AERONAUTICAL MATERIALS AND STRUCTURES

SYSTEMS TECHNOLOGY

OVERVIEW

FIREMEN—FIRE RESISTANT MATERIALS

RTOP 510-56-01

D. A. KOURTIDES

FIREMEN PROGRAM REVIEW
NASA AMES RESEARCH CENTER
APRIL 13, 14, 1978

PROGRAM OBJECTIVE: AERO MATERIALS & STRUCTURES SYSTEMS TECHNOLOGY

SPECIFIC OBJECTIVE: FIREMEN—FIRE RESISTANT MATERIALS

- RTOP OBJECTIVE (510-56-01)

  TO PROVIDE THE MATERIALS TECHNOLOGY REQUIRED TO MAKE FUTURE AIRCRAFT MATERIALS, STRUCTURES AND SUBSYSTEMS AS FIRE RESISTANT AS FEASIBLE, AND TO ACCELERATE THE TRANSFER OF THIS TECHNOLOGY TO AIRCRAFT MANUFACTURERS.

- TARGETS
  - PROVIDE MATERIALS TECHNOLOGY FOR REDUCING FLAME PROPAGATION, SMOKE, AND TOXICITY IN CABIN
  - INCREASE FIRE CONTAINMENT CAPABILITY IN SELECTED AREAS OF THE CABIN/CARGO
  - EVALUATE FIRE-RESISTANT TRANSPARENT DUST COVERINGS
  - DEVELOP ADVANCED SEAT CUSHION SYSTEMS
  - PROVIDE MATERIALS TECHNOLOGY FOR FIRE-RESISTANT FILMS, ADHESIVES AND INKS

PROGRAM OBJECTIVE: AERO MATERIALS & STRUCTURES SYSTEM TECHNOLOGY

SPECIFIC OBJECTIVE: FIRE-RESISTANT MATERIALS (RTOP 510-56-01)

RESOURCE REQUIREMENTS

RESOURCE	'77	'78	'79	'80	'81
NET R&D FUNDS ($K)	100	265	100	0	0
IMS	30	35	60	0	0
MANPOWER (MY)					
PROFESSIONAL (IN-HOUSE)					
CIVIL SERVICE	1	0.7	1	0	0
SUPPORT					
CIVIL SERVICE	1	1	1	0	0

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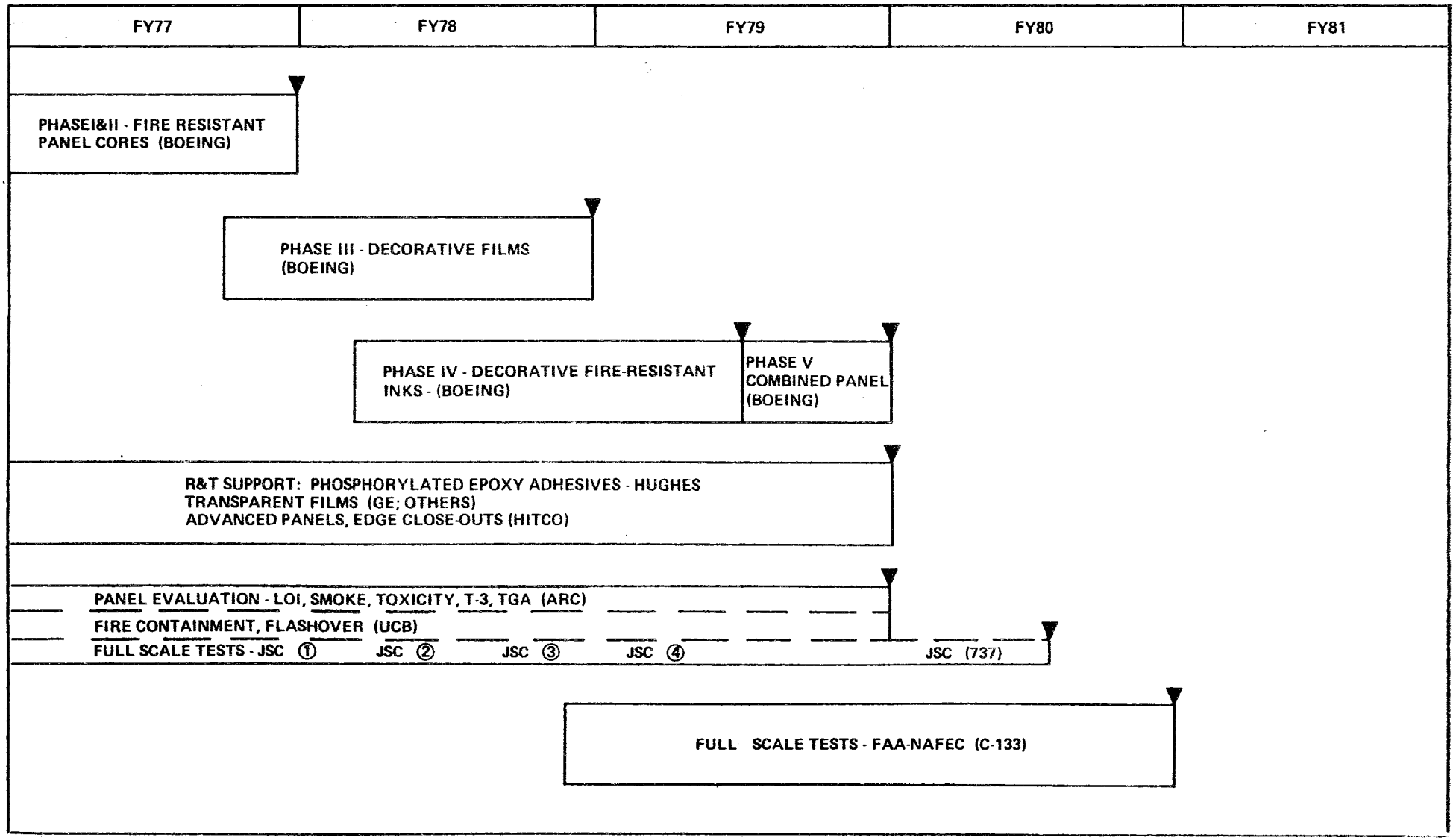
SPECIFIC OBJECTIVE: FIRE RESISTANT MATERIALS
RTOP: 510-56-01

