D4

N79-31170

D. SUPKIS

STATUS OF CANDIDATE MATERIALS FOR FULL-SCALE TESTS IN THE 737 FUSELAGE

OBJECTIVES

- INCREASED PASSENGER EVACUATION TIME TO A MINIMUM OF 5 MINUTES FROM COMMERCIAL AIRCRAFT IN CASE OF A FIRE
- PREVENT AN EXTERNAL FIRE FROM ENTERING CLOSED CABINS FOR 5 MINUTES BY USING FIRE BARRIER MATERIALS IN THE EXTERIOR WALL
- DEMONSTRATE THAT A CLOSED CABIN WILL NOT REACH 400°F NOR CONTAIN SMOKE OR TOXIC GASES UP TO 400°F
- PROVE THAT A FIRE NEAR A CABIN OPENING WILL NOT PROPAGATE THROUGH THE CABIN FOR A MINIMUM OF 5 MINUTES

MATERIALS STATUS

- SEAT CUSHIONS
  - FIRE BARRIER CONFIGURATION USING PRESENT FOAM (AMES-DAC)
  - PRESENT POLYIMIDE FOAM MEETS MAJORITY OF SEAT REQUIREMENTS (JSC-SOLAR)
  - INITIAL EVALUATION OF POLYIMIDE FOAM BY FAIRCHILD-BURNS INDICATED THE FOAM IS FUNCTIONAL IN SEATS
  - POLYIMIDE FOAM SAMPLES PROVIDED WEBER AIRCRAFT CO. FOR ADDITIONAL EVALUATION
- UPHOLSTERY AND ASSOCIATED SEAT MATERIALS
  - WOOL OR WOOL-LEAVIL BLENDS UPHOLSTERY FABRICS CURRENTLY USED ARE SATISFACTORY
  - DISPOSABLE HEAD REST TOWELS ARE FIRE-RETARDANT AND AVAILABLE
  - FIRE-RETARDANT COTTON TICKING FOR CUSHIONS MEETS AIRCRAFT REQUIREMENTS AND IS AVAILABLE
  - FIRE-RETARDANT LEATHER ARM REST AND TRIM MEETS JSC FLAMMABILITY REQUIREMENTS
- WALL AND CEILING PANELS
  - PHENOLIC/FIBERGLASS LAMINATES AVAILABLE FROM AMES RESEARCH AND LOCKHEED DEVELOPMENT PROGRAMS
  - EVALUATION OF INITIAL PRODUCTION RUNS OF FLUOREL GLASS WILL RESULT IN AN ADDITIONAL PANEL

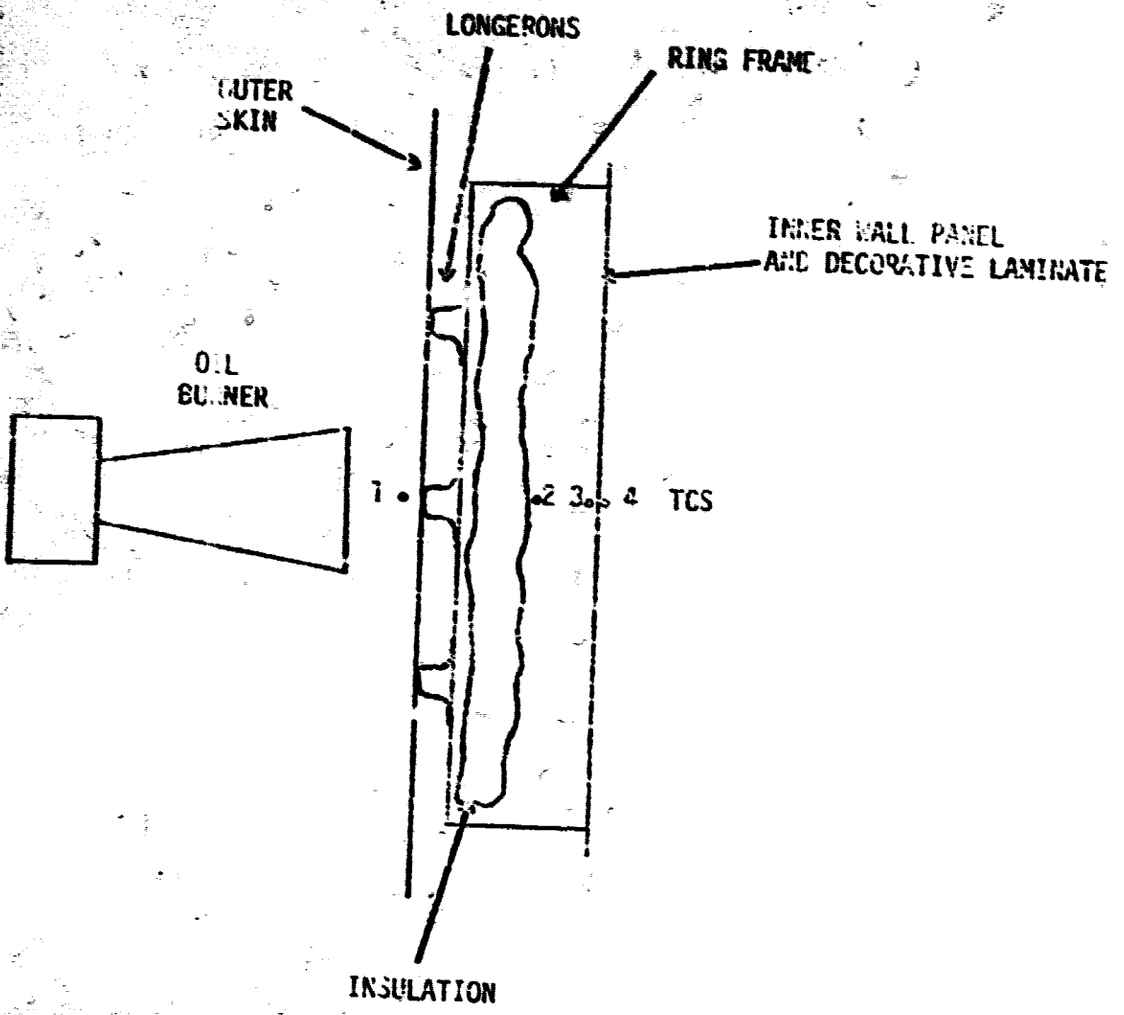
MATERIALS STATUS (CONTINUED)

