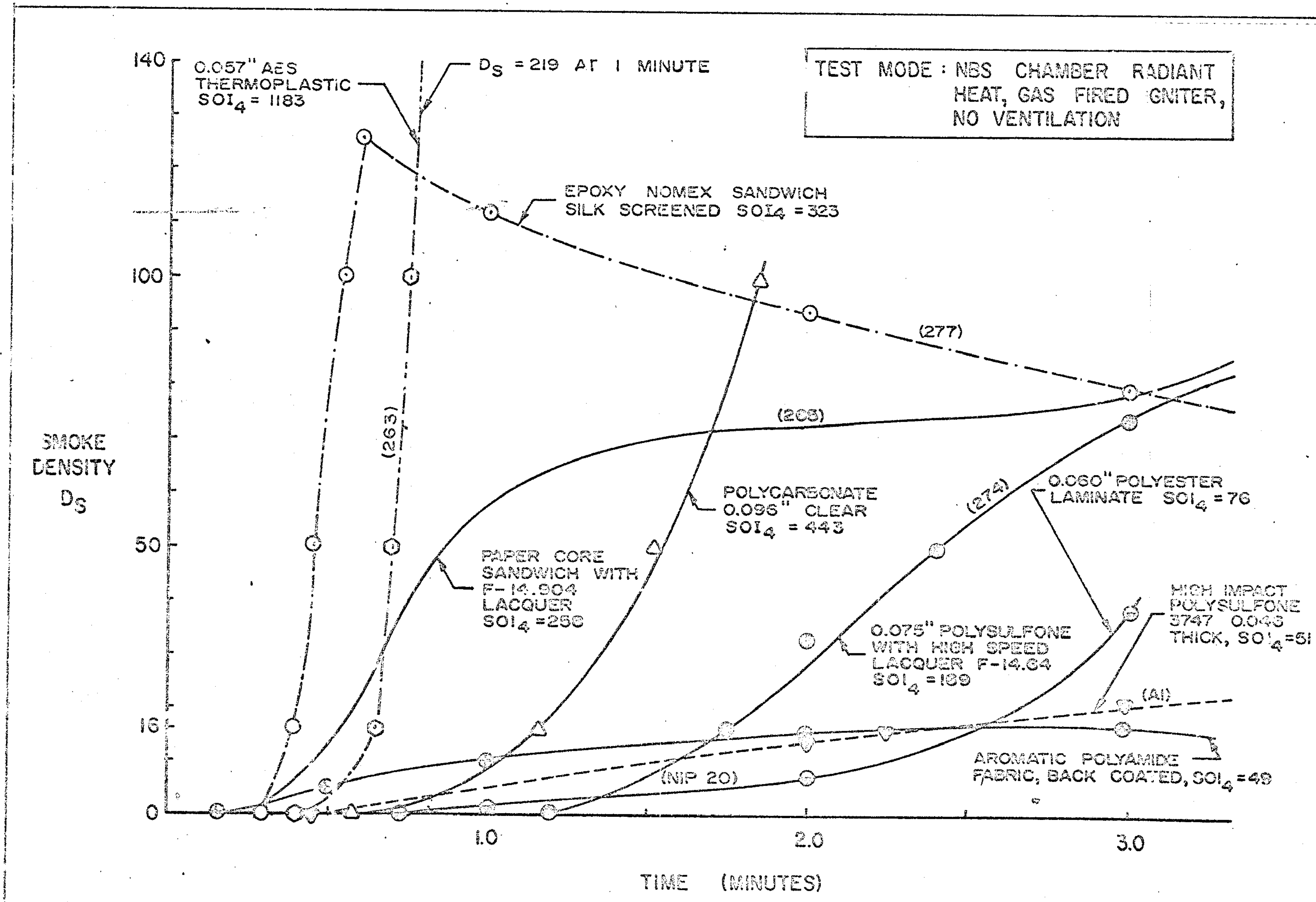
  (15 Second Ignition, Horizontal)

Acrylic Window Edge Lighted Panels Seat Belts Cargo Restraints	2.5 Inch/Minute Burn Rate
Non-Significant Items	4 Inch/Minute Burn Rate



RECOMMENDED FLAMMABILITY REGULATIONS

FIGURE 2



COMPARATIVE SMOKE EMISSION OF MATERIALS (NBS TEST CHAMBER)

FIGURE 5