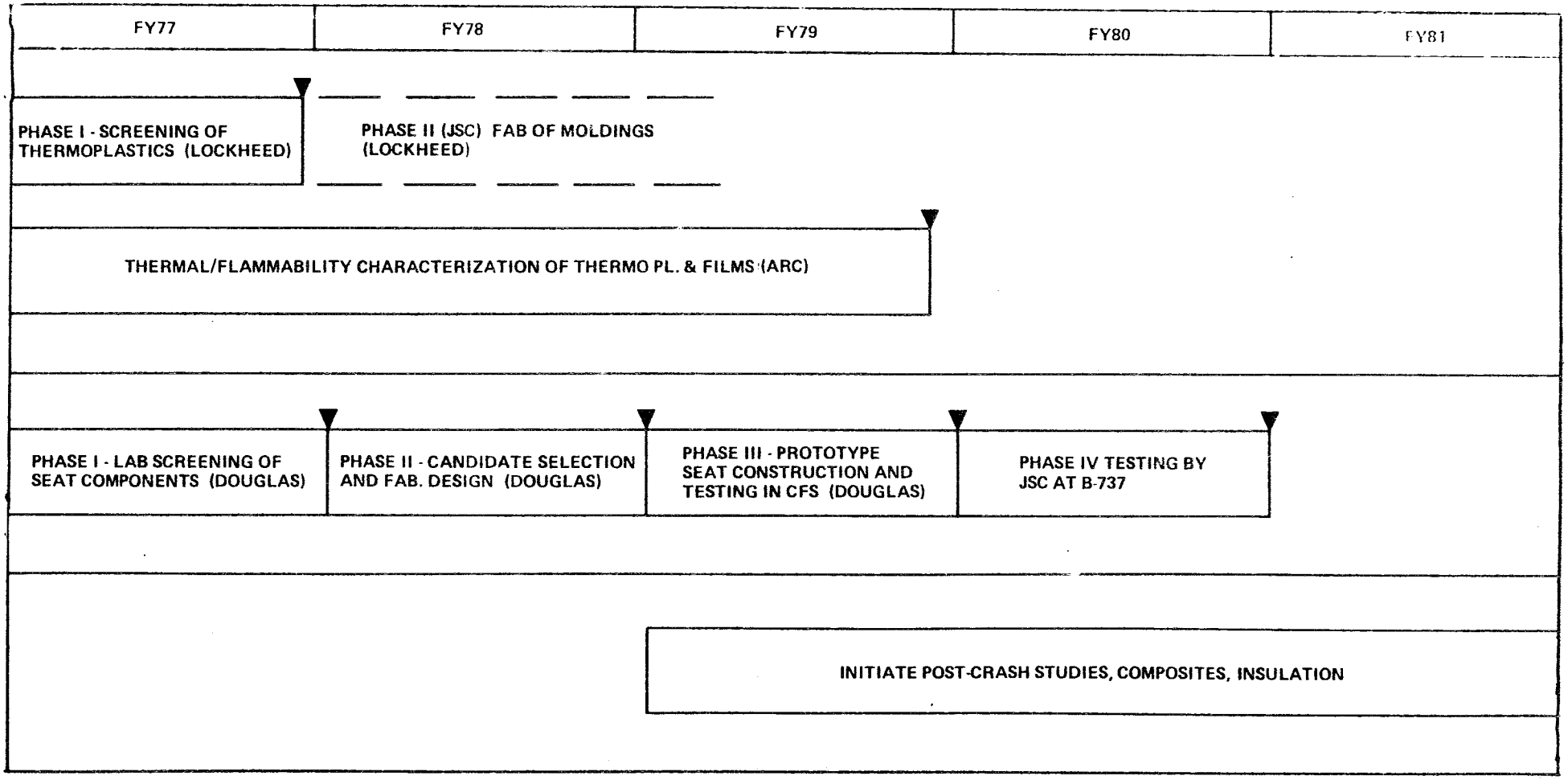
PROGRAM PLAN, FY '78

NO.	ACTIVITY	NET R&D $K		DURATION
1.	NAS2-7978, MOD. NO. 3, "DEVELOPMENT AND EVALUATION OF INTERIOR PANEL COMPOSITES AND FILMS," BOEING.	99(PY77)		9/77-9/78
2.	RFP 2-27132, "DEVELOPMENT AND EVALUATION OF INKS," BOEING.	99		1/78-1/79
3.	NAS2-9337, "DEVELOPMENT OF FIRE-RESISTANT AIRCRAFT SEAT," DOUGLAS.	99		10/77-10/78
4.	RFP 2- , "FLAME PROPAGATION, FLASHOVER TESTS OF DECORATIVE FILMS/INKS," BOEING.	32		3/78-3/79
5.	NAS-2-7980, "EVALUATION OF FIRE-RESISTANT EDGE SEALS FOR PANELS," HITCO.	35		3/78-3/79

PROGRAM OBJECTIVE: AERO MATERIALS & STRUCTURES SYSTEMS TECHNOLOGY
SPECIFIC OBJECTIVE: FIRE RESISTANT MATERIALS - FIREMEN



PROGRAM OBJECTIVE: AERO MATERIALS & STRUCTURES SYSTEMS TECHNOLOGY
SPECIFIC OBJECTIVE: FIRE RESISTANT MATERIALS - FIREMEN



AIRCRAFT PANELS

PROGRAM OBJECTIVES

OBJECTIVE

DETERMINE THERMAL-CHEMICAL AND FLAMMABILITY PROPERTIES OF TYPICAL STATE-OF-THE-ART AND OTHER ADVANCED AIRCRAFT INTERIOR COMPOSITE PANELS IN ORDER TO ASSESS THEIR RELATIVE FIRE RESISTANCE.

SCOPE

- DETERMINE PROPERTIES OF PANEL COMPONENTS AND PANELS
- THERMOMECHANICAL

  THERMOGRAVIMETRIC ANALYSIS
  DIFFERENTIAL THERMAL ANALYSIS

- PROCESSING

  TEMPERATURE, PRESSURE (MOLDING) AND CURE PARAMETERS

- FLAMMABILITY

  OXYGEN INDEX
  SMOKE EVOLUTION (NBS AND OSU APPARATUS)

- PHYSICAL-MECHANICAL

  FLATWISE TENSION
  COMPRESSION
  WEAR
  PEEL STRENGTH
  ELONGATION

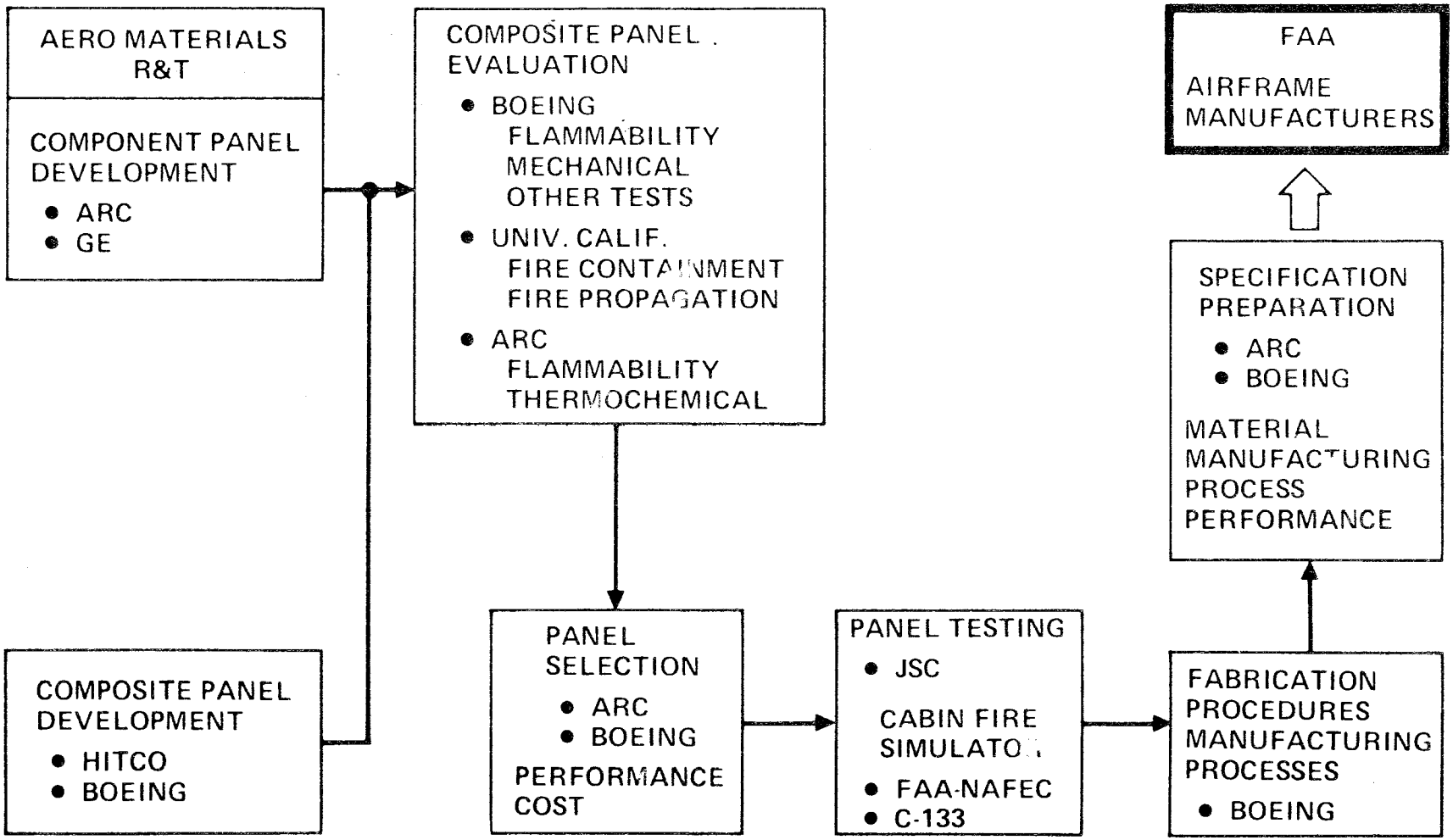
- THERMAL

  THERMAL EFFICIENCY
  HEAT RELEASE

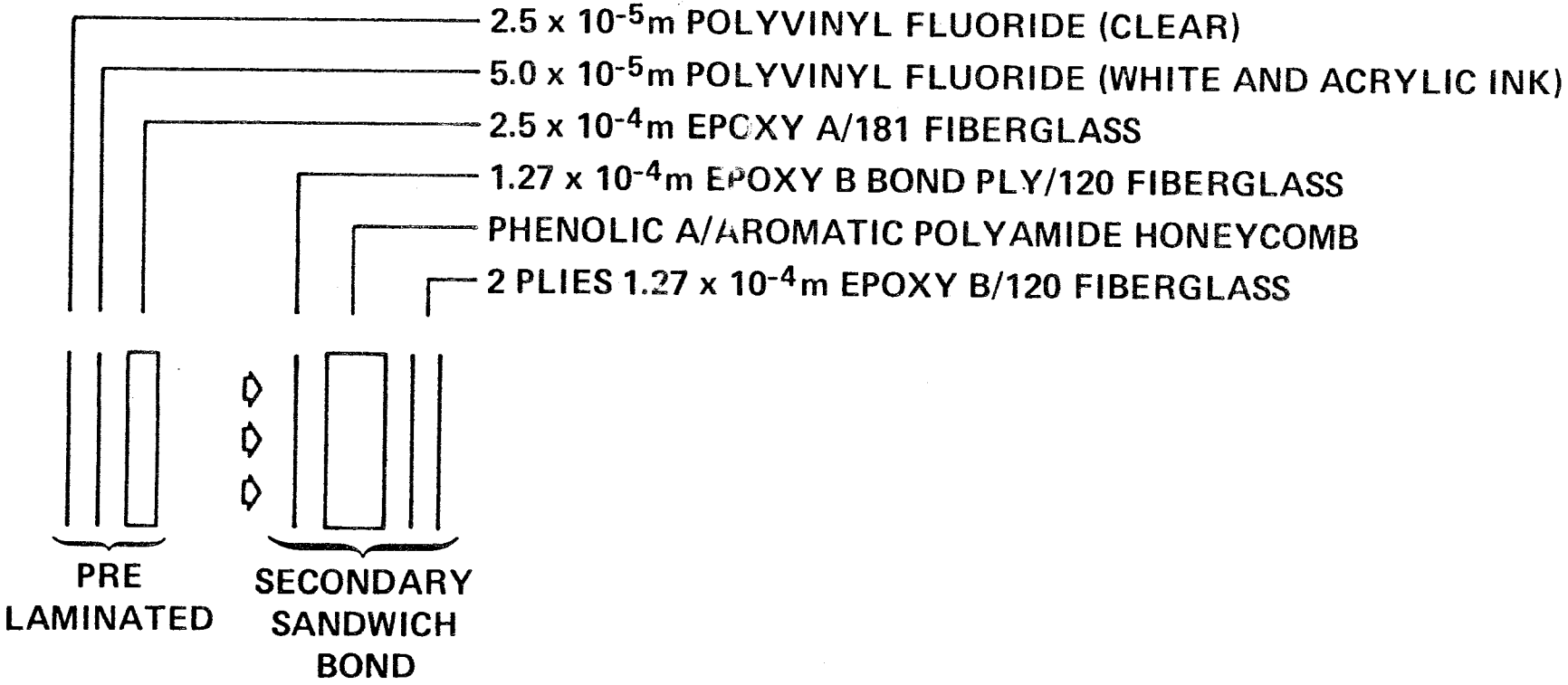
- TOXICITY

  APPARENT LETHAL CONCENTRATION
  TOXIC GAS EVOLUTION

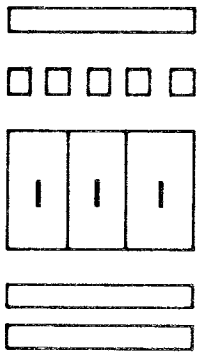
INTEGRATION OF COMPOSITE PANEL PROGRAM



BASELINE EPOXY PANEL CONFIGURATION

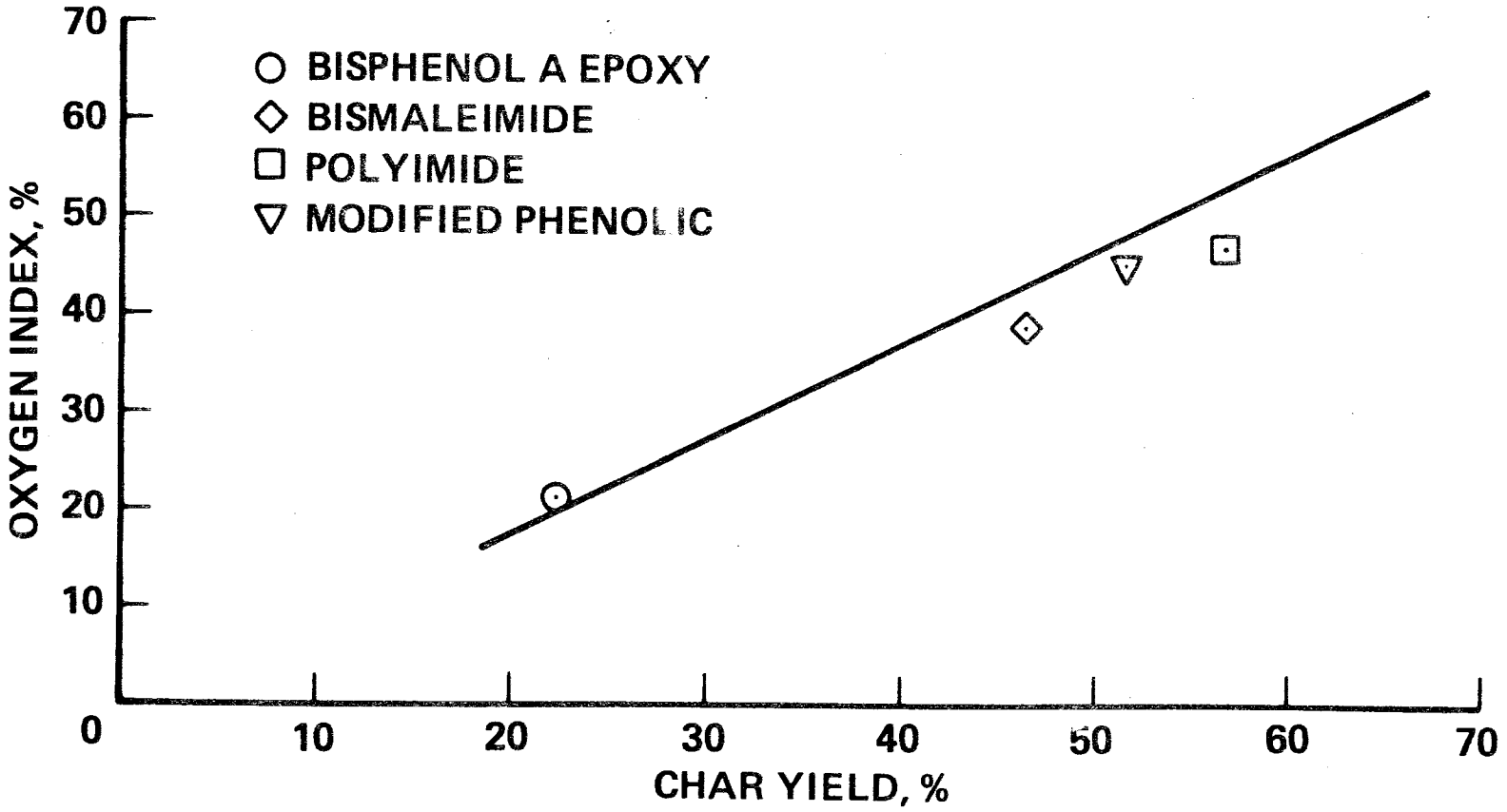


ADVANCED PANEL CONFIGURATION

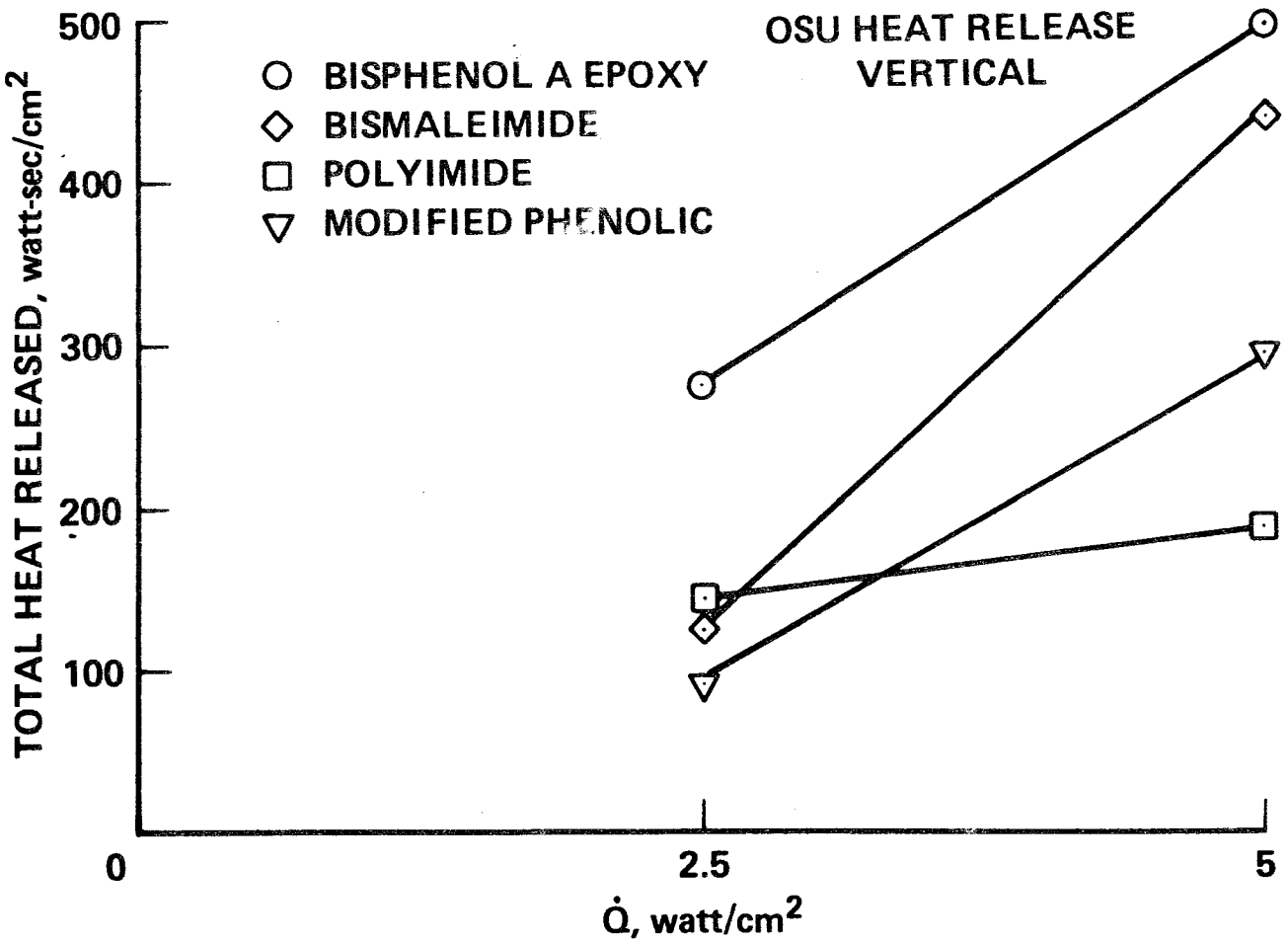


	BISMALEIMIDE	POLYIMIDE	PHENOLIC
	BISMALEIMIDE/181 FIBERGLASS BISMALEIMIDE/120 FIBERGLASS POLYIMIDE A ADHESIVE PHENOLIC A/ AROMATIC POLYAMIDE 29 kg/m^3 32 kg/m^3 QDO FOAM POLYIMIDE A ADHESIVE 2 PLIES BISMALEIMIDE/ 120 FIBERGLASS	POLYIMIDE B/181 FIBERGLASS POLYIMIDE B/120 FIBERGLASS POLYIMIDE C ADHESIVE POLYIMIDE C/ AROMATIC POLYAMIDE 48 kg/m^3 POLYIMIDE C ADHESIVE 2 PLIES POLYIMIDE B/ 120 FIBERGLASS	PHENOLIC B/181 FIBERGLASS PHENOLIC B/120 FIBERGLASS PHENOLIC A/ AROMATIC POLYAMIDE 48 kg/m^3 2 PLIES PHENOLIC B/ 120 FIBERGLASS
CURE CYCLE:			
PRESSURE	5.76 x 10^4 sec, 68.9 kN/m^2, 160°C	3.60 x 10^3 sec, 68.9 kN/m^2, 177°C	720 sec, 68.9 kN/m^2, 160°C
BOND	5.76 x 10^4 sec, 68.9 kN/m^2, 177°C	3.60 x 10^3 sec, 68.9 kN/m^2, 177°C	3.60 x 10^3 sec, 68.9 kN/m^2, 127°C

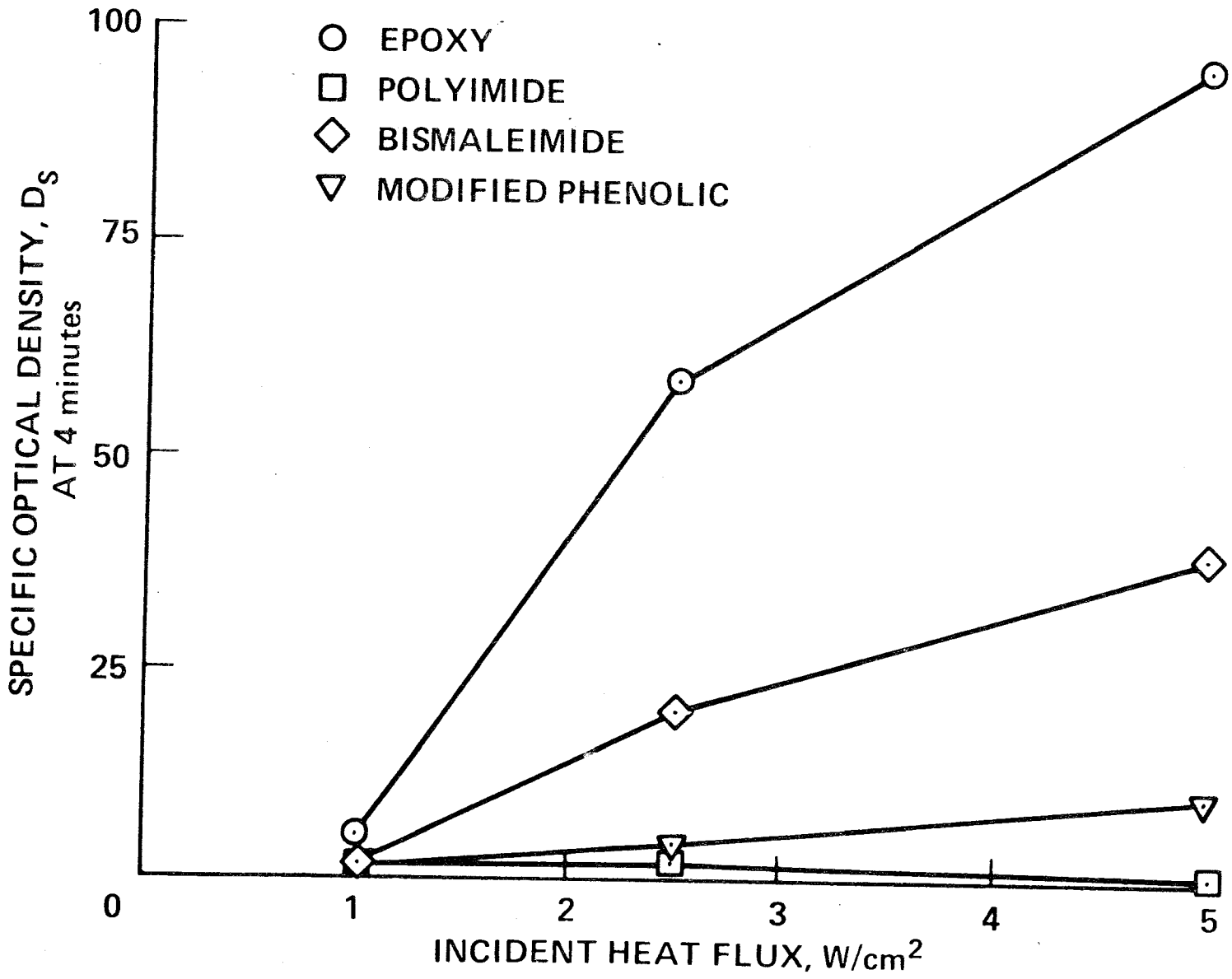
EFFECT OF CHAR YIELD ON OXYGEN INDEX OF FACESHEET LAMINATING RESINS



EFFECT OF HEAT FLUX ON TOTAL HEAT RELEASED FROM PANELS



EFFECT OF HEAT FLUX ON SMOKE DENSITY

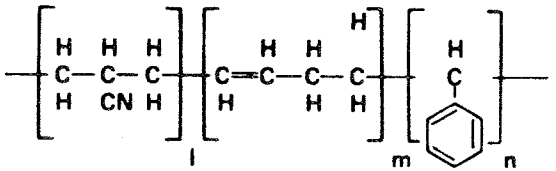
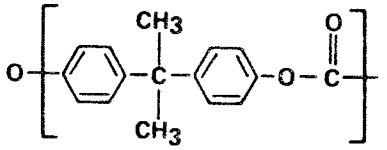
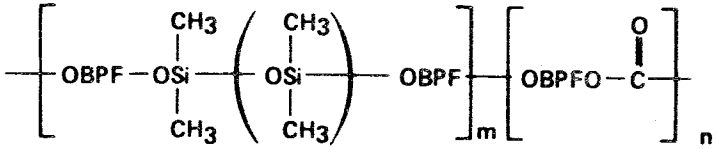
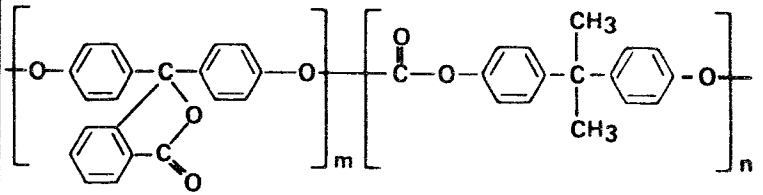
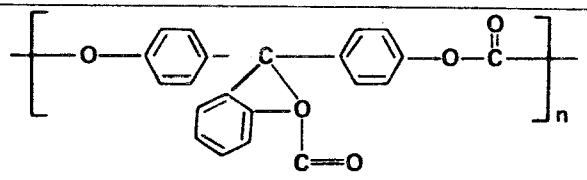


COMPARATIVE FLAMMABILITY PROPERTIES OF EPOXY AND PHENOLIC FACE SHEETS

	EPOXY	PHENOLIC
PROPENSITY TO BURN (LOI)		
FACE SHEET	29.0	100
ADHESIVE	27.7	53.5
SMOKE EMISSION (D_s, 4 min), NBS		
2.5 W/cm^2	62.8	2.5
5.0 W/cm^2	96.5	8.4
HEAT RELEASE (W-sec/cm^2) OSU		
$\dot{Q}$ 2.5 W/cm^2	--	120
$\dot{Q}$ 5.0 W/cm^2	500	320
FILM	**PVF/PVF**	**PVF/PC**
GAS RELEASE (HF mg/g)		
MONEL TUBE PYROLYSIS	74.1	27.5

THERMOPLASTICS

TYPICAL CHEMICAL STRUCTURES OF POLYMERS

SAMPLE NUMBER	SAMPLE DESCRIPTION	POLYMER	POLYMER STRUCTURE
18	SHEET	ACRYLONITRILE BUTADIENE STYRENE (ABS)	
14	SHEET	BISPHENOL A POLY-CARBONATE (BPAPC)	
19	FIRE RETARDANT; SHEET		
21	FILM; SOLVENT CAST FROM CHLOROFORM, 21% DMS	9,9 BIS (4-HYDROXYPHENYL) FLUORENE POLYCARBONATE-POLY (DIMETHYLSILOXANE) BLOCK POLYMER (BPFC-DMS)	
23	INJECTION MOLDED DISCS, 10.16 cm. DIA. by 0.3175 cm, 15% DMS		
27	UNCURED, MOLDING POWDER		
28	MOLDING POWDER, CURED AT 315.56°C		
30	80% MOLE PHENOLPHTHALEIN, