

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.

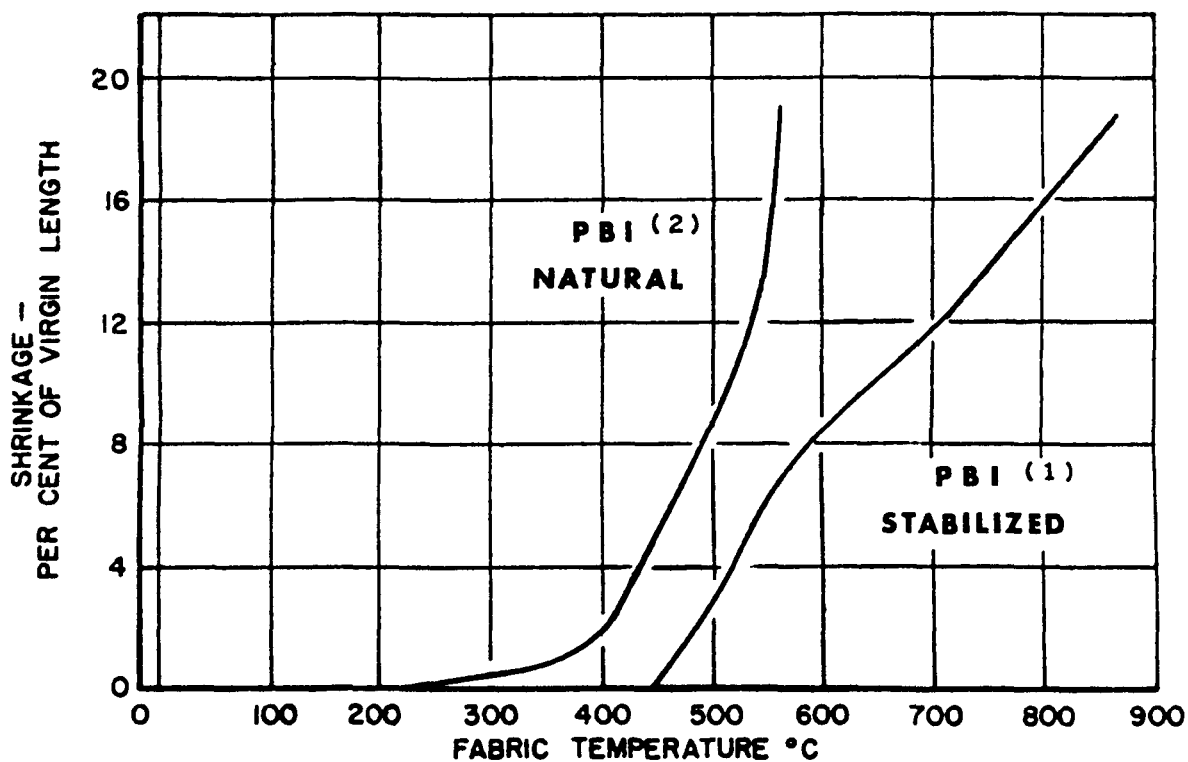
FABRICS FOR FIRE RESISTANT PASSENGER SEATS IN AIRCRAFT

LIST OF SLIDES

1. Seat upholstery fabrics
 2. Fibers from thermally stable polymers
 3. Performance requirements of seat upholstery fabrics
 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
- } Ref.
} NASA
} TM X-73, 144



THERMAL DIMENSIONAL STABILITY



1. 4.5 OZ/YD² FABRIC, AFML-TR-73-28
2. DRAWN, TEXTILE YARN

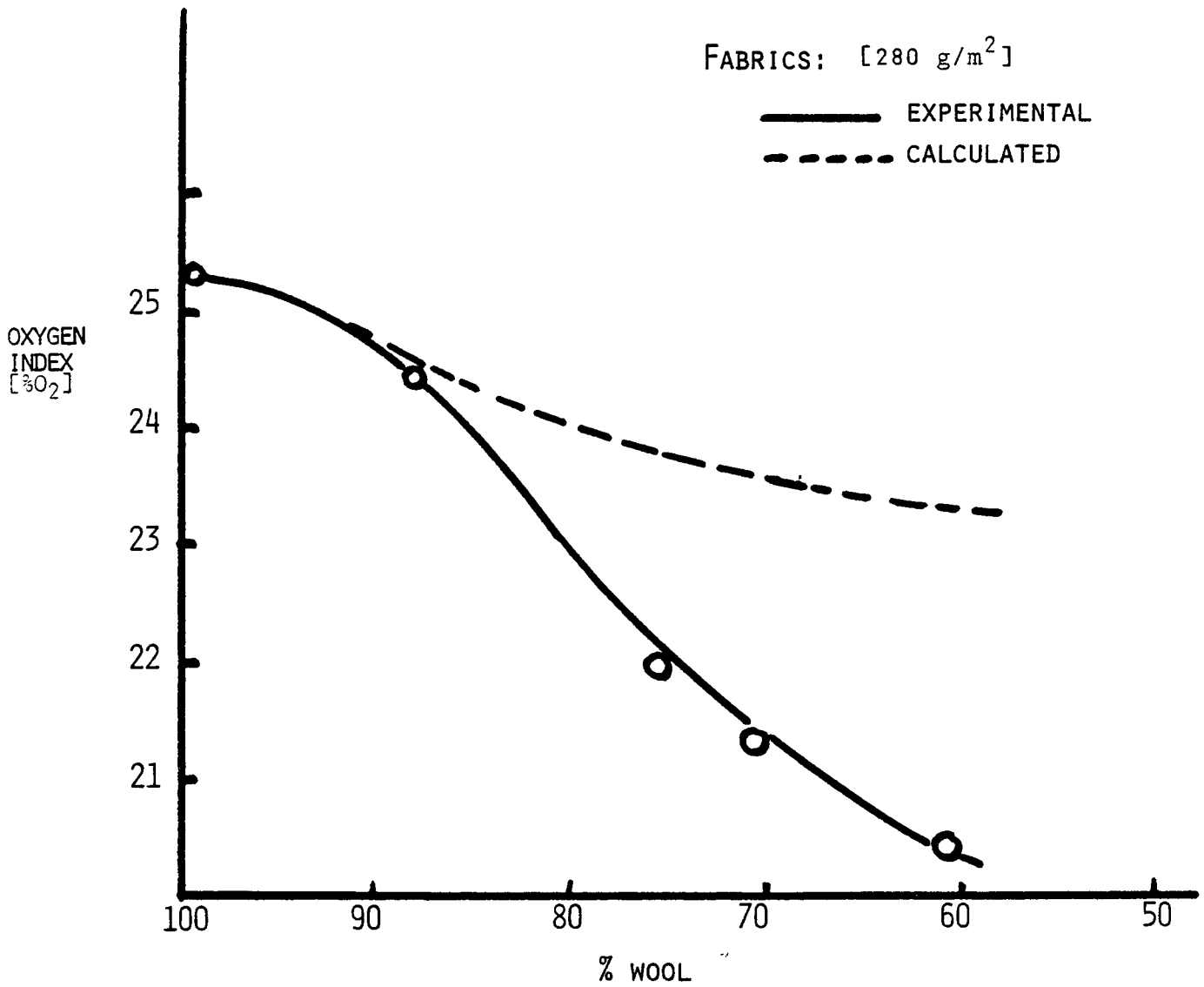
UPHOLSTERY FABRICS - (EXAMPLES)