- FLOOR PANELS
  - POLYIMIDE FOAM FILLED HONEYCOMB CORE WITH PHENOLIC/GLASS FACE SHEETS MEETS ALL BOEING FLOOR SPECIFICATIONS
  - SAME CONFIGURATION WITHSTOOD BOEING OIL BURNER 15 MINUTES
  - IMPROVED FIRE RETARDANT ADHESIVE NEEDED
- CARPET AND CARPET UNDERLAY
  - NO DEVELOPMENT PROGRAMS ANTICIPATED
  - CURRENT STATE-OF-THE-ART WOOL AND WOOL BLENDS MATERIALS ADEQUATE
  - POLYIMIDE FOAM APPEARS ADEQUATE FOR UNDERLAY
- WINDOWS
  - AMES DEVELOPED WINDOWS CHAR, ELIMINATE RADIANT HEAT AND RESIST BURNTHROUGH FOR 4-5 MINUTES
- CARGO BAY LINERS
  - POLYIMIDE/GLASS AND PHENOLIC/GLASS LAMINATES CURRENTLY A NON-FUNDED DEVELOPMENT EFFORT BY NORDAM AND CIBA-GEIGY
  - SOLAR CAPABLE OF DEVELOPING TECHNOLOGY FOR 50K
- INSULATION BAGGING
  - CERAMIC FIBER SCRIM COMBINED WITH PRESENT ALUMINIZED TEDLAR BAGS TO RETAIN THERMAL-ACOUSTICAL INSULATION
  - CONFIGURATIONS TO BE TESTED IN SEMI-FULL SCALE TESTING IN FUSELAGE CROSS-SECTIONS

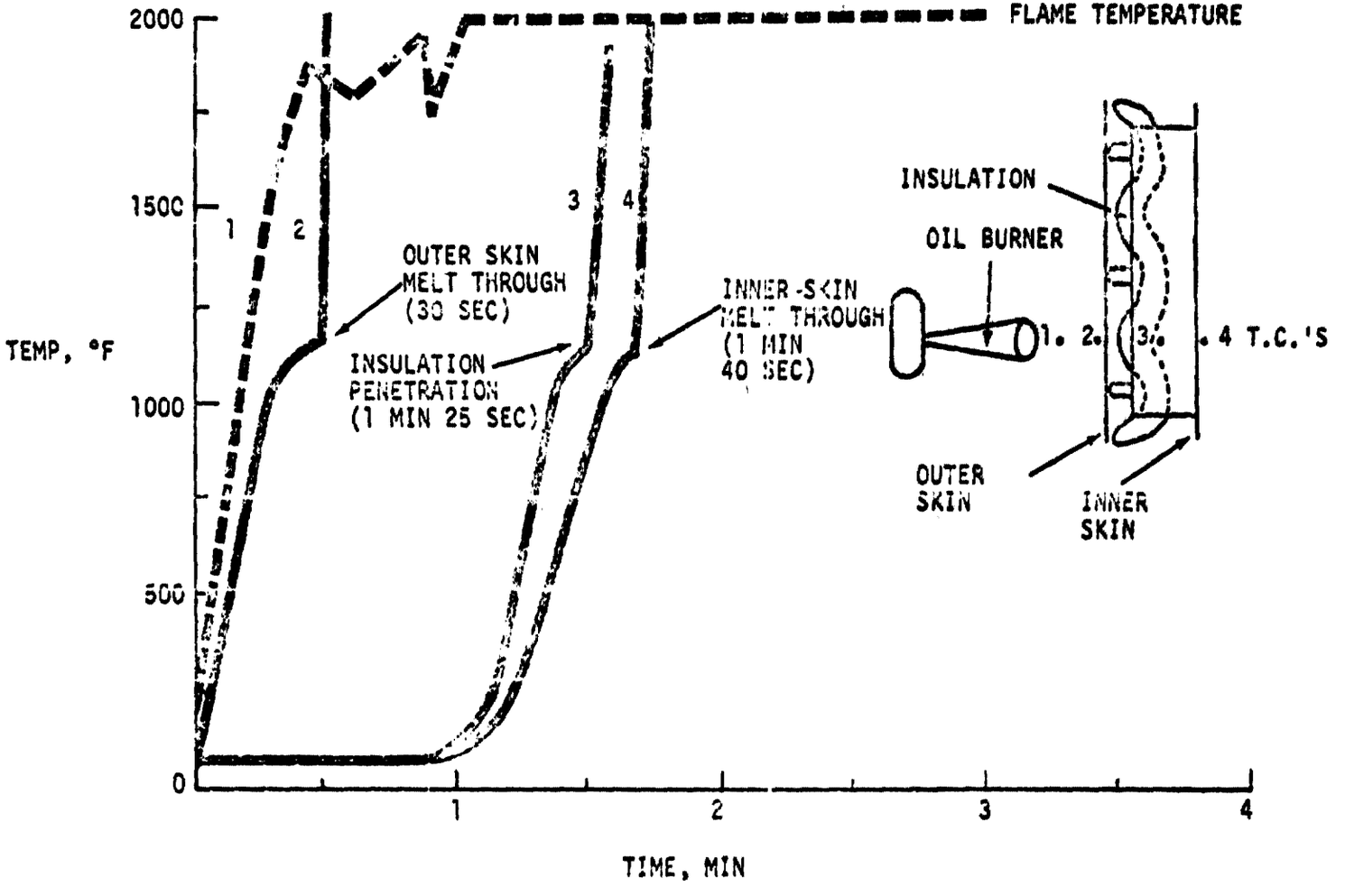
MATERIALS STATUS

- THERMAL ACOUSTICAL INSULATION
  - LITAFLEX ASBESTOS FOAM MEETS WEIGHT, TEMPERATURE DIFFERENTIAL, AND FIRE BARRIER PROPERTIES BUT LOW IN ACOUSTICAL ATTENUATION
  - POLYIMIDE FOAM MEETS WEIGHT REQUIREMENTS ONLY
  - PREVIOUS POLYIMIDE SAMPLES, TOO LOW IN DENSITY, FAILED TO MEET ACOUSTIC AND FIRE BARRIER REQUIREMENTS
  - RECENT SAMPLES OF HIGHER DENSITY SHOW IMPROVEMENT IN FIRE BARRIER PROPERTIES
  - CERAMIC AND CERAMIC-ASBESTOS FOAM UNDER DEVELOPMENT BY RAYBESTOS-MANHATTAN

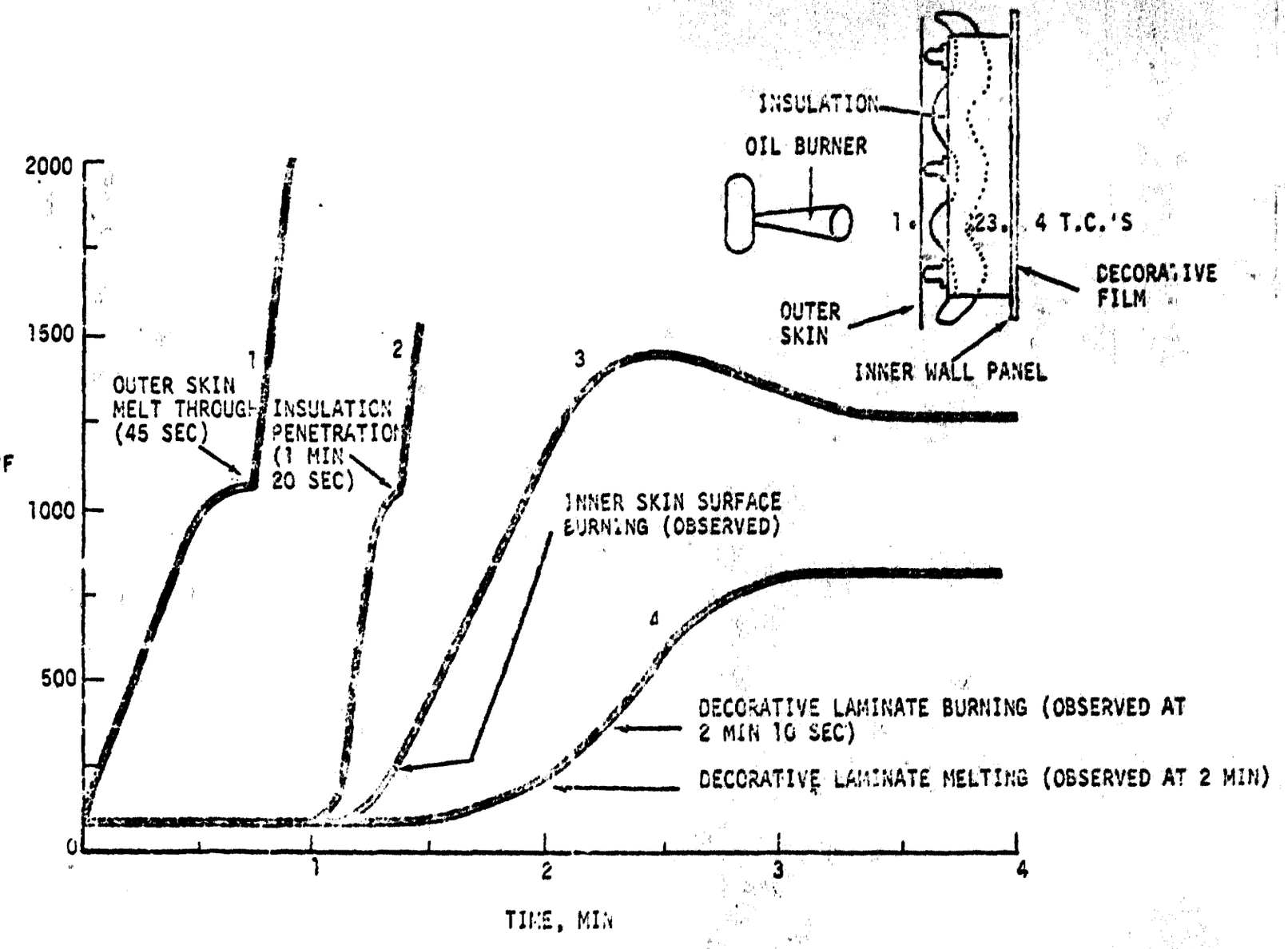
TEST CONFIGURATION



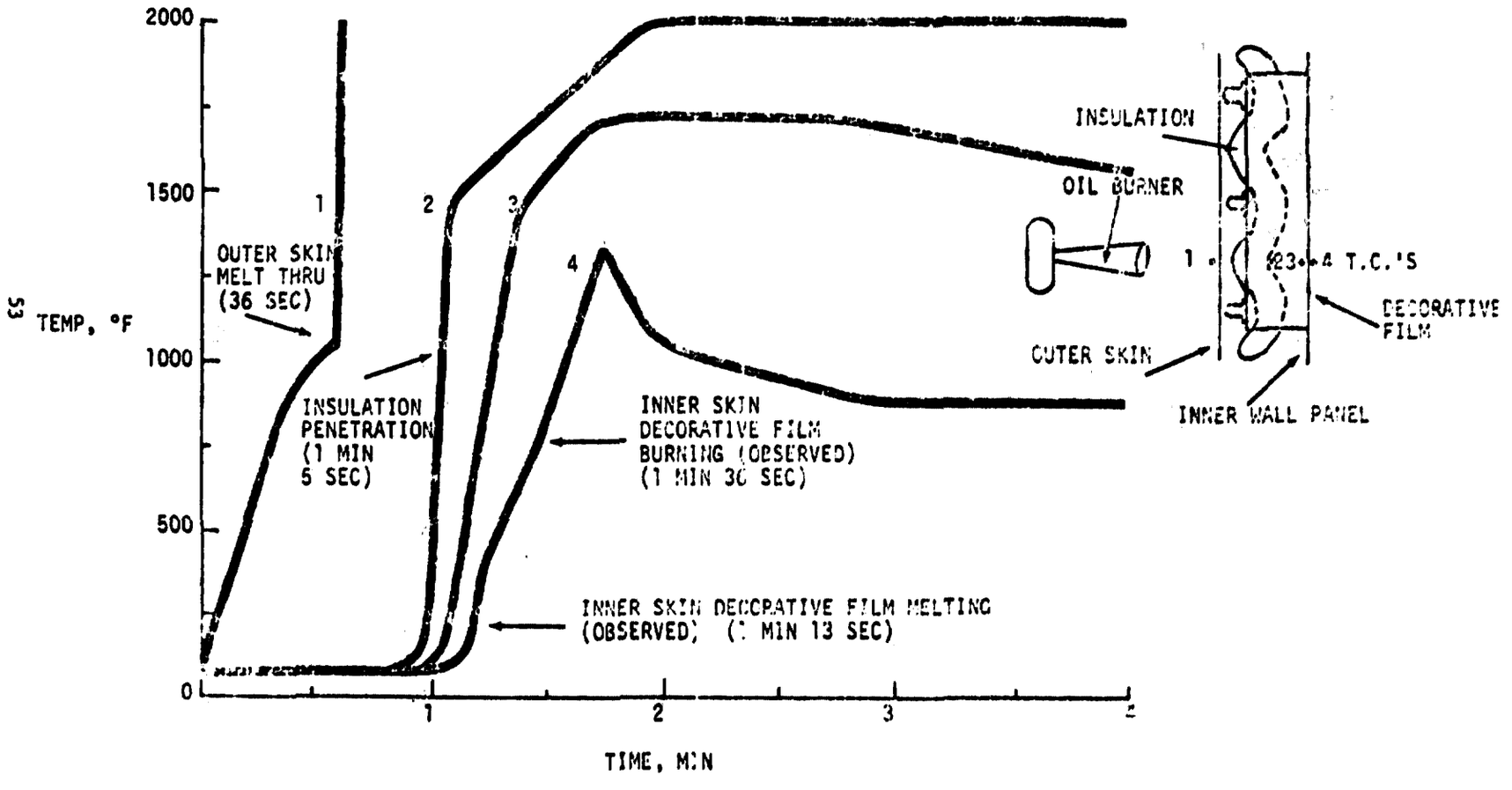
TEMPERATURES DURING TEST OF TYPICAL STANDARD BODY FUSELAGE CROSS SECTION



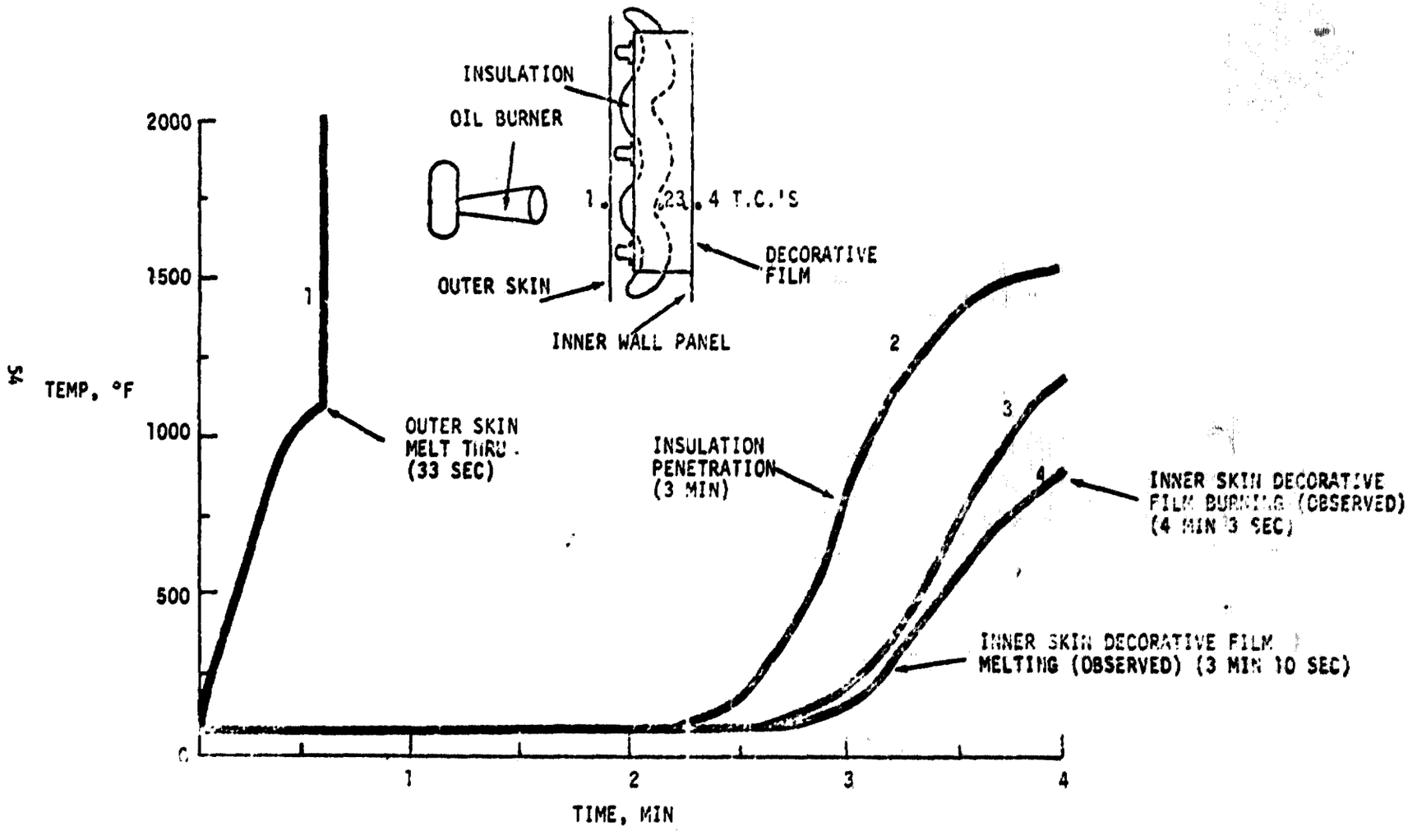
TEMPERATURES DURING TEST OF TYPICAL WIDE BODY FUSELAGE CROSS SECTION



TEMPERATURES DURING TEST OF NARROW BODY FUSELAGE CROSS SECTION
(WITH DECO .040/DECORATIVE FILM INNER SKIN)

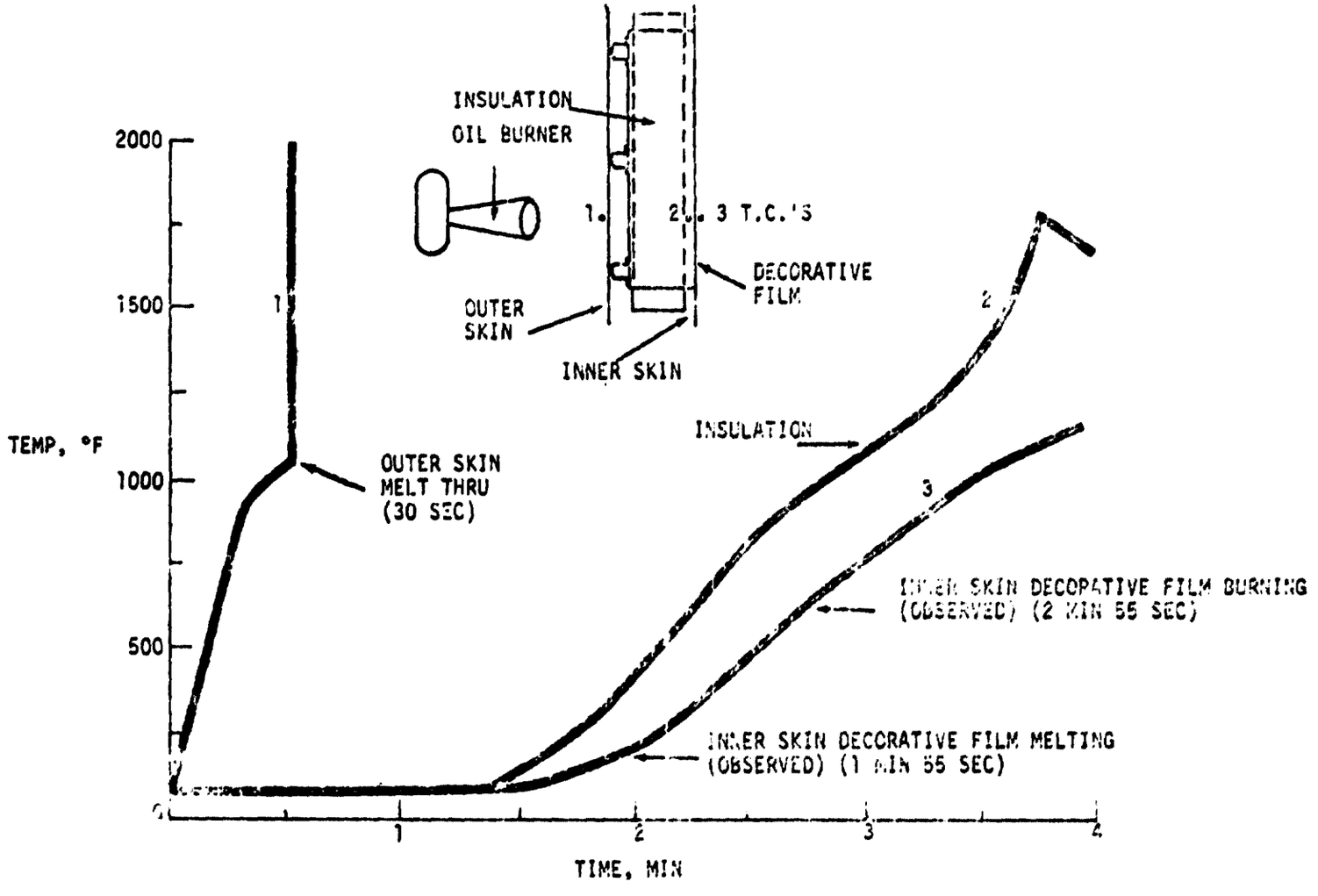


TEMPERATURES DURING TEST OF NARROW BODY FUSELAGE CROSS SECTION
(WITH .005 GRAFOIL/.(4) 1.5 LB F^3 FIBERGLASS/.005 GRAFOIL/DECO .040 DECORATIVE FILM INNER SKIN)



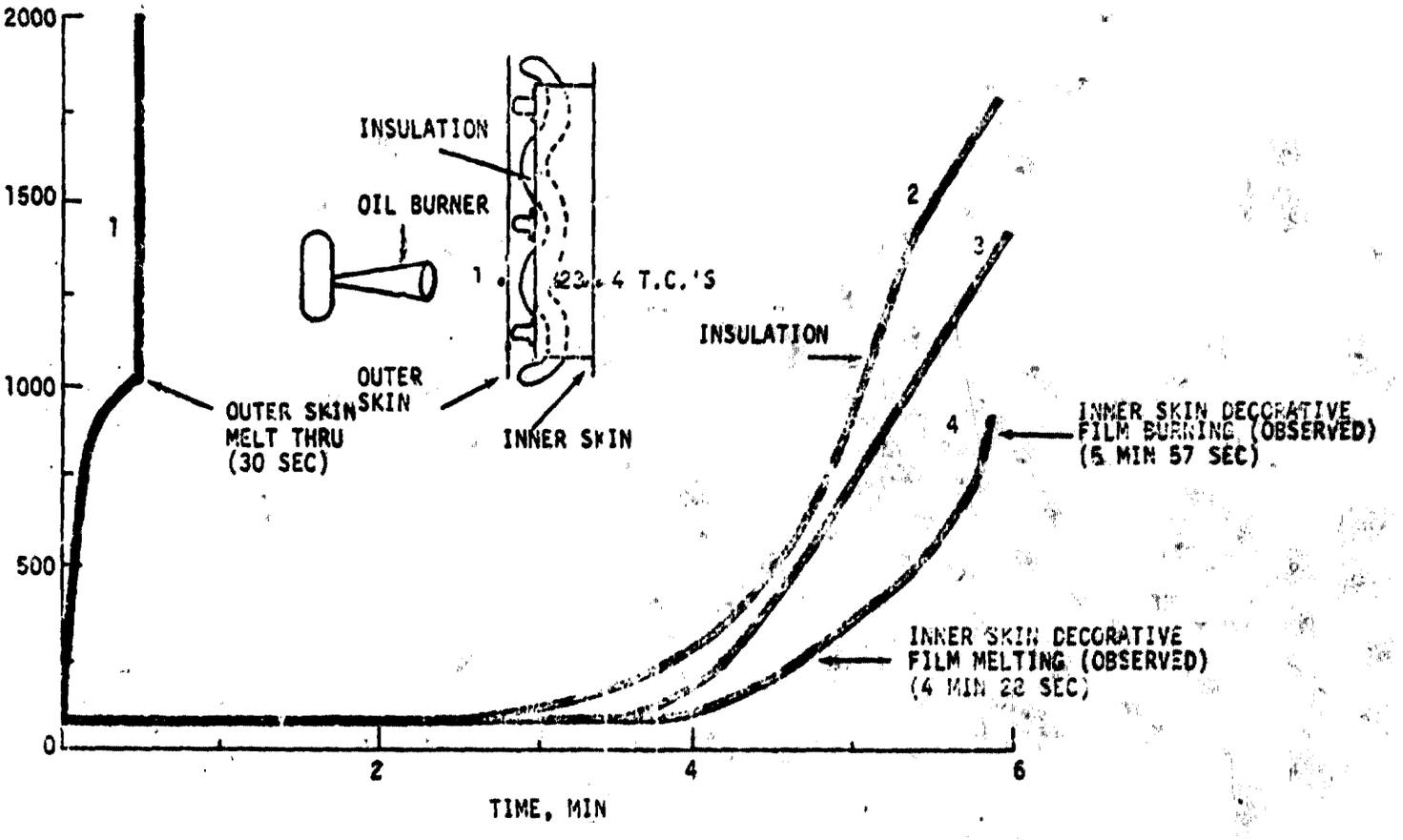
TEMPERATURES DURING TEST OF [illegible] FUSELAGE CROSS SECTION

(WITH .005 GRAFOIL/3" POLYMIDE THERMO/ACOUSTICAL FOAM/.005 GRAFOIL/.040 DECO DECORATIVE FILM INNER SKIN

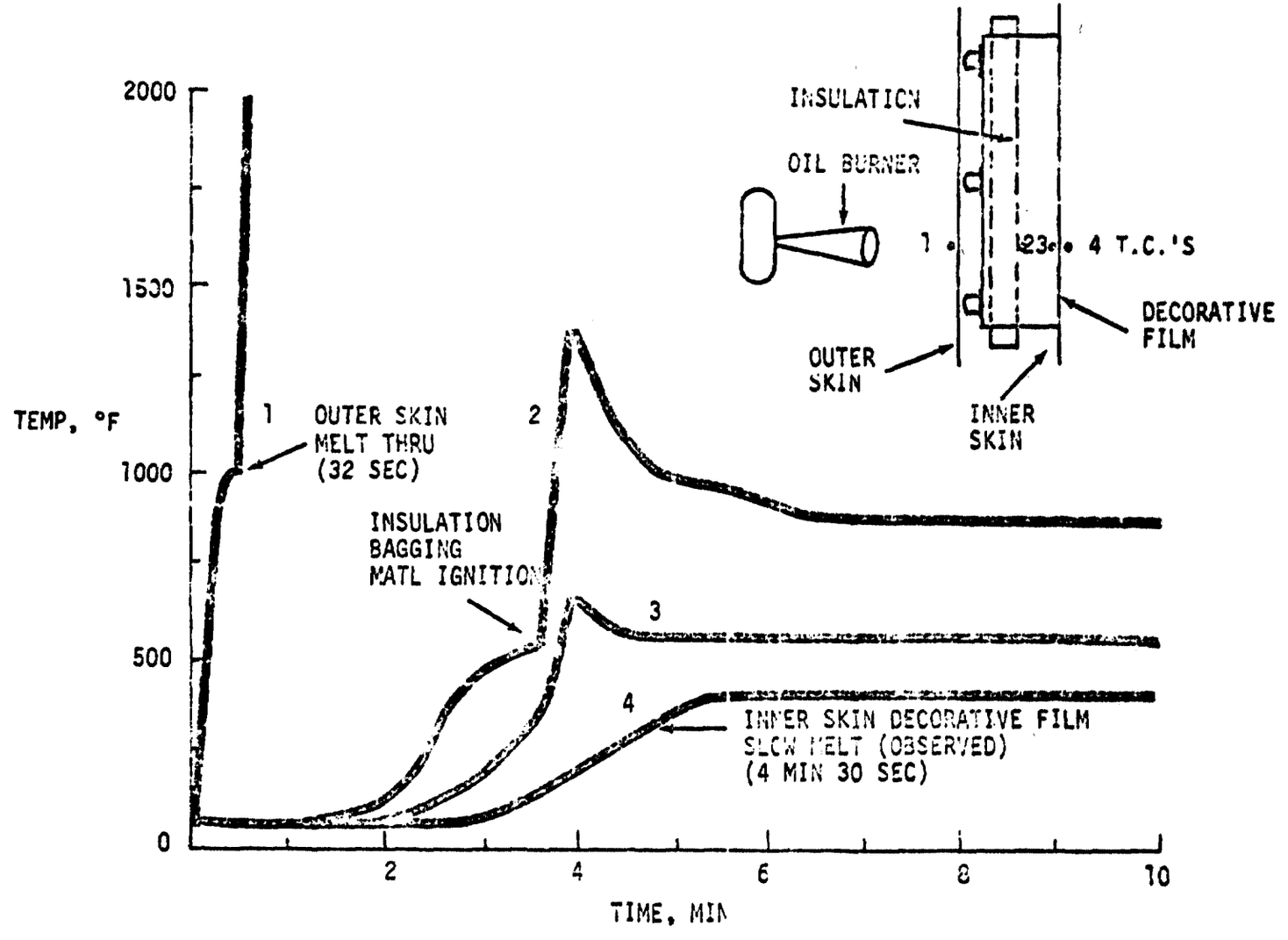


TEMPERATURES DURING TEST OF NARROW BODY FUSELAGE CROSS SECTION

(WITH .015 GRAFOIL/(4) 1.5 LBFT^3 FIBERGLASS/.040 DECO DECORATIVE FILM INNER SKIN)



TEMPERATURES DURING TEST OF NARROW BODY FUSELAGE CROSS SECTION
(WITH (1) 1.5" THICK K-25 LITOFLEX FOAM/040 DECORATIVE FILM & ALUMINUM INNER SKIN)

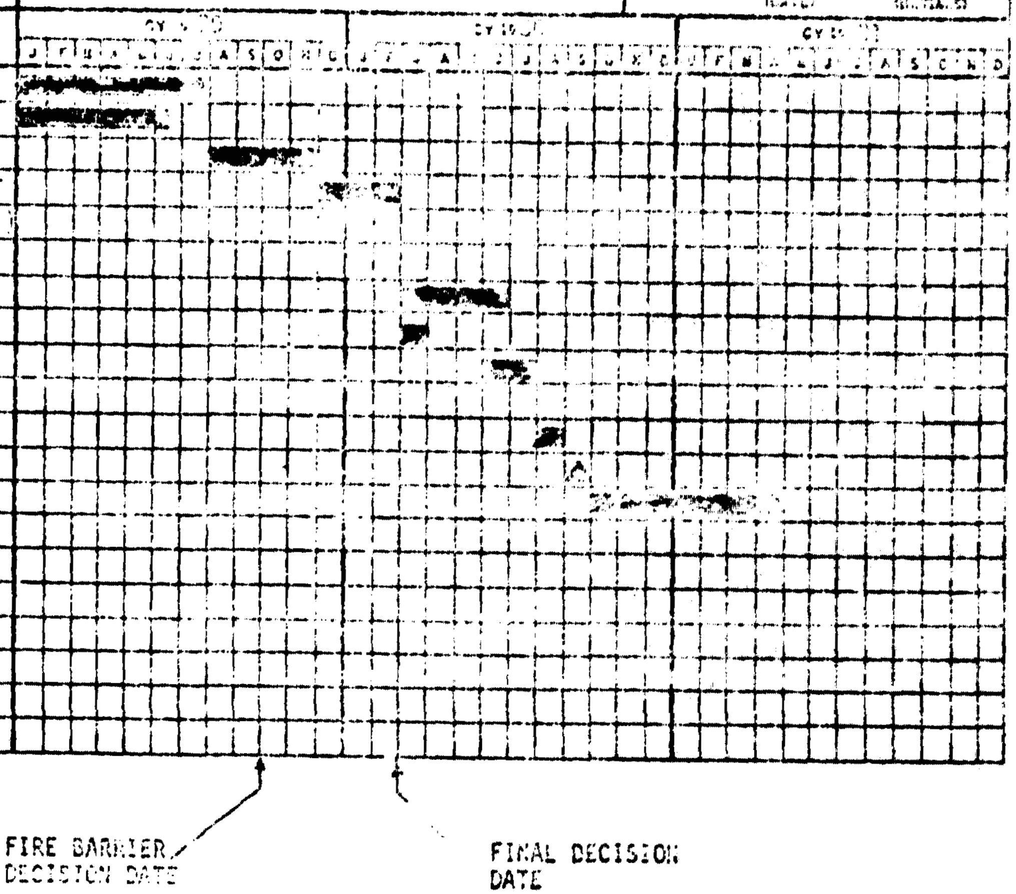


STATUS RESPONSIBILITY

RTOP NO.: 510

RTOP TITLE: FIRE RESISTANT MATERIALS ENG.

	MILESTONES
1	AIR RESEARCH CONTRACT
2	POOL FIRE TESTS (PHASE I)
3	FABRICATION OF TEST PANELS
4	ASSEMBLE, INSTRUMENT, AND TEST
5	OF 10' X 10' PANELS (PHASE II)
6	REFURBISH 737 (AIR RESEARCH)
7	-PROCUREMENT OF GFE
8	-PROCUREMENT OF CFE
9	-FABRICATION AND INSTALL
10	FULL SCALE TEST (1)
11	-INSTRUMENT & CHECKOUT
12	-CONDUCT TEST (PHASE III)
13	SECOND FULL SCALE TEST (DOOR
14	OPEN) (PHASE III)
15	
16	
17	
18	
19	
20	



NOTES:

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RESEARCH AND TECHNOLOGY OBJECTIVE AND PLAN (CONTINUATION SHEET)

ORIGINAL PAGE IS OF POOR QUALITY

MSC Form 300A (Feb 71) NASA — MSC

SUMMARY

- SEAT CUSHIONS
  - FINAL CONFIGURATION CONTINGENT ON TEST RESULTS FROM SwRI AND DAC
  - POLYIMIDE FOAM A PROMISING CANDIDATE
- UPHOLSTERY AND ASSOCIATED SEAT MATERIALS
  - TEXTILE DEVELOPMENT FOR UPHOLSTERY AND ASSOCIATED SEAT MATERIALS PROHIBITIVE IN COST AND TIME
  - THE BEST STATE-OF-THE-ART MATERIALS AVAILABLE AT THE SCHEDULED TIME WILL BE PROCURED
- WALL AND CEILING PANELS
  - LOCKHEED DEVELOPED PANELS OFFER WEIGHT SAVINGS OVER ALUMINUM
  - FORTY LOCKHEED PHENOLIC/GLASS PANELS BEING SUPPLIED UNDER PRESENT CONTRACT
  - FLUOREL/GLASS PANELS HAVE SUPERIOR ACOUSTICAL AND FIRE BARRIER PROPERTIES
- FLOOR PANELS
  - MOST PROMISING IS RIGID POLYIMIDE FOAM FILLED HONEYCOMB CORE WITH PHENOLIC/GLASS FACE SHEETS
- CARPET AND CARPET UNDERLAY
  - COMMERCIALLY AVAILABLE WOOL AND WOOL BLENDS ARE ADEQUATE
  - CARPETS AND UNDERLAY NOT SIGNIFICANTLY INVOLVED IN AIRCRAFT FIRES DURING EVACUATION
  - POLYIMIDE FOAM UNDERLAY PROVIDES GOOD FIRE BARRIER

SUMMARY (CONTINUED)

- WINDOWS
  - AMES-INDUSTRY DEVELOPMENT ONLY IMPROVEMENT AVAILABLE
- CARGO BAY LINERS
  - POLYIMIDE/GLASS AND PHENOLIC/GLASS DEVELOPMENTS APPEAR PROMISING
  - ADVANCED LINERS NOT ESSENTIAL FOR FULL-SCALE TESTS IF FUSELAGE FIRE BARRIER PROVES ADEQUATE: NEW FLOOR PANEL PROVIDES EXCELLENT BARRIER TO FIRES BENEATH THE CABIN
- INSULATION BAGGING
  - CERAMIC FIBER SHOWS PROMISE TO HOLD THERMAL-ACOUSTICAL INSULATION IN PLACE WHEN TEDLAR BURNS OFF
- THERMAL-ACOUSTICAL INSULATION
  - POLYIMIDE FOAM PROMISING CANDIDATE IF ACOUSTICAL AND FIRE BARRIER PROPERTIES CAN BE UPGRADED
  - CERAMIC FOAM MAY BE CANDIDATE IF DEVELOPMENT CAN KEEP PACE WITH FULL-SCALE TEST SCHEDULE
  - LITAFLEX AND CERAMIC-ASBESTOS MAY BE INCLUDED IF OSHA REQUIREMENTS CAN BE MET
  - GRAPHOIL PROVIDES ADDITIONAL FIRE BARRIER PROTECTION FOR THERMAL-ACOUSTICAL INSULATION BUT IS EXPENSIVE

D. SUPKIS

DEVELOPMENT OF PROCESSES AND TECHNIQUES FOR MOLDING FIRE RESISTANT POLYMERIC MATERIALS

CONTRACT NAS 9-15405
LOCKHEED-CALIFORNIA COMPANY
BURBANK, CALIFORNIA

OBJECTIVES

- SELECT FIRE-RETARDANT MATERIALS FOR MOLDING AIRCRAFT PARTS
- EVALUATE MATERIALS FOR FLAMMABILITY AND THERMAL STABILITY [illegible]ES
- DEVELOP PROCESSES AND TECHNIQUES FOR FORMING THESE MATERIALS BY COMPRESSION, INJECTION AND THERMOFORM MOLDING

COMPRESSION MOLDING DATA

Property	Lac.22-1339 Phenolic Glass	CIBA/GEIGY FIBER DUX 917 Phenolic/Glass	NARMCO 8250 Phenolic Glass	Solar Intl Polyimide Glass	3M Fluorel	Requirement
Density, GM/CC	1.90	1.90	1.90	1.50	≈1.75	1.30 (Max)
Heat Deflection, °C @ 264/PSI	200	175	175	204	≈180	121 (Min)
Flammability Test FAR 25.853 60 Sec. Vertical						
Flame Time, sec.	3	0	3	0	0	15 (Max)
Burn length, in.	1.32	2.44	1.52	1.20	1.08	6 (Max)
Burntime-Drippings, sec.	0	0	0	0	0	3 (Max)
Smoke Obscuration Ds(6Min)Flaming	8.0	8.8	8	3	10	75 (Max)
Limiting Oxygen Index	40	30	40	60	60	35 (Min)
Thermogravimetric Analysis, °C	390	390	390	590	476	205 (Min)
Material Cost, $/LB	2.25	6.75	5.60	11.25	8.00	20% increase over present in prod. quantities (Max)
Handling Properties	Adequate	Adequate	Adequate	Currently limited to simple parts	Adequate	Same as present materials
Availability	Production Quantities	Production Quantities	Production Quantities	Limited Production	Limited Production	Production Quantities

DISCUSSION OF RESULTS

COMPRESSION MOLDING

- PHENOLIC MOLDINGS MEET FLAMMABILITY, SMOKE, AND THERMAL REQUIREMENTS
- TEDLAR DECORATIVE FILM INCREASES SMOKE AND BURN LENGTH
- SOLAR POLYIMIDE MOLDABLE BUT REQUIRES PROCESSING INSTRUCTION TO CONVERTERS
- SELECTION OF FLUOREL/GLASS FABRIC OR FLUOREL/GLASS MAT CONTINGENT ON EVALUATION OF PRODUCTION RUNS

INJECTION MOLDING DATA

Property	Polycarbonate Lexan 940	Arom. Polyest. E200-3Z	Polyphenylsulfone Radel 5010N	Polyether-sulfone PES KM-1	Requirements
Density, Gm/CC	1.21	1.19	1.29	1.37	1.30 (Max)
Heat Deflection °C @ 264 psi	132	170	204	190	121 (Min)
Flammability Test FAR 25.853 60 Sec. Vertical					
Flametime, Sec	5	2	1	1	15 (Max)
Burn length, Inches	3.00	2.48	2.8	3.40	6 (Max)
Burntime-Drippings, Sec	2	7	0	0	3 (Max)
Smoke Obscuration D_s (6 Min) Flaming	110	90	3.2	20	75 (Max)
Limiting Oxygen Ind.	35	33	38	36	35 (Min)
Thermogravimetric Analysis °C	440	329	570	299	205 (Min)
Material Cost, $/LB	2.50	8.00	15.00	8.00	20% Increase over present in prod. Quan
Availability	Prod.Quant.	Dev. Quant.	Limited Pilot blank quant.	Limited Prod.	Prod.Quant.
IZOD Impact, Notched FT-LBS/INCH	10	3	12	1.6	3.0 (Min)
Tensile Strength PSI, Min.	8500	12,000	10,400	12,000	6000 (Min)
Elongation, %	90	60	60	10	20 (Min)

DISCUSSION OF RESULTS

INJECTION MOLDING

- POLYETHERSULFONE (PES) AND POLYPHENYLSULFONE (PPS) HAVE BETTER FLAMMABILITY PROPERTIES THAN LEXAN 940
- PES AND PPS MATERIALS AND PROCESSING COSTS MUCH HIGHER THAN LEXAN 940
- MONSANTO'S POLYESTER FAILS FLAMMABILITY TESTS
- LEXAN 940 MELTS AND DRIPS BURNING PARTICLES

THERMOFORM DATA

Property	Polycarbonate Lexan F-6000	Polycarbonate Lexan EF-6000	Polyethersulfone PES KM-1	Requirements
Density, Gm/CC	1.21	1.21	1.37	1.40 (Max)
Heat Deflection °C @ 264 psi	132	122	190	121 (Min)
Flammability Test FAR 25.853				
Flame time, seconds	4	97	0	15 (Max)
Burn length, inches	3.0	7.4	3.4	6 (Max)
Burntime-drippings, sec.	1.0	1.0	0	3 (Max)
Smoke Obscuration D_s (6 Min) Flaming	110	120	20	75 (Max)
Limiting Oxygen Index	33.5	33	36	35 (Min)
Thermogravimetric Analysis °C	440	440	550	205 (Min)
Material Cost $LB	3.00	3.00	8.00	20%, Max, over present materials
Availability	Production Quantities	Limited Production	Limited Production	Production Quantities
IZOD Impact, Notched FT-LBS/INCH	10	12	1.3	3.0 (Min)
Tensile Strength psi minimum	9,800	9,600	12,000	6,000 (Min)
Elongation %	75	75	3	20 (Min)
180° Peel/LB/INCH	10	10	7	8 (Min)
Cleaner and Solvent Resist.	Fair	Fair	Good	Good

SUMMARY OF RESULTS

THERMOFORM

- POLYCARBONATE EF 6000 CLEANABILITY AND FLAMMABILITY PROPERTIES DO NOT MEET REQUIREMENTS
- POLYCARBONATE F6000 BETTER BUT MELTS AND DRIPS BURNING PARTICLES
- POLYETHERSULFONE SATISFACTORY BUT SPECIAL EXPENSIVE DIES ARE REQUIRED FOR THERMOFORMING

CONCLUSIONS

COMPRESSION MOLDING

- PHENOLICS MEET ALL REQUIREMENTS
- PHENOLIC FORMULATIONS COMMERCIALLY AVAILABLE FOR FY 80 TESTS
- SELECTION OF ONE OF TWO FLUOREL/GLASS CONFIGURATIONS TO BE MADE AFTER EVALUATION OF PRODUCTION RUNS
- FLUOREL/GLASS MATERIALS OFFER ADVANTAGES IN WEIGHT SAVINGS, ACOUSTICS, AND FIRE BARRIER PROPERTIES

INJECTION MOLDING

- PES KM-1, POLYETHERSULFONE MAY SHOW PROMISE FOR REPLACING POLYCARBONATE IF DEVELOPMENT CONTINUES

THERMOFORMING

- NO THERMOFORMABLE MATERIALS HAS BEEN IDENTIFIED THAT MEETS JSC REQUIREMENTS