FABRICS FOR FIRE RESISTANT PASSENGER SEATS IN AIRCRAFT

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The essential elements of the problem and of approaches to improved fire resistance in aircraft seats are briefly reviewed. In the context of performance requirements and availability of materials, delay in the ignition of upholstery fabric by a small source may be considered a realistic objective. Results of experimental studies on the thermal response of fabrics and fabric/foam combinations suggest significant conclusions regarding (a) the ignition behavior of a commercial 90/10 wool/nylon upholstery fabric relative to fabrics made from thermally stable polymers; (b) the role of the foam backing; (c) the behavior of seams. These results, coupled with data from other sources, also confirm the importance of materials' interactions in multicomponent assemblies, and the need for system testing prior to materials' selection. The use of an interliner or thermal barrier between upholstery fabric and foam is a promising and viable approach to improved fire resistance of the seat assembly, but experimental evaluation of specific combinations of materials or systems is an essential part of the selection process.

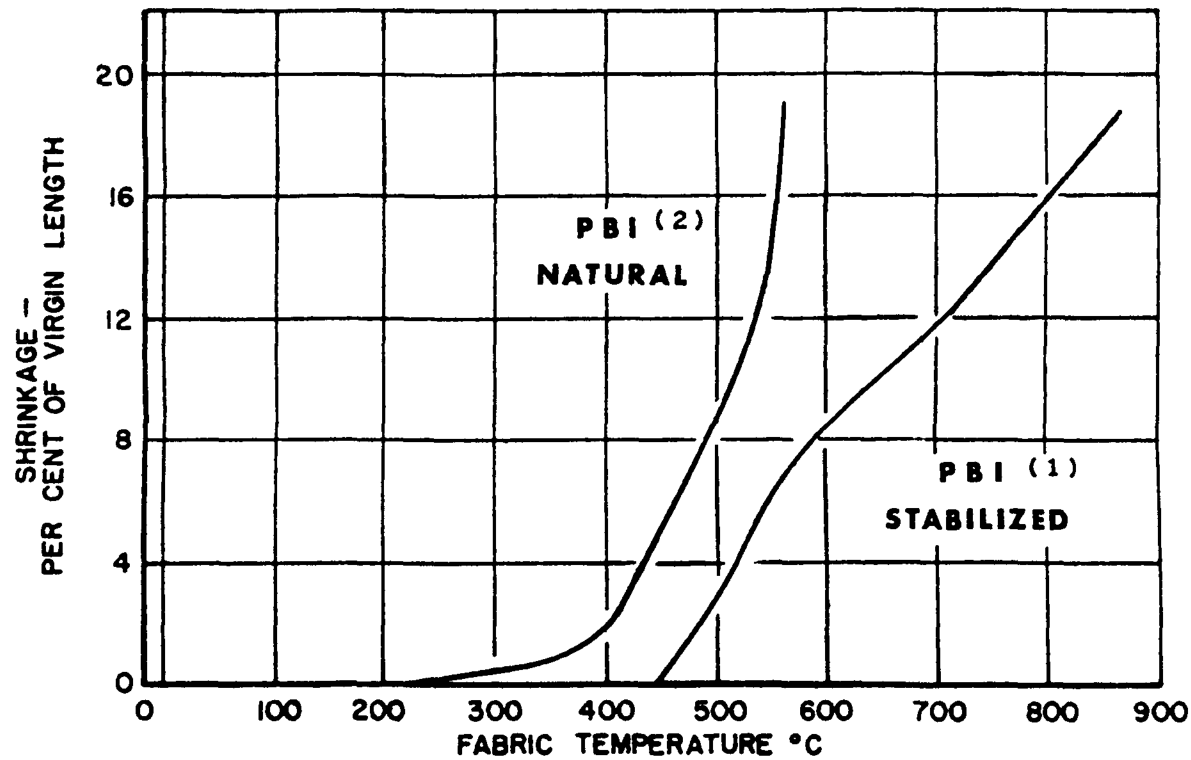
FABRICS FOR FIRE RESISTANT PASSENGER SEATS IN AIRCRAFT

LIST OF SLIDES

1. Seat upholstery fabrics)
2. Fibers from thermally stable polymers)
3. Performance requirements of seat upholstery fabrics) Ref. NASA TM X-73, 144
4. Possible approaches to improved assembly)
5. Stabilization (thermal) of PBI (shrinkage vs. temperature)
6. Examples of commercial upholstery fabrics (summary of sources and properties)
7. Oxygen Index of wool/nylon blends (O.I. vs % wool)
8. Oxygen Index of wool blends (O.I. vs % wool)
9. Maximum measured heat flux levels from various sources
10. Schematic diagram of experimental apparatus for study of thermal response
11. Imposed heat flux as function of radius from spot center
12. Materials used in experimental investigation of thermal response
13. Time to smoke (fabrics alone)
14. Time to char, hole or melt (fabrics alone)
15. Time to ignition (fabrics alone)
16. Time to smoke, melt, ignition for wool/nylon with foam backing
17. Time to smoke, char, ignition for PBI with foam backing
18. Time to smoke, char, ignition for Kynol with foam backing
19. Time to ignition (fabrics with foam backing)
20. Schematic diagram of single felled seam
21. Conclusions

CELANESE
FIBERS MARKETING COMPANY

THERMAL DIMENSIONAL STABILITY



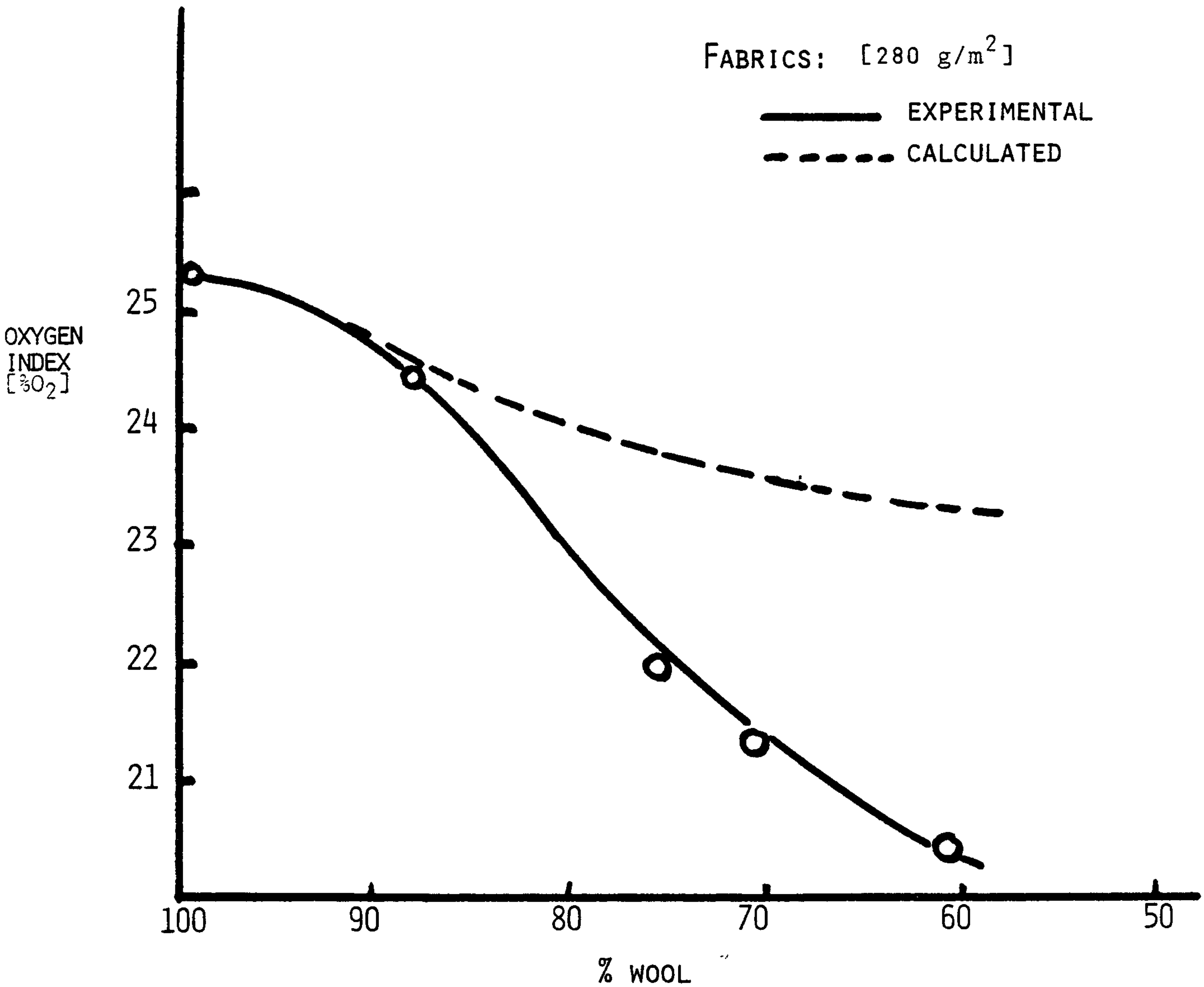
1. 4.5 OZ/YD^2 FABRIC, AFML-TR-73-28
2. DRAWN, TEXTILE YARN

UPHOLSTERY FABRICS - (Examples)

Adequate Flame Resistance [FAR 25.853(b)]

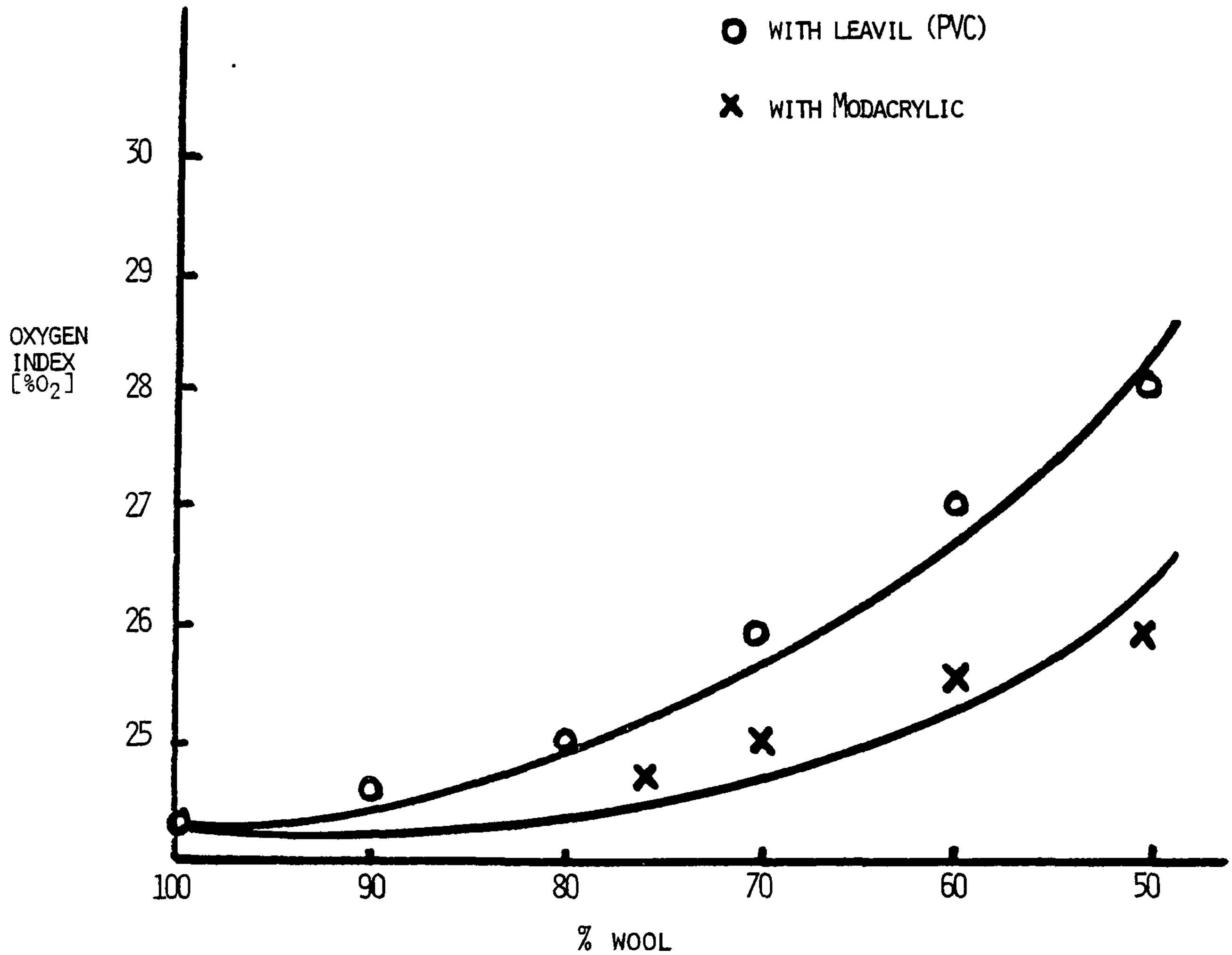
Manufacturer	Fiber Composition	Colors	Light Fastness	Weight oz/yd^2	Tensile Strength lb/in Warp	Flame Retardant Treatment	Smoke Generation	Toxicity of Combustion Products	Oxygen Index Range Reported [$\%O_2$]
American Kynol	50/50 Kynol/ Aramid	Few	-	10.0	-	-	-	Moderate	29-32
Collins & Aikman	100% Nomex	Several	Poor	12.2	170	-	Low	Moderate	26-29
	90/10 Wool/ Nylon	Many	Good	14.5	159	+	Moderate	High	-
	100% Nylon	Many	Good	22.0	400	+	Low	High	-
Orinoka-Aviation Fabrics Sales Inc	90/10 Wool/ Nylon	Many	Good	14.5	130	+	Moderate	High	-
JP Stevens & Co Inc	100% Mod-acrylic	Many	Good	6.5	-	-	-	High	28-30
Celanese Fibers Marketing Co.	100% PBI Stabi-lized	Gold (natural); green (pigmented)	Poor	4.5	-	-	Low	Low	38-43

O.I. OF WOOL/NYLON BLENDS*



*L. BENISEK - J. TEX. INST. 1976, P. 262

O.I. OF WOOL BLENDS*



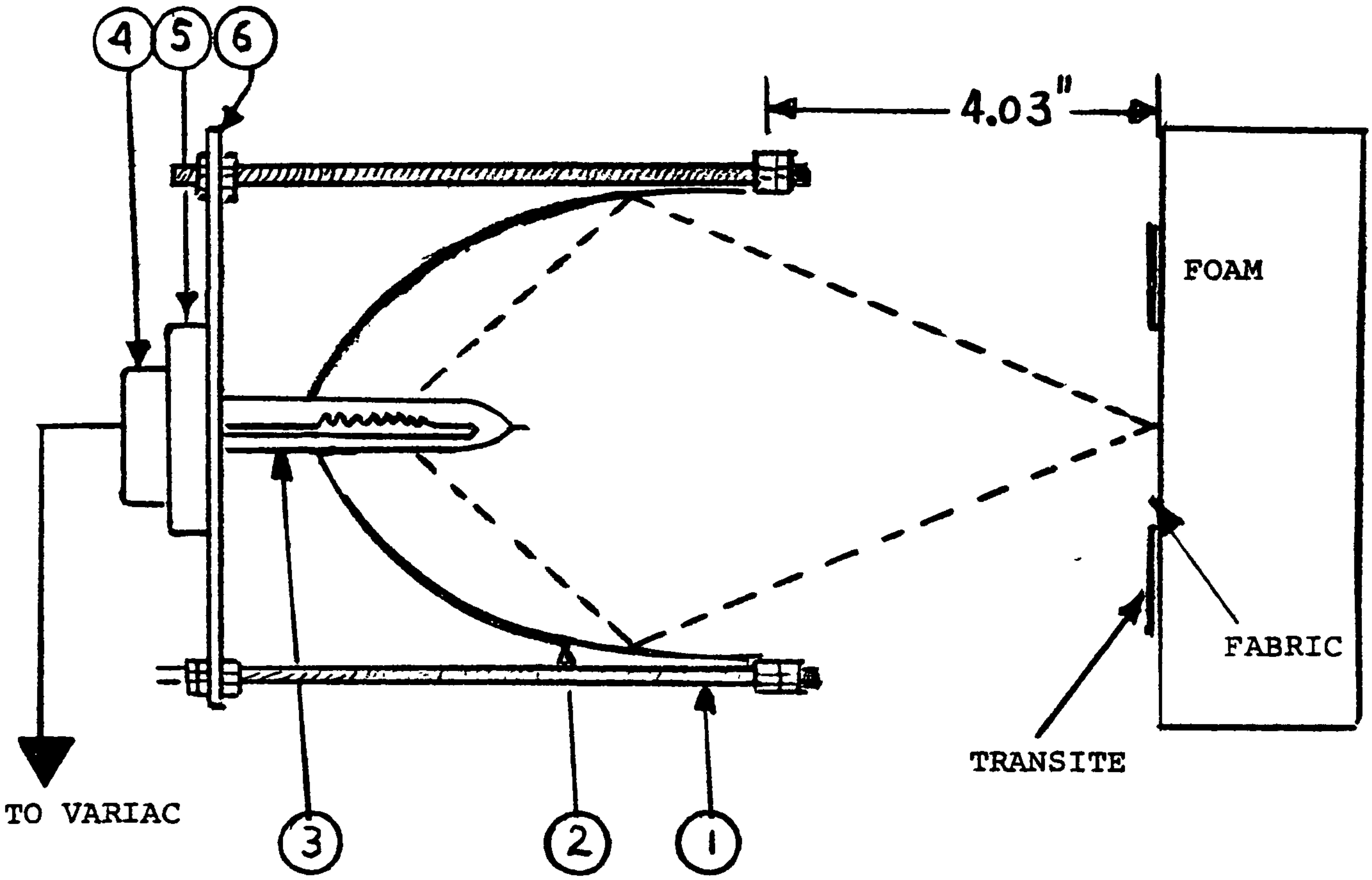
*L. BENISEK - TEX. CHEM. COLORIST, FEB. 1974, P. 25

MAXIMUM MEASURED HEAT FLUX LEVELS FROM VARIOUS SOURCES*

Source	Maximum Flux W/cm^2
Hot Plate (0.8 kW)	3
Hot Plate (2.6 kW)	5
Kitchen Gas Range	
Kenmore 119.15031	6
Kenmore 71731	6
Match	5.4
Lighter	5.8
Candle	7.8
Methane Flame Microburner	15-16

*P. Durbetaki et al. Third Annual Report to the National Science Foundation by Georgia Institute of Technology, NTIS-PB-242-740/AS.

Schematic Diagram of the Experimental Apparatus



(1) Three 3/32" threaded rods and nuts.

(2) Ellipsoidal Reflector #4085-A, Research Inc., Minneapolis, Minnesota.

(3) Quartz light bulb, 500 Watts, General Electric #Q500CL/DC.

(4) Bulb socket.

(5) Transite spacer.

(6) 1/8" aluminum plate.

Imposed heat flux as function of radius from spot center

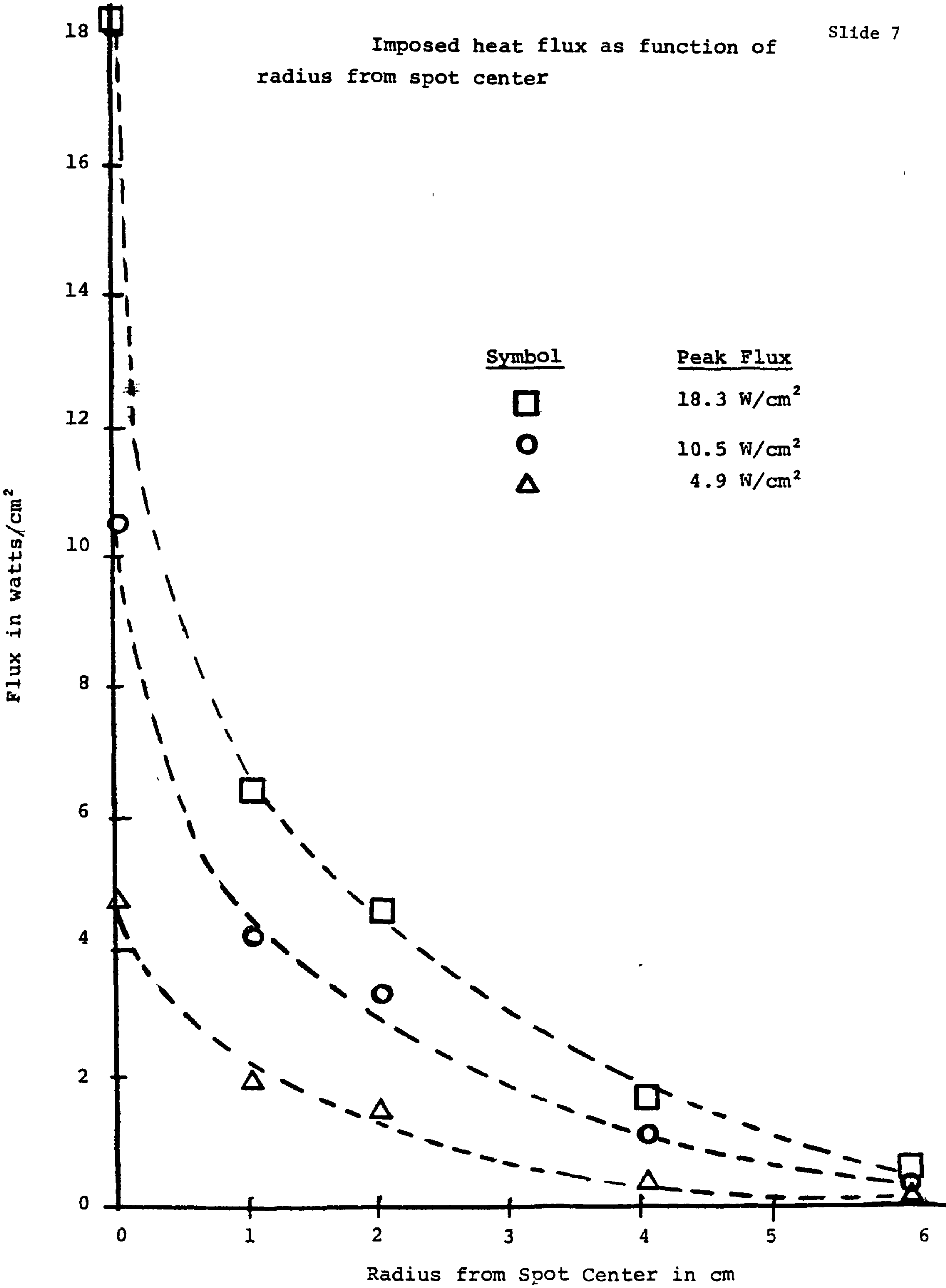
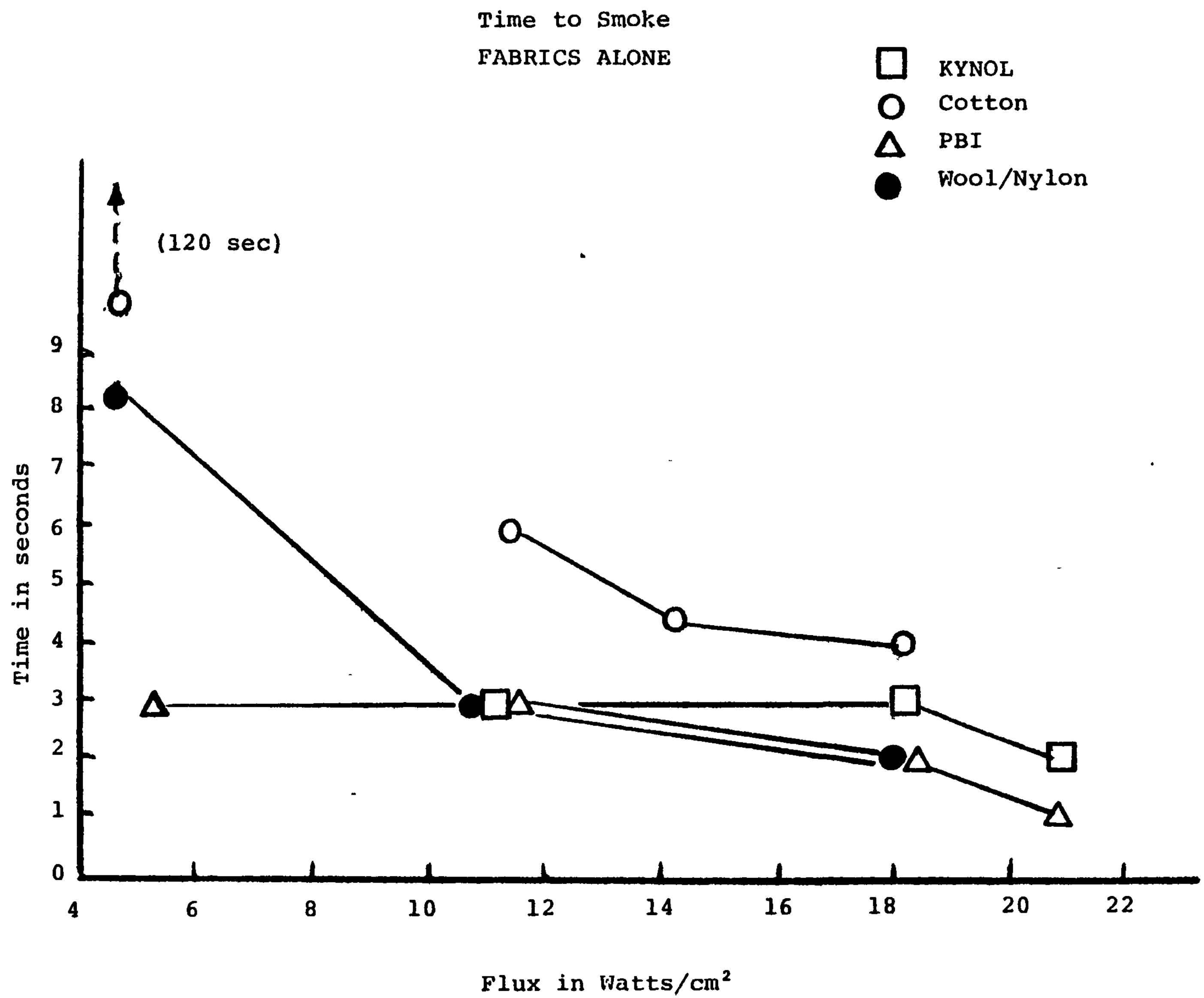


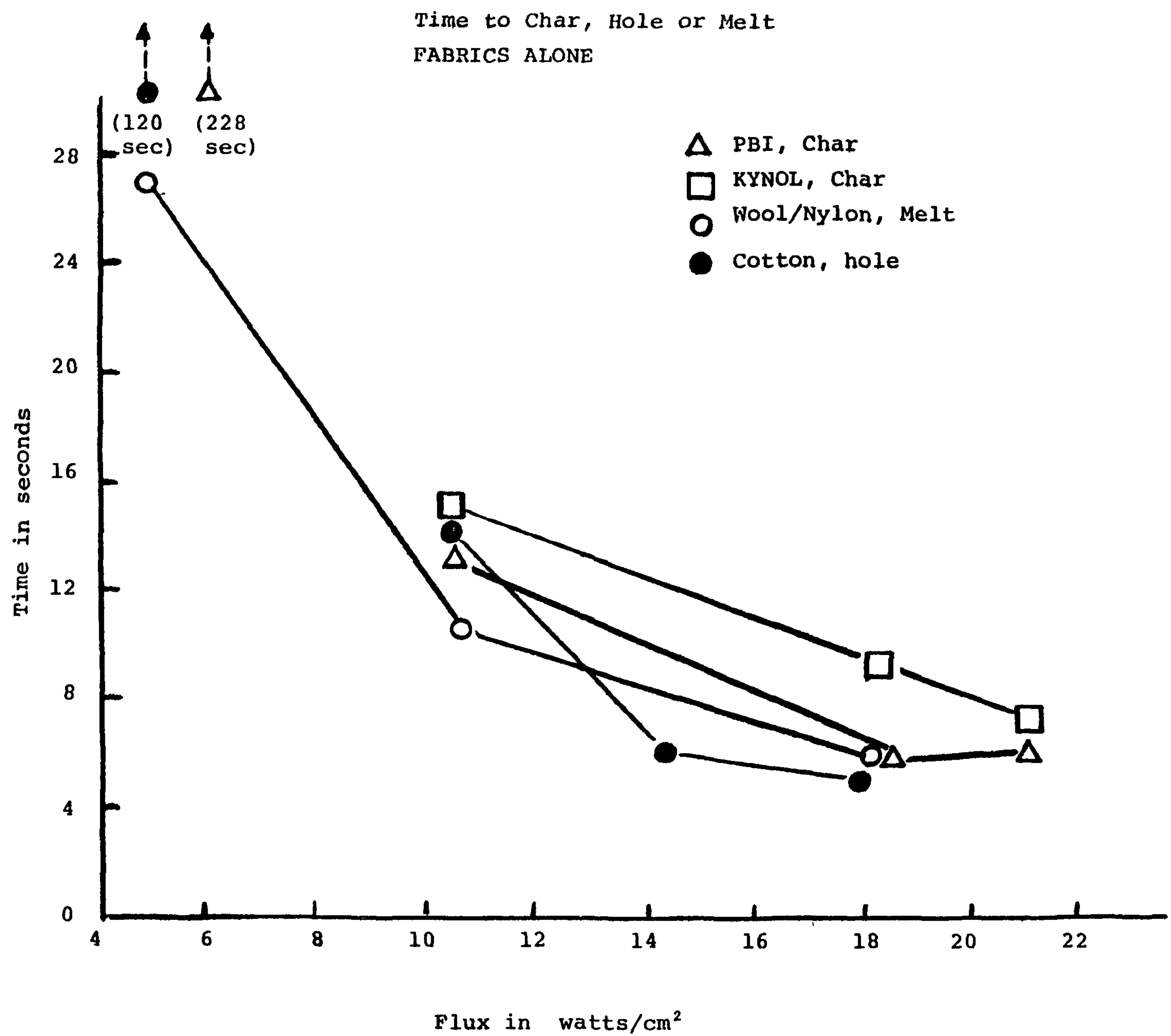
Table 1

Fabric*	Description	Supplier
Wool-nylon (state-of-the-art)	R76423 Sun-Eclipse Blue/Red; ST7427-115, Color 73/3252; 90% wool/10% nylon	UOP Corporation, Aerospace Div., Bantam, Conn.
PBI (experimental)	#40-90/0-1; 5 oz/yd^2	Celanese Research Corporation Summit, New Jersey
KYNOL (experimental)	#7979; 10.7 oz/yd^2	Collins and Aikman Corporation, New York, N.Y.
Cotton (reference)	White, 2.6 oz/yd^2	N/A
Foam		
Urethane (state-of-the-art)	4" thick UU-44(FR) urethane foam, 1.9 lb/ft^3	UOP Corporation, Aerospace Div., Bantam, Conn.
Neoprene	RP medium, 2" thick, 7.4 lb/ft^3	Toyad Corporation, Latrobe, Penna.

*NOTE: Among the fabrics tested, only the wool/nylon was an upholstery fabric with regard to construction (yarn, weave, weight, etc.) and color. This fact must be considered in interpreting the results of the comparative evaluation.


Time to Smoke
FABRICS ALONE
KYNOL
Cotton
PBI
Wool/Nylon
(120 sec)
Time in seconds
0
1
2
3
4
5
6
7
8
9
4
6
8
10
12
14
16
18
20
22
Flux in Watts/cm²

Slide 9

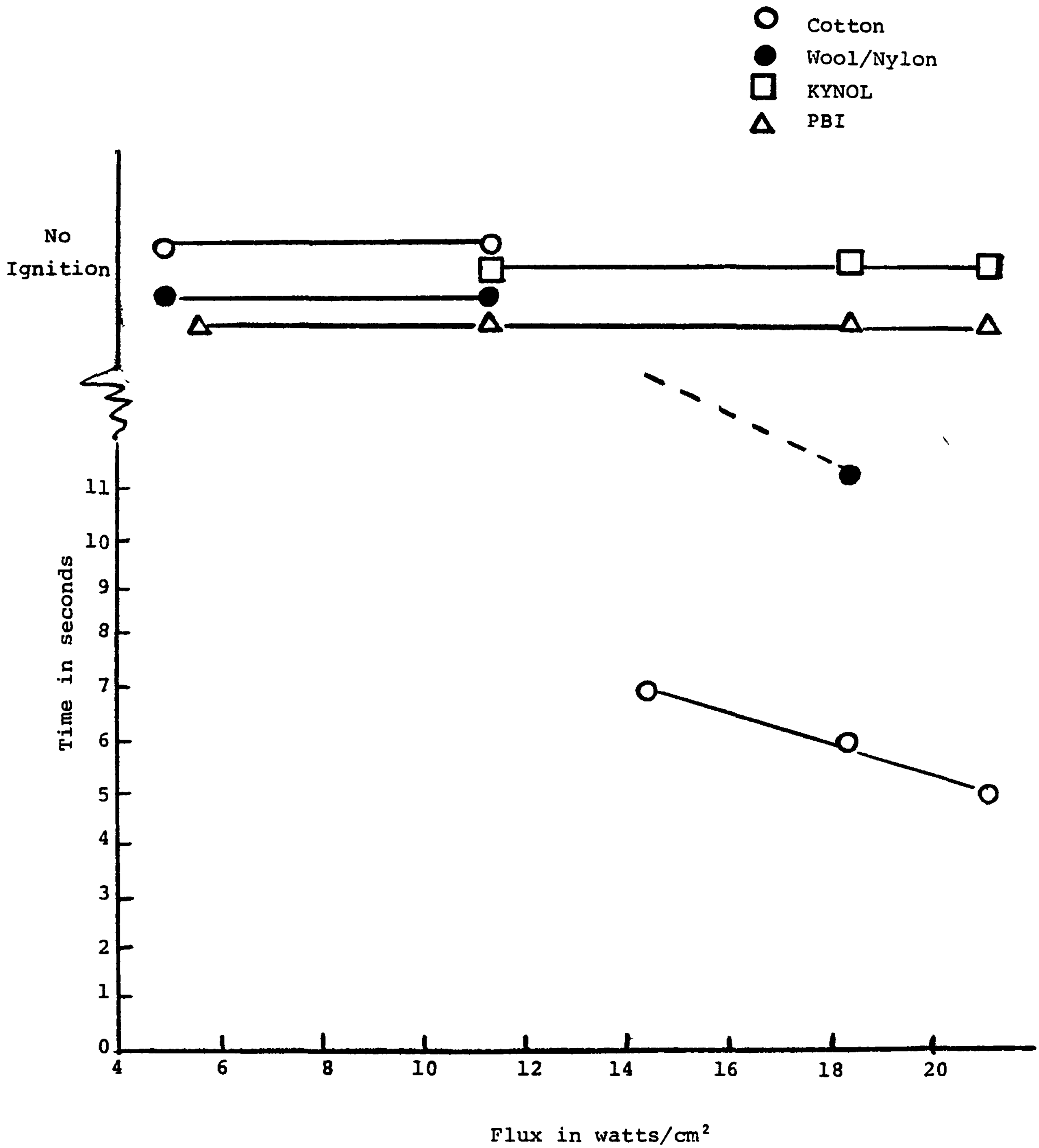


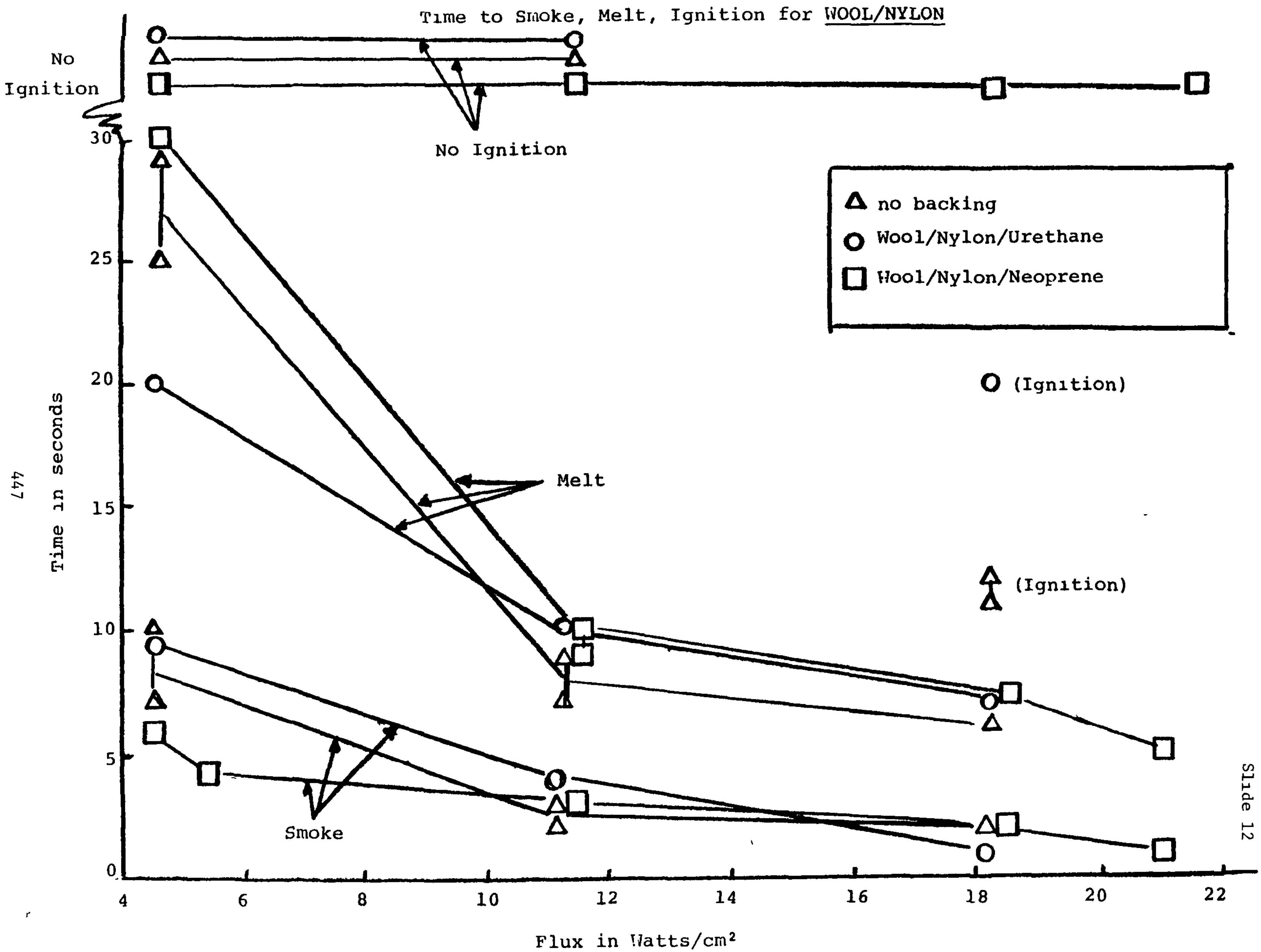
Time to Char, Hole or Melt
FABRICS ALONE
PBI, Char
KYNOL, Char
Wool/Nylon, Melt
Cotton, hole
(120 sec)
(228 sec)
Time in seconds
0
4
8
12
16
20
24
28
4
6
8
10
12
14
16
18
20
22
Flux in watts/cm²

445

Slide 10

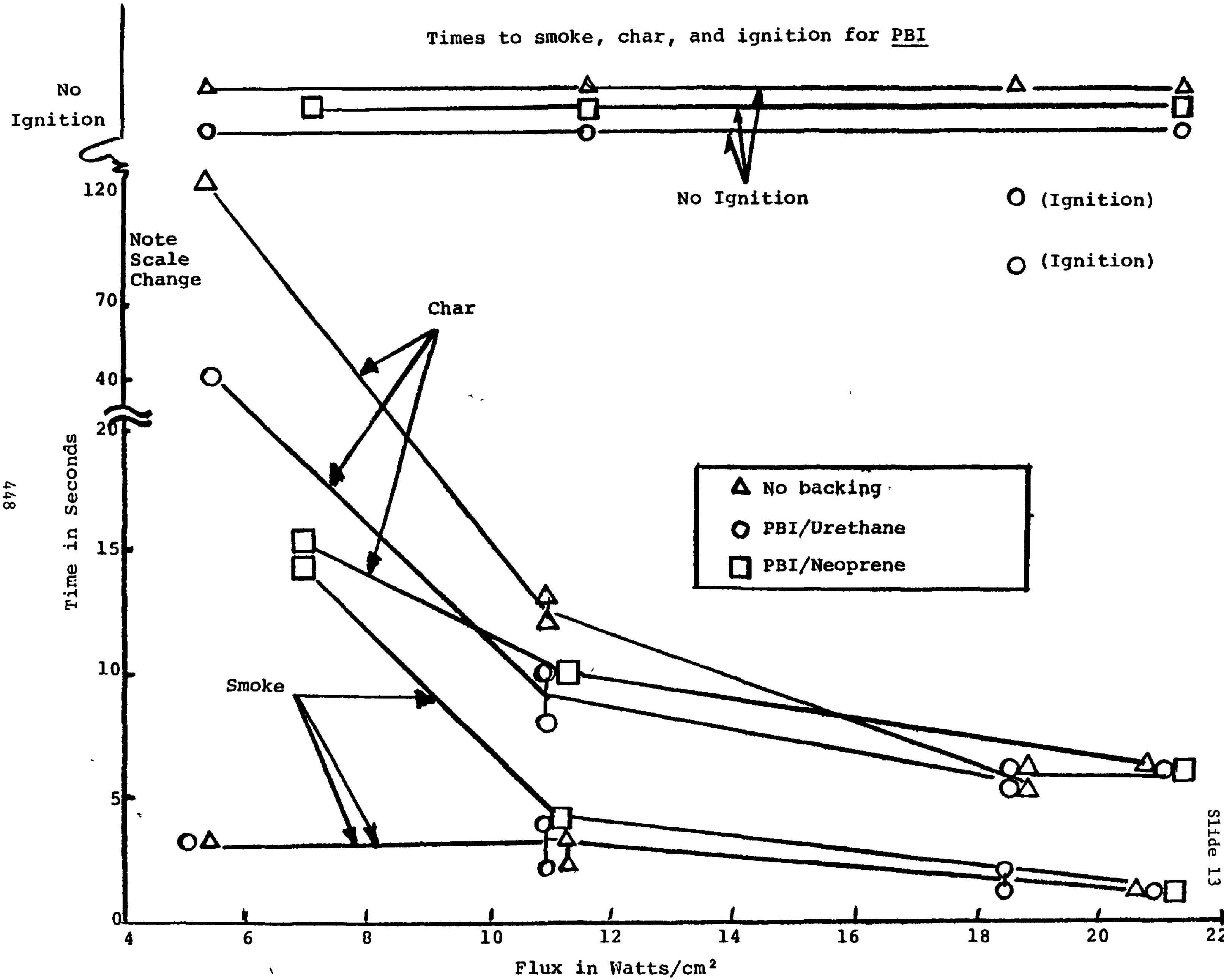
Time to Ignition, FABRICS ALONE




Time to Smoke, Melt, Ignition for WOOL/NYLON
No Ignition
No Ignition
no backing
Wool/Nylon/Urethane
Wool/Nylon/Neoprene
(Ignition)
(Ignition)
Melt
Smoke
Time in seconds
0
5
10
15
20
25
30
4
6
8
10
12
14
16
18
20
22
Flux in Watts/cm²

447

Slide 12

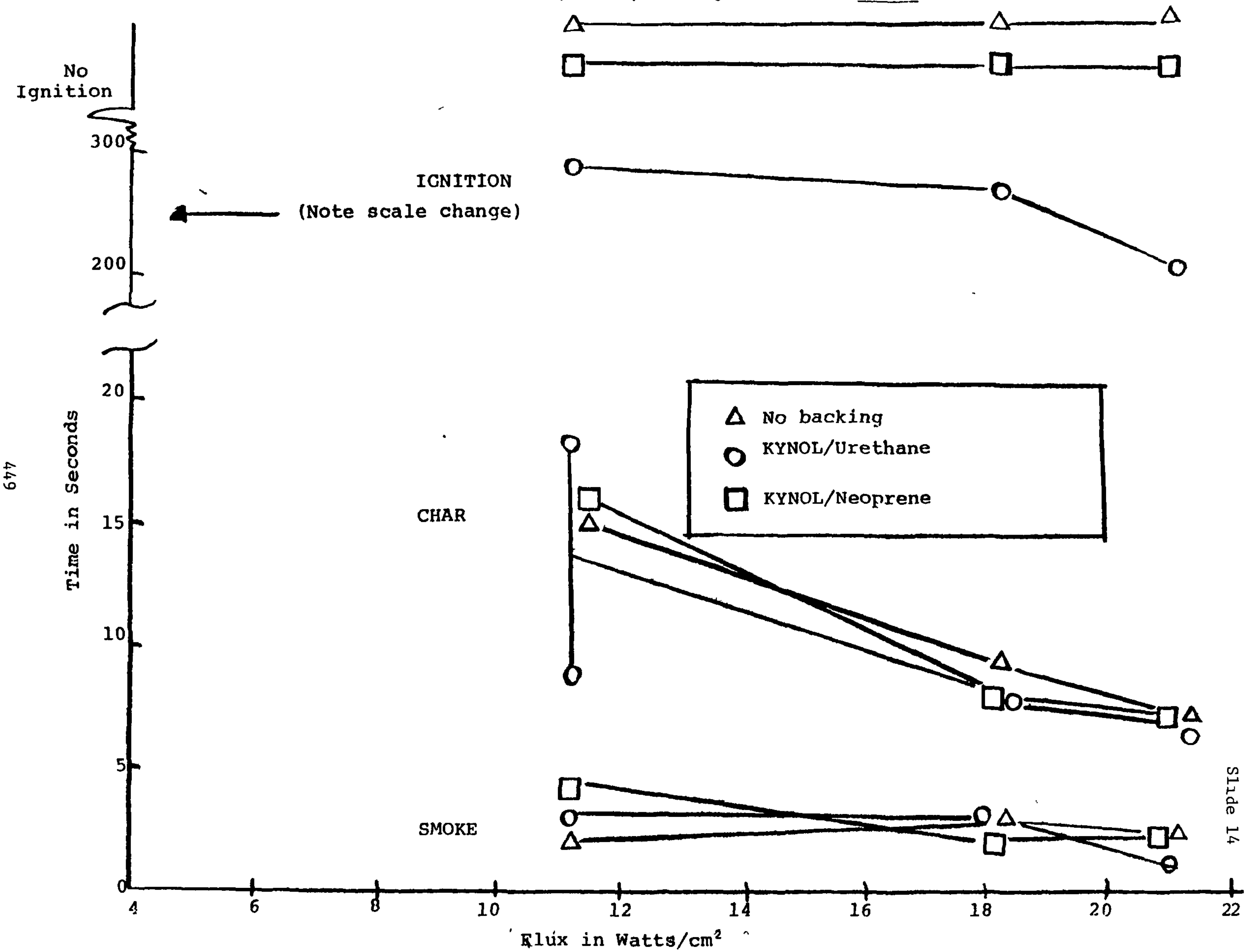


Times to smoke, char, and ignition for PBI
No Ignition
No Ignition
(Ignition)
(Ignition)
Note Scale Change
Char
Smoke
No backing
PBI/Urethane
PBI/Neoprene
Time in Seconds
Flux in Watts/cm²
120
70
40
20
15
10
5
0
4
6
8
10
12
14
16
18
20
22

448

Slide 13

Times to Smoke, Char, and Ignition for KYNOL



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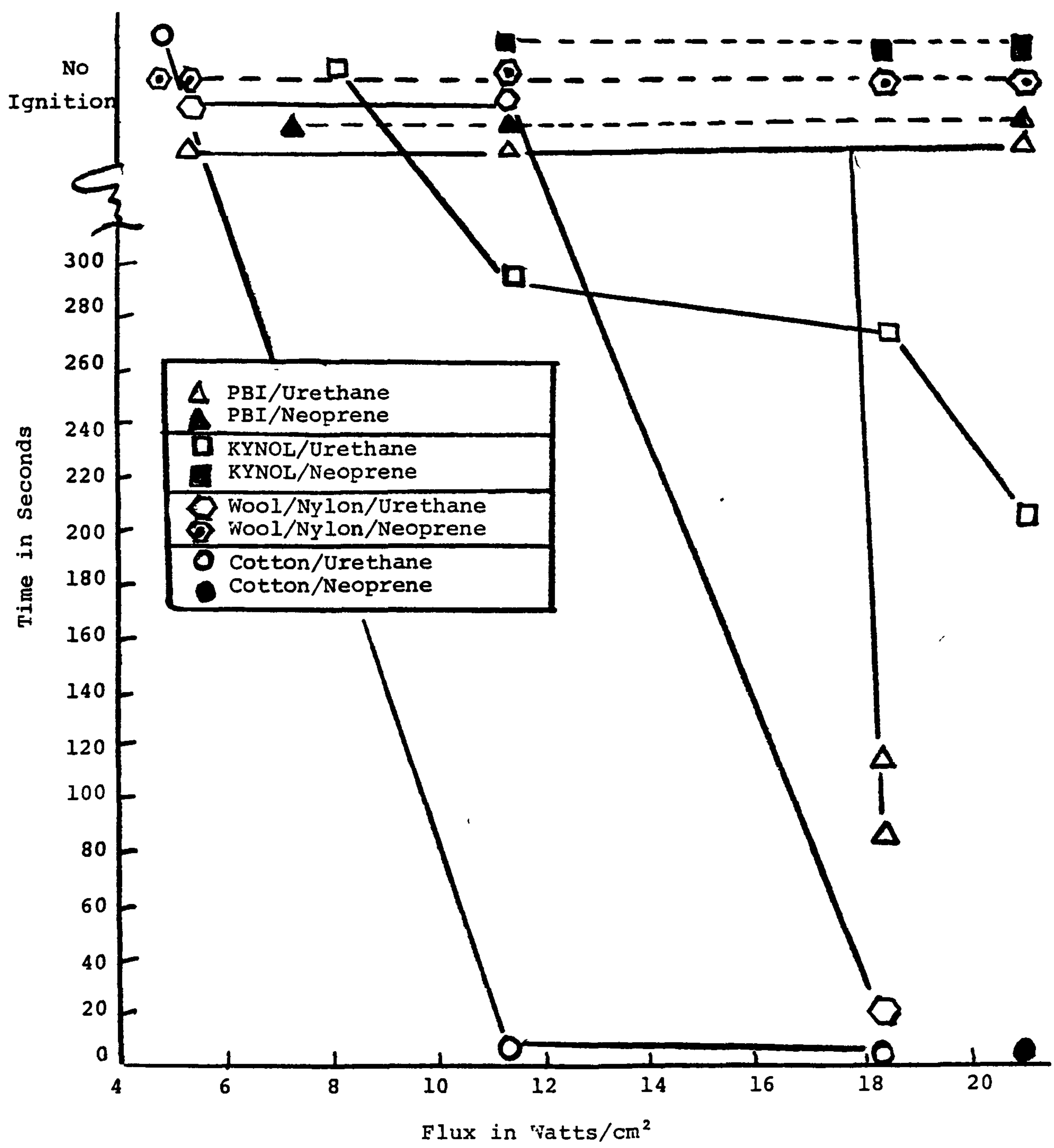
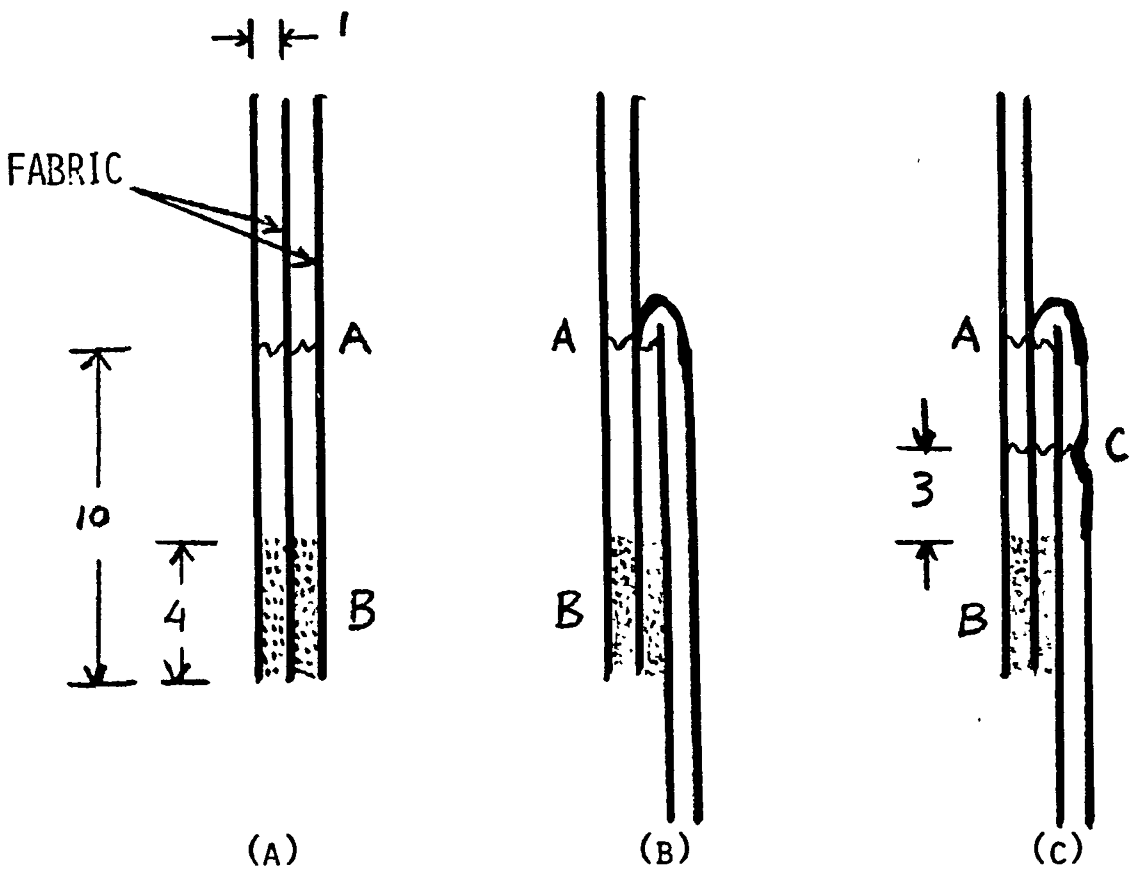
Slide 14

Time to Ignition, FABRICS/FOAM

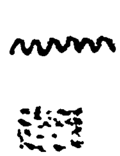


SINGLE FELLED SEAM WITH THREE STITCHES

(TWO LOCK, ONE OVERCAST)



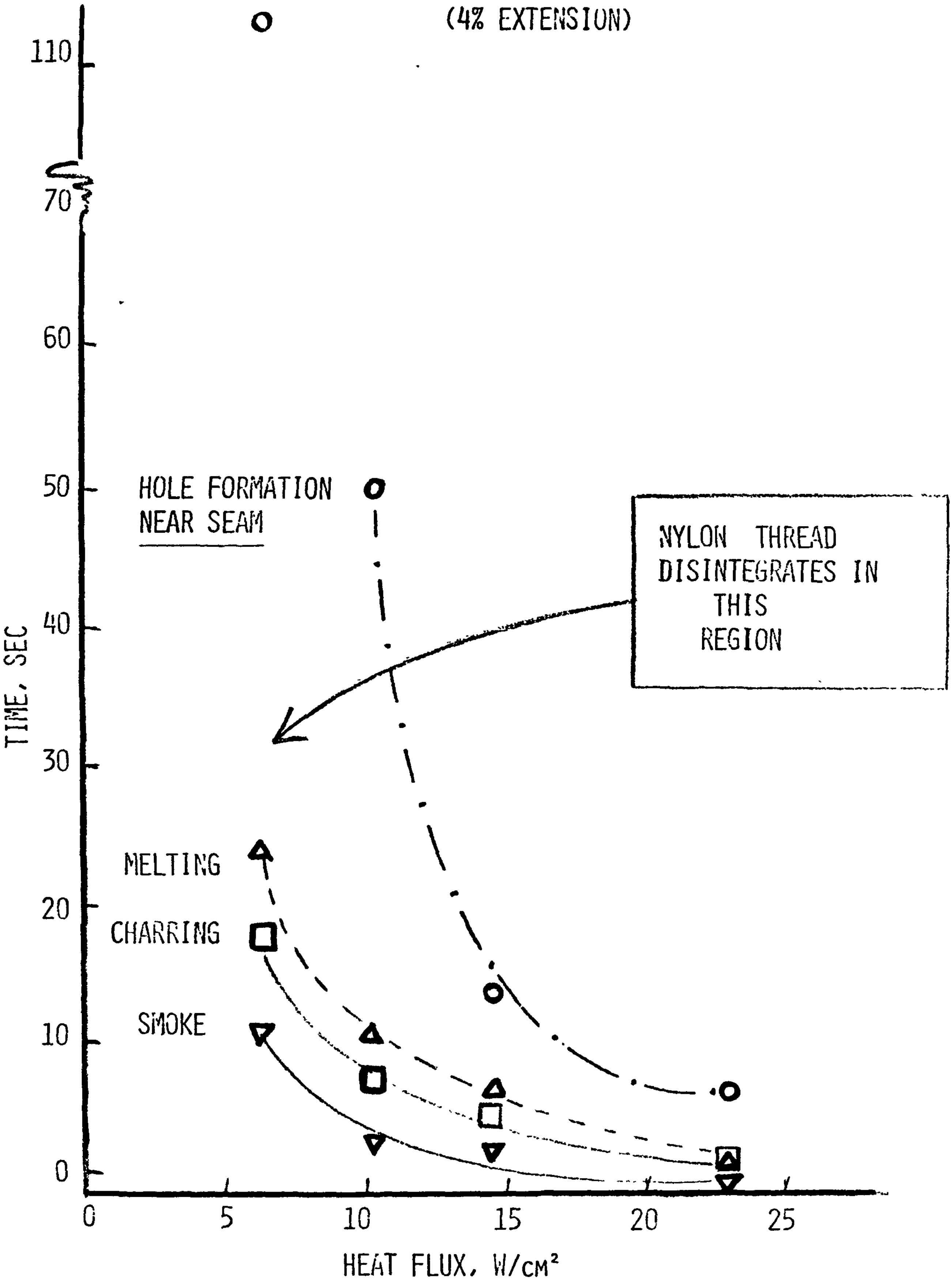
ALL DIMENSIONS IN MM



LOCK STITCH

OVERCAST STITCH

RESPONSE OF SEAMED FABRIC TO RADIATIVE HEATING
(4% EXTENSION)



SMOLDERING OF UPHOLSTERY COVERED FLEXIBLE PU FOAMS AT ATMOSPHERIC CONDITIONS**

WEIGHT OF COTTON UPHOLSTERY FABRIC	PU FOAM* A	B	C
0.07 g/cm^2	SUSTAINED SMOLDERING	SUSTAINED SMOLDERING	SUSTAINED SMOLDERING
0.03 g/cm^2	"	SUSTAINED SMOLDERING	TRANSITION TO EXTINGUISHMENT
BARE BLOCK	"	TRANSITION TO EXTIN-GUISHMENT	TRANSITION TO EXTINGUISHMENT

*FOAM BLOCK: 5 x 12 x 45CM -(CIGARETTE INITIATION)

**T. Y. TOONG ET AL. FINAL REPORT TO THE PRODUCT RESEARCH COMMITTEE BY MASSACHUSETTS INSTITUTE OF TECHNOLOGY - JANUARY L978 - RP-76-U-3.

SMOKE EMISSION OF AIRCRAFT SEAT MATERIALS*

MATERIAL	Ds 4 MINUTES** −	+
WOOL FABRIC	200	111
NOMEX FABRIC	-	-
PU FOAM SLAB	172	50
PU FOAM SLAB + MUSLIN	158	165
PU FOAM COLD CURING	55	31
PU FOAM COLD CURING + MUSLIN	102	88

− WITHOUT FLAME
+ WITH FLAME

*G. BORSINI & C. CARDINALI, J. FIRE FLAMMABILITY 7, 530-539 (1976)

**PROPOSED LIMITING VALUE:100

VONAR INTERLINERS*

(NEOPRENE LATEX FOAM-CONTAINING HYDRATED ALUMINUM OXIDE AND ANTIMONY OXIDE)

MATERIALS	HEAT INPUT AT IGNITION BTU	TIME TO CORE INVOLVEMENT
POLYPROPYLENE FABRIC + PU FOAM	12	2 MIN
POLYPROPYLENE FABRIC BACKCOATED WITH VONAR + PU FOAM	3375	>30 MIN
POLYPROPYLENE FABRIC + VONAR INTERLINER + PU FOAM	85	9.5 MIN
COTTON/RAYON FABRIC + PU FOAM	38	2 MIN
COTTON/RAYON FABRIC BACKCOATED WITH VONAR + PU FOAM	525	12 MIN
COTTON/RAYON FABRIC + VONAR INTERLINE + PU FOAM	5160	34 MIN

*DUPONT INDUSTRY NEWS, MAY 19, 1976, AND "A GUIDE TO VONAR INTERLINERS."

CONCLUSIONS

1. CURRENT (1978) AVAILABILITY OF UPHOLSTERY FABRICS MADE FROM ADVANCED MATERIALS <u>AND</u> MEETING PERFORMANCE REQUIREMENTS, IS NOT ADEQUATE.

2. IGNITION OF STATE-OF-THE-ART UPHOLSTERY FABRICS <u>CAN</u> BE DELAYED BY A CAREFULLY SELECTED LAYER OR INTERLINER BETWEEN FABRIC AND FOAM.

3. THERMAL RESPONSE OF MULTICOMPONENT ASSEMBLIES IS DEPENDENT ON HEAT FLUX <u>AND</u> ON THE SPECIFIC MATERIALS EMPLOYED. THUS, EXPERIMENTAL EVALUATION OF CANDIDATE <u>SYSTEMS</u> IS AN ESSENTIAL PART OF MATERIALS' SELECTION.

ENCLOSURE FIRE MODELING

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