ADEQUATE FLAME RESISTANCE [FAR 25.853(B)]

MANUFACTURER	FIBER COMPOSITION	COLORS	LIGHT FASTNESS	WEIGHT OZ/YD ²	TENSILE STRENGTH LB/IN WARP	FLAME RETAR-DANT TREAT-MENT	SMOKE GENERA-TION	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

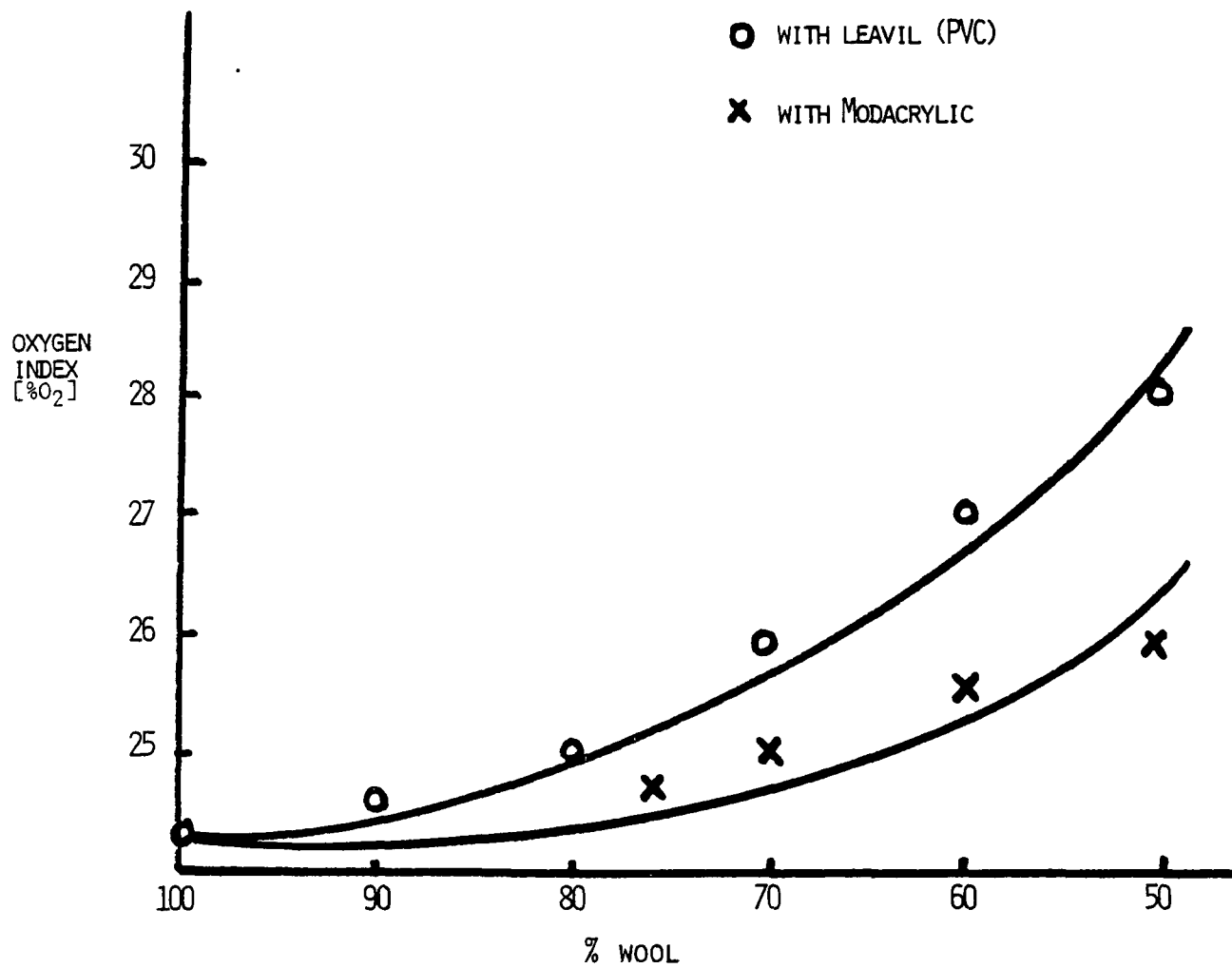
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O.I. OF WOOL/NYLON BLENDS*



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

O.I. OF WOOL BLENDS*



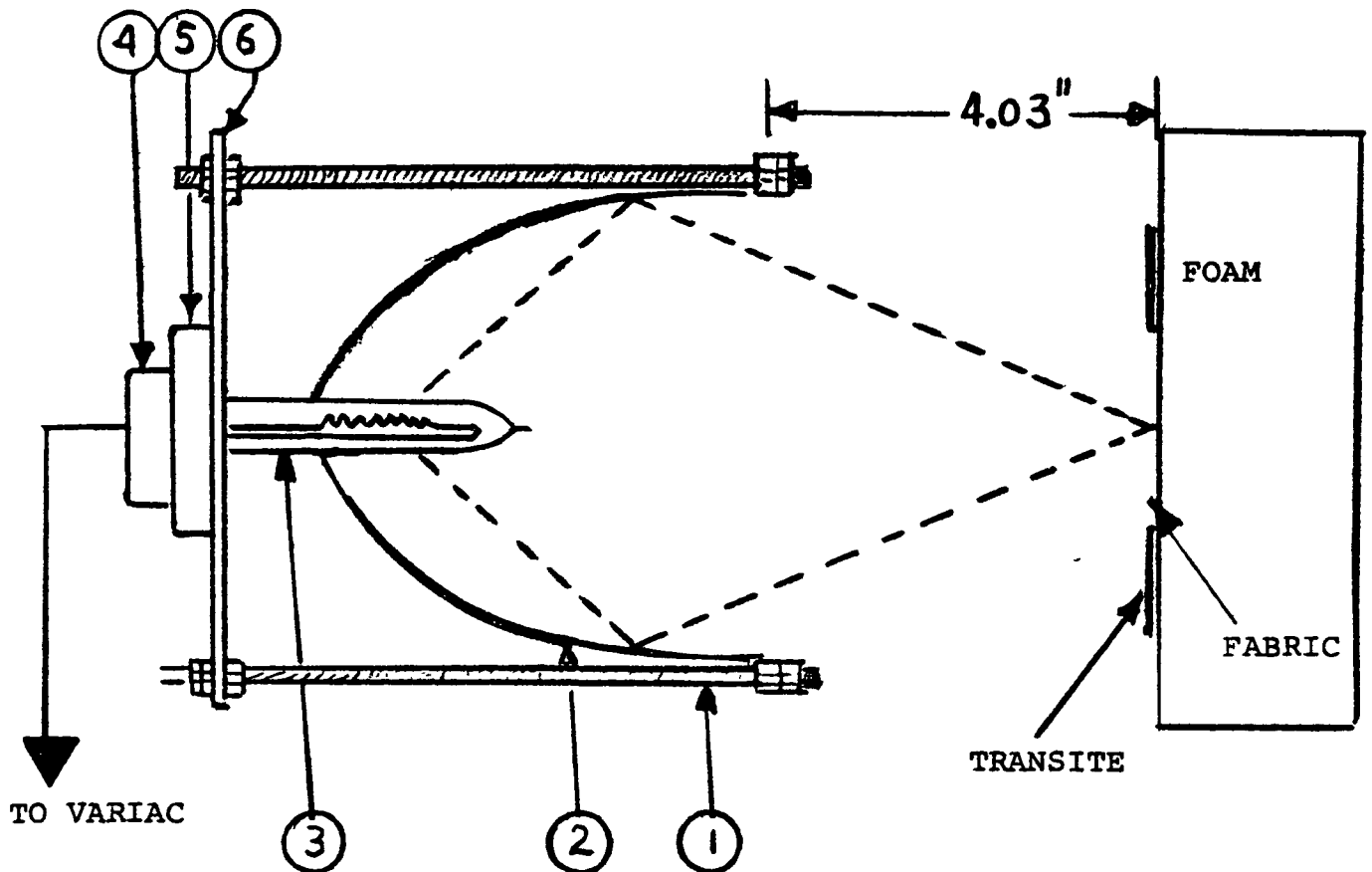
*L. BENISEK - TEX. CHEM. COLORIST, FEB. 1974, P. 25

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

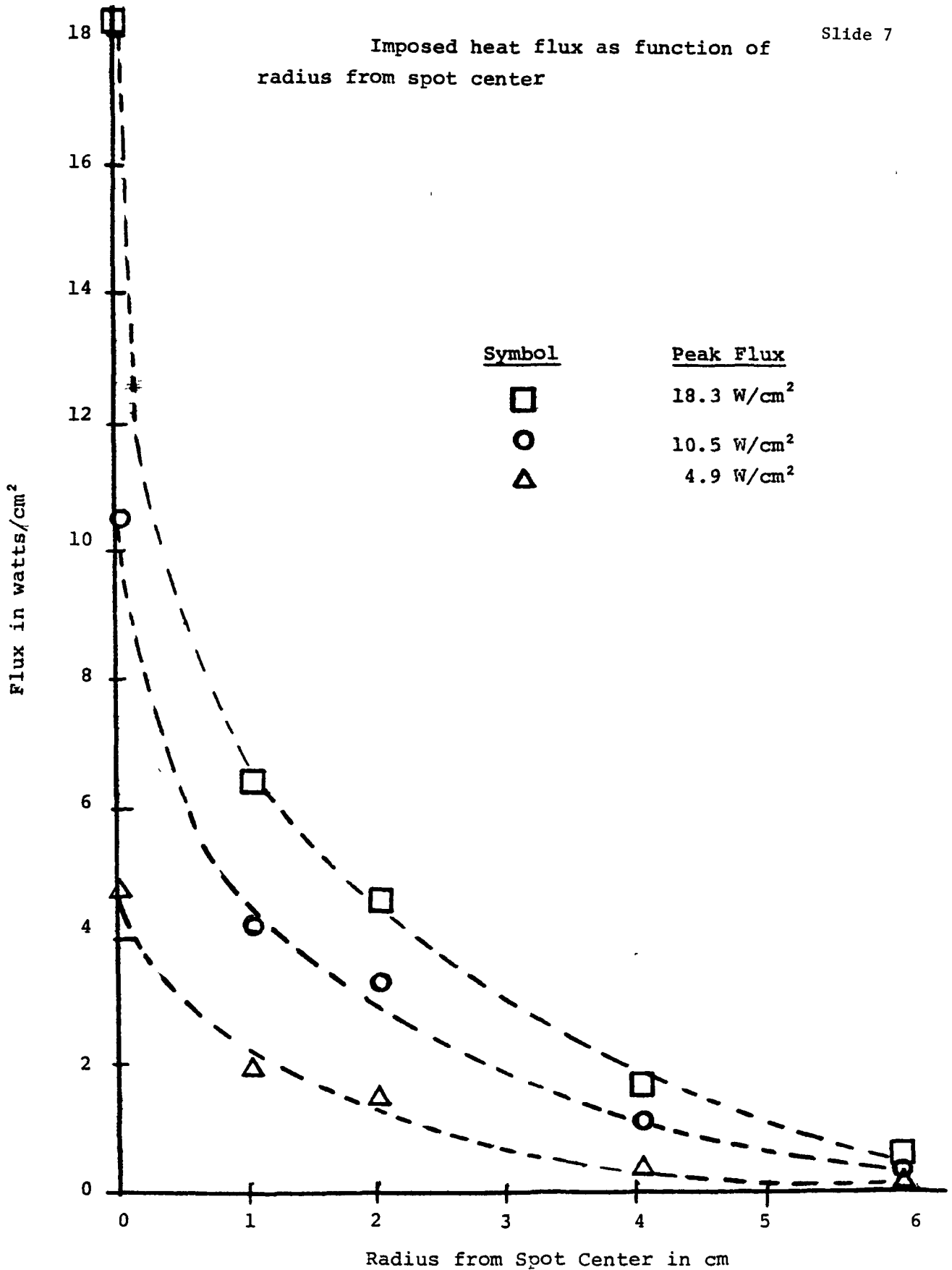


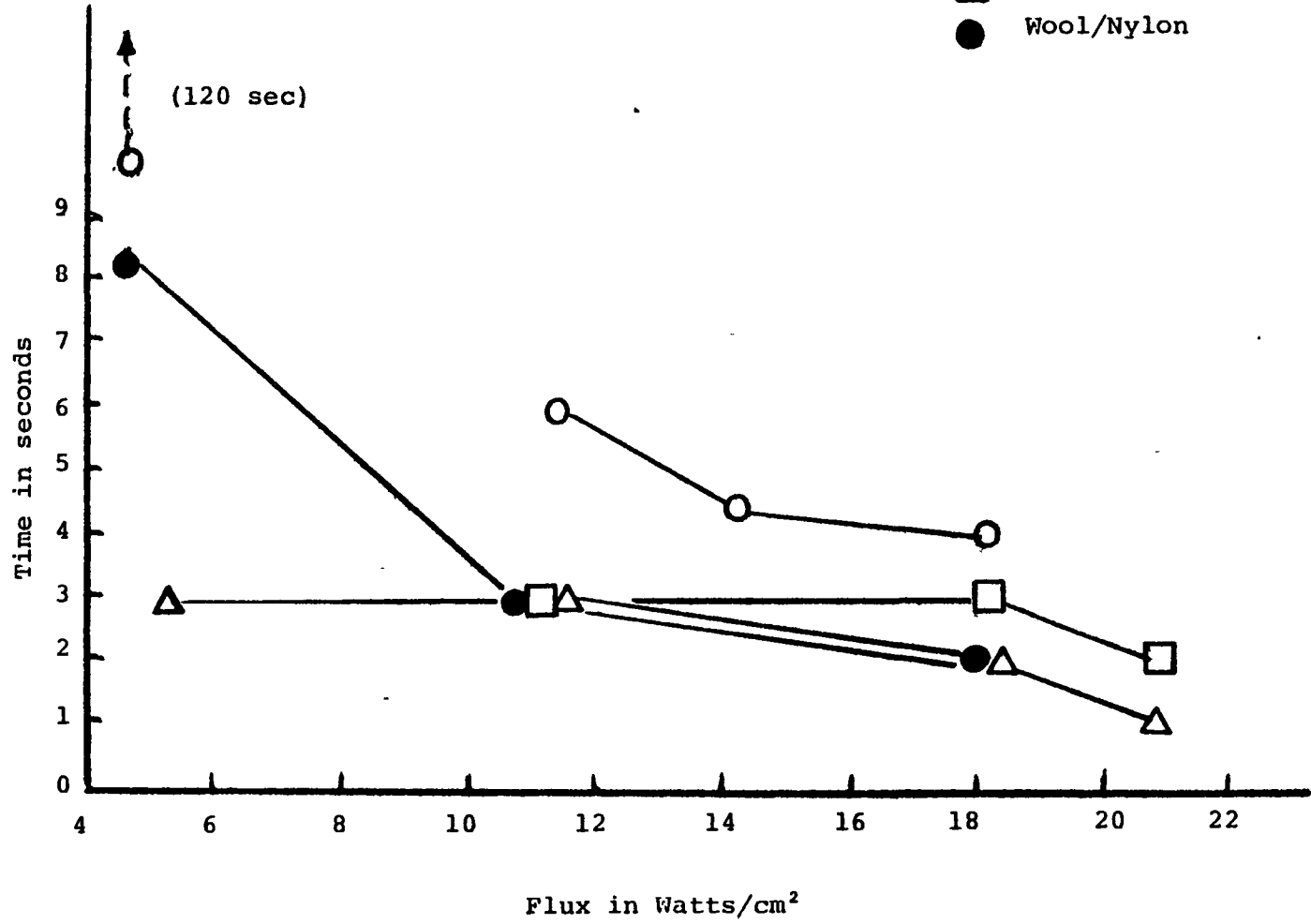
Table 1

<u>Fabric</u> *	<u>Description</u>	<u>Supplier</u>
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
<u>Foam</u>		
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.

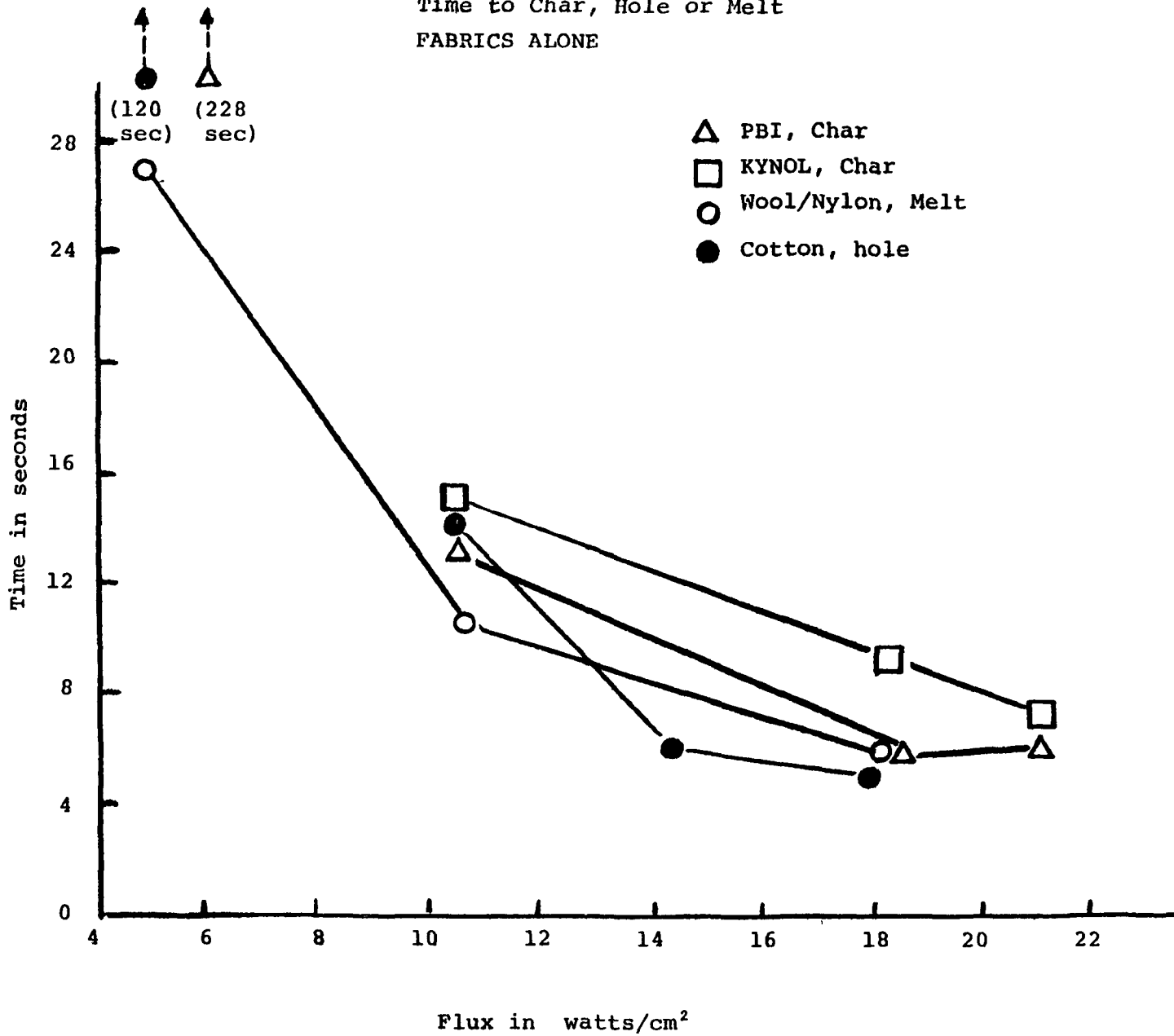
Time to Smoke
FABRICS ALONE

- KYNOL
- Cotton
- △ PBI
- Wool/Nylon



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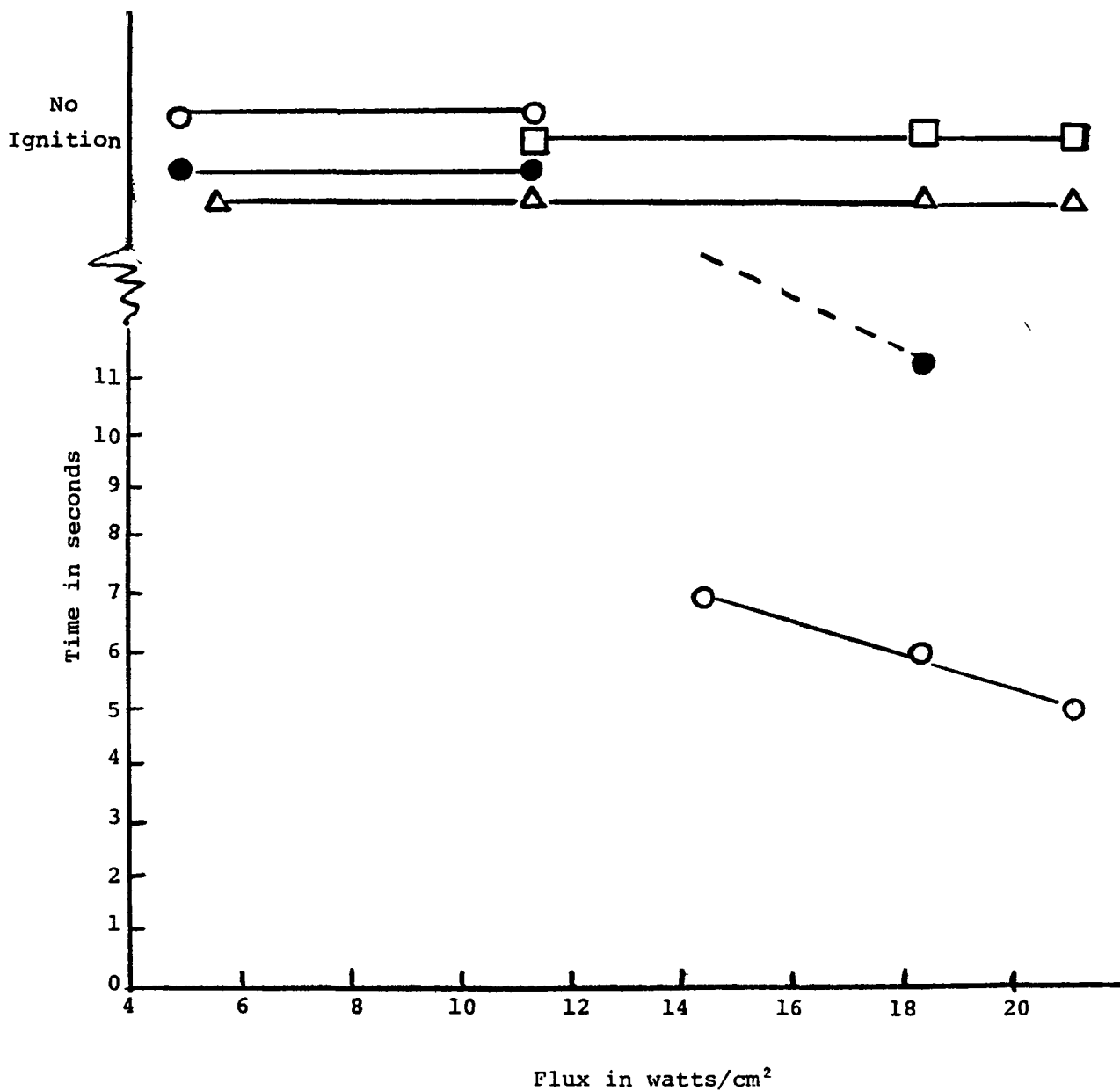
Time to Char, Hole or Melt
FABRICS ALONE

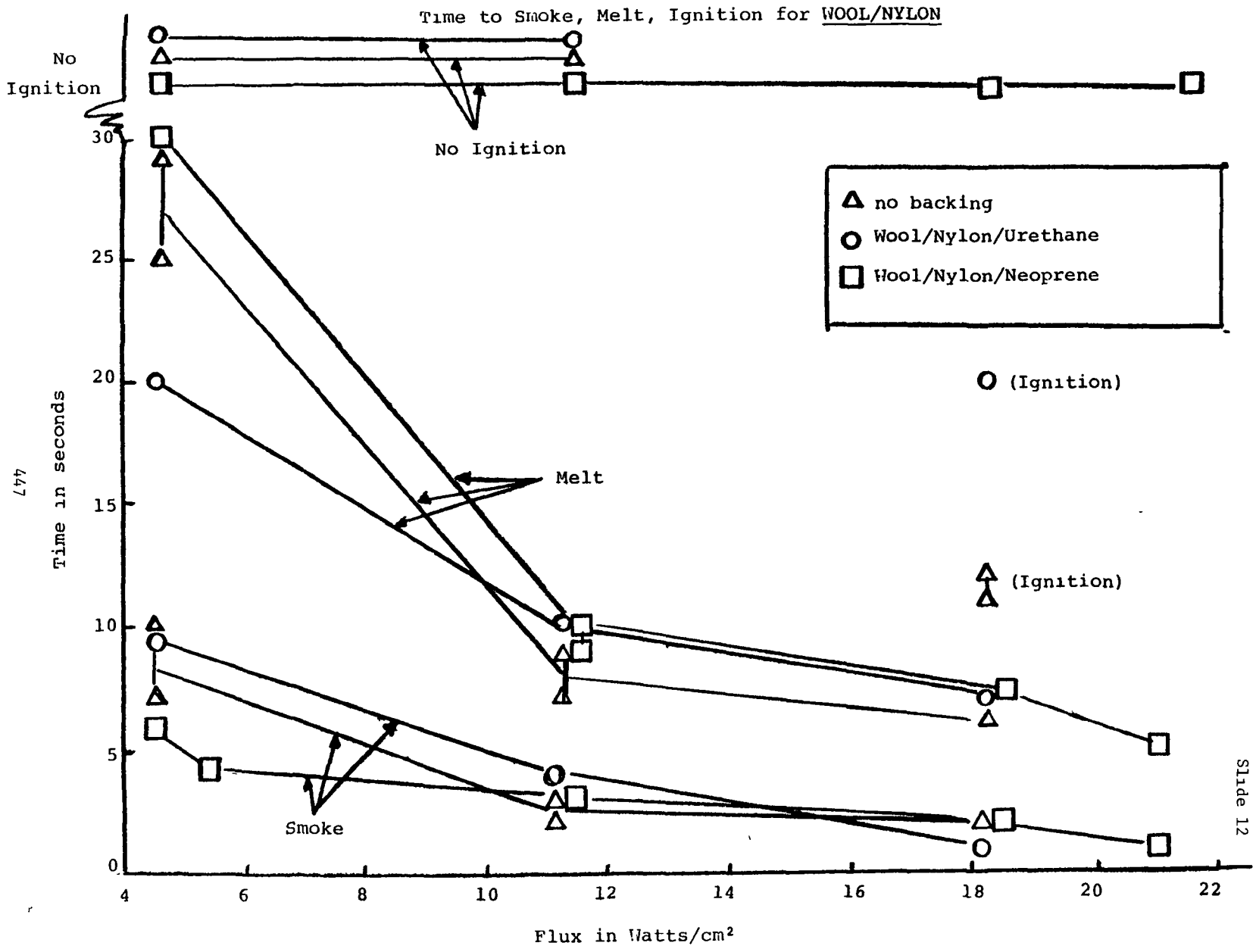


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Time to Ignition, FABRICS ALONE

- Cotton
- Wool/Nylon
- KYNOL
- △ PBI

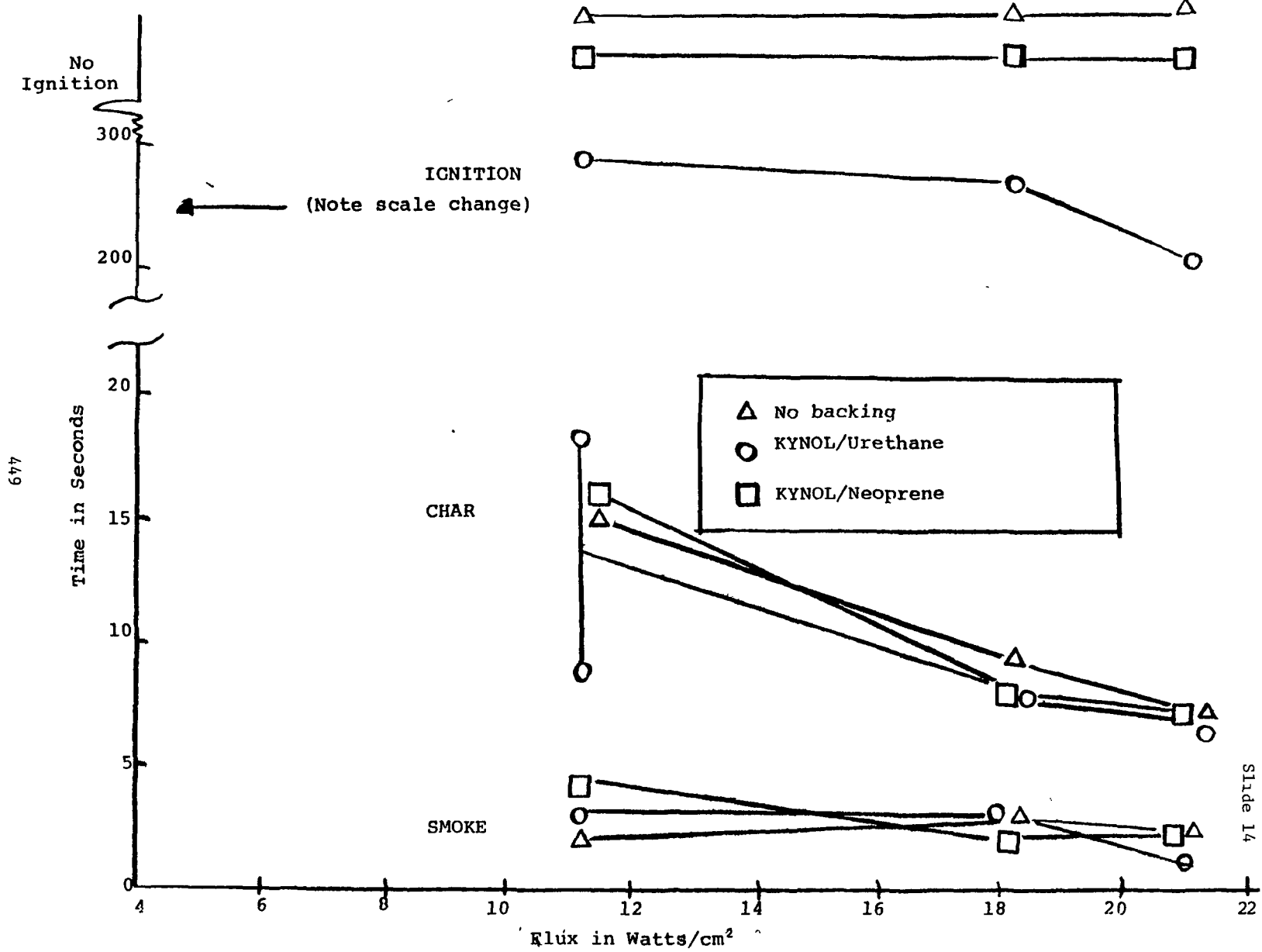




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Slide 12

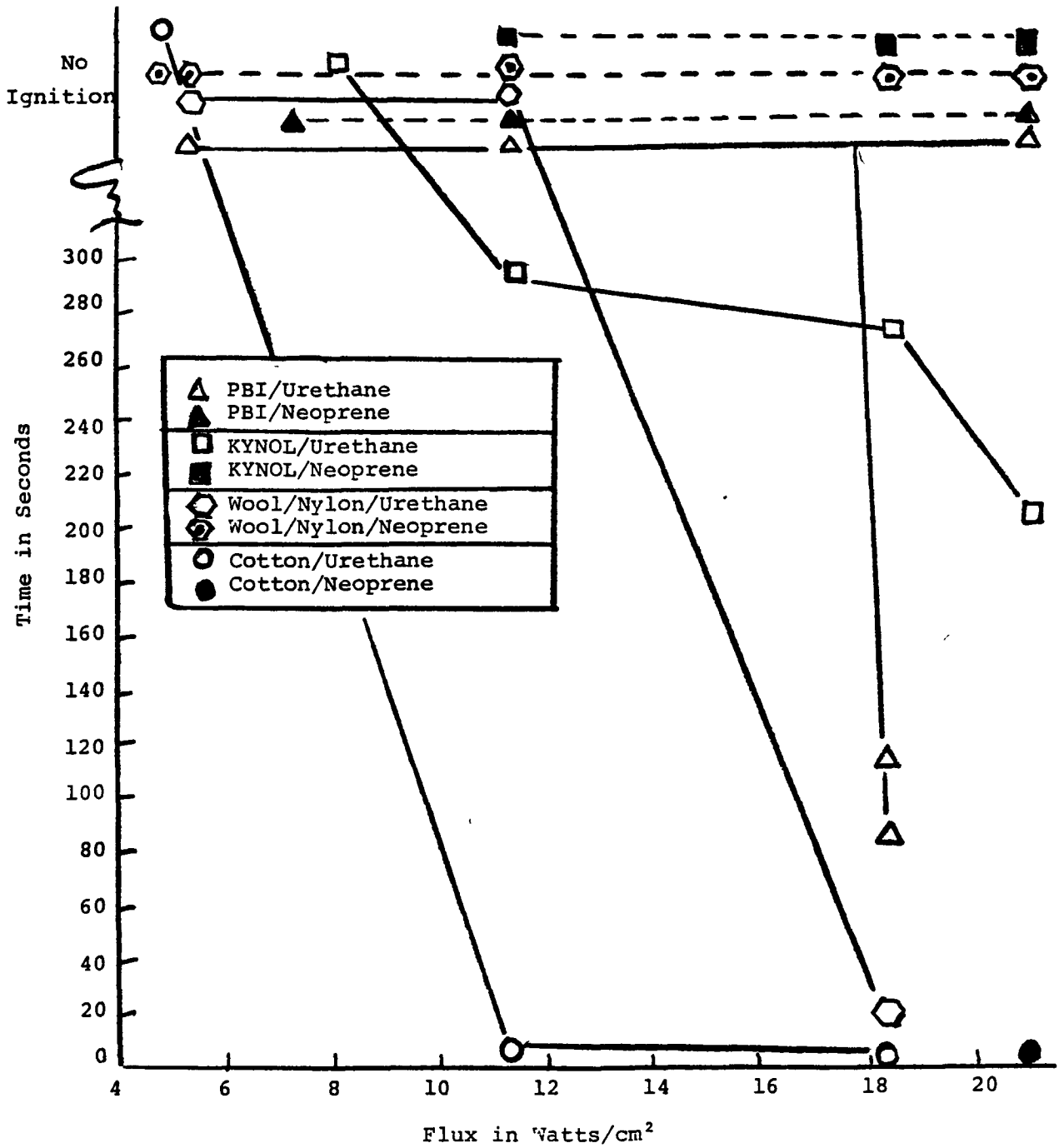
Times to Smoke, Char, and Ignition for KYNOL



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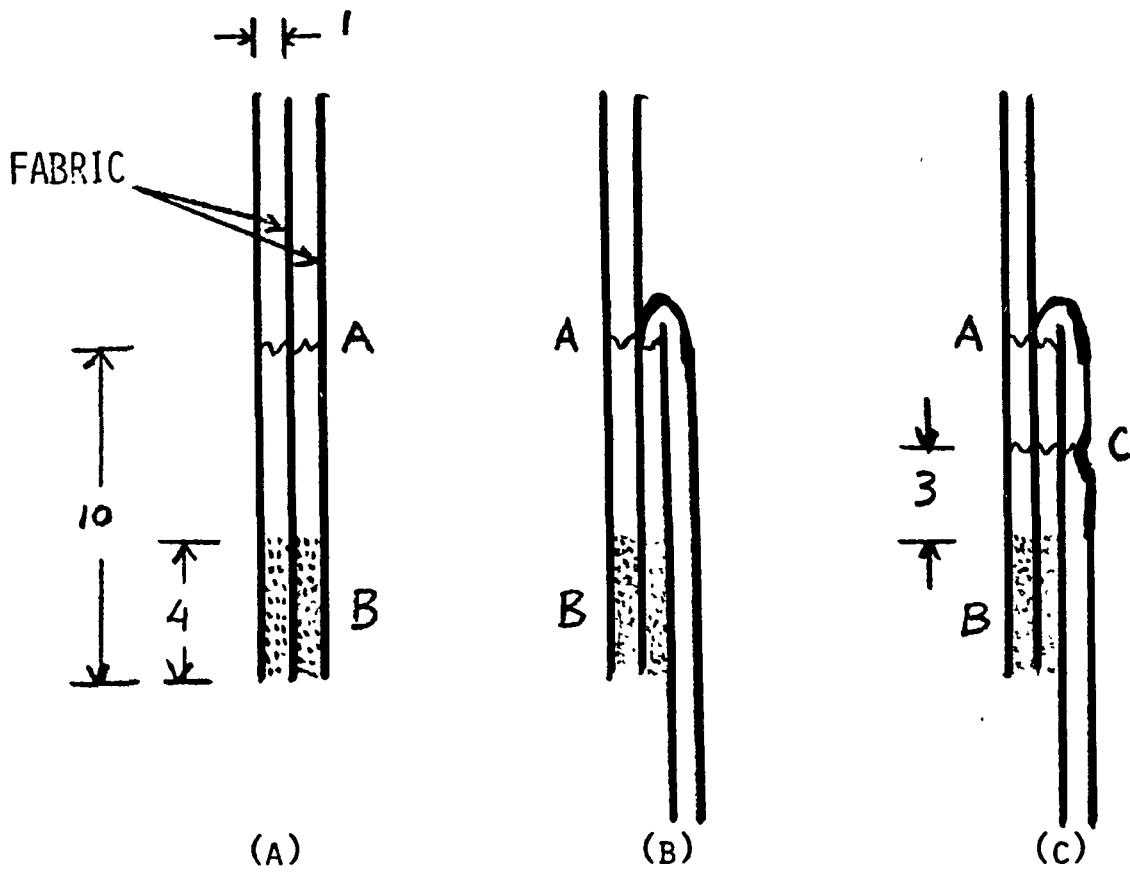
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Time to Ignition, FABRICS/FOAM



SINGLE FELLED SEAM WITH THREE STITCHES

(TWO LOCK, ONE OVERCAST)

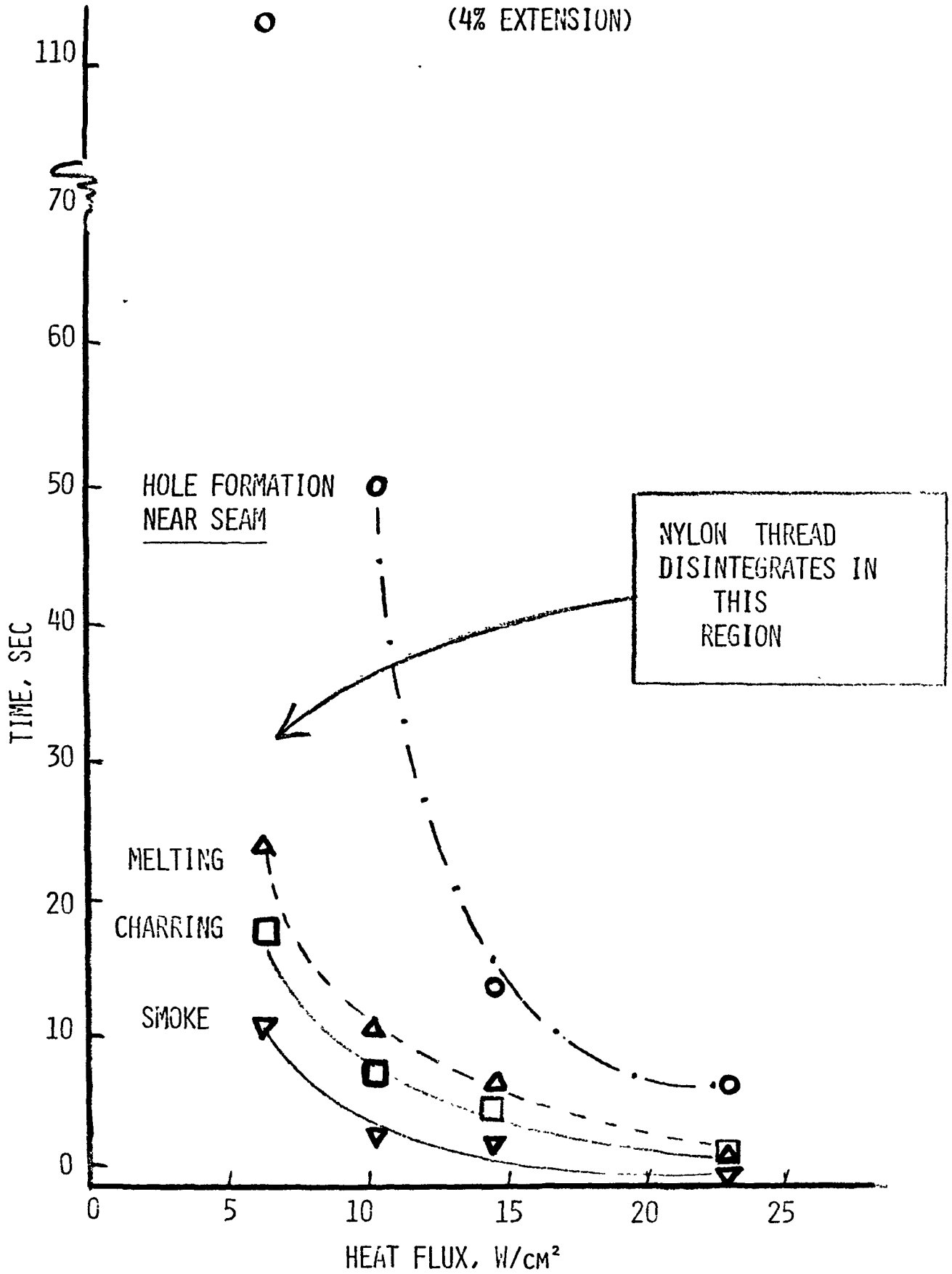


ALL DIMENSIONS IN MM

~~~~~ 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<br>UPHOLSTERY FABRIC | A                       | PU FOAM*<br>B                        | C                               |
|---------------------------------------|-------------------------|--------------------------------------|---------------------------------|
| 0.07 g/cm <sup>2</sup>                | SUSTAINED<br>SMOLDERING | SUSTAINED<br>SMOLDERING              | SUSTAINED<br>SMOLDERING         |
| 0.03 g/cm <sup>2</sup>                | "                       | SUSTAINED<br>SMOLDERING              | TRANSITION TO<br>EXTINGUISHMENT |
| BARE BLOCK                            | "                       | TRANSITION<br>TO EXTIN-<br>GUISHMENT | TRANSITION TO<br>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 1978 - RP-76-U-3.

SMOKE EMISSION OF  
AIRCRAFT SEAT MATERIALS\*

| MATERIAL                        | Ds<br>4 MINUTES** |     |
|---------------------------------|-------------------|-----|
|                                 | -                 | +   |
| WOOL FABRIC                     | 200               | 111 |
| NOMEX FABRIC                    | -                 | -   |
| PU FOAM SLAB                    | 172               | 50  |
| PU FOAM SLAB<br>+ MUSLIN        | 158               | 165 |
| PU FOAM COLD CURING             | 55                | 31  |
| PU FOAM COLD CURING<br>+ 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<br>IGNITION BTU | TIME TO CORE<br>INVOLVEMENT |
|------------------------------------------------------------|-------------------------------|-----------------------------|
| POLYPROPYLENE FABRIC<br>+ PU FOAM                          | 12                            | 2 MIN                       |
| POLYPROPYLENE FABRIC<br>BACKCOATED WITH<br>VONAR + PU FOAM | 3375                          | >30 MIN                     |
| POLYPROPYLENE FABRIC<br>+ VONAR INTERLINER<br>+ PU FOAM    | 85                            | 9.5 MIN                     |
| COTTON/RAYON FABRIC<br>+ PU FOAM                           | 38                            | 2 MIN                       |
| COTTON/RAYON FABRIC<br>BACKCOATED WITH<br>VONAR + PU FOAM  | 525                           | 12 MIN                      |
| COTTON/RAYON FABRIC<br>+ VONAR INTERLINE<br>+ 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 AND MEETING PERFORMANCE REQUIREMENTS, IS NOT ADEQUATE.
2. IGNITION OF STATE-OF-THE-ART UPHOLSTERY FABRICS CAN BE DELAYED BY A CAREFULLY SELECTED LAYER OR INTERLINER BETWEEN FABRIC AND FOAM.
3. THERMAL RESPONSE OF MULTICOMPONENT ASSEMBLIES IS DEPENDENT ON HEAT FLUX AND ON THE SPECIFIC MATERIALS EMPLOYED. THUS, EXPERIMENTAL EVALUATION OF CANDIDATE SYSTEMS IS AN ESSENTIAL PART OF MATERIALS' SELECTION.

ENCLOSURE FIRE MODELING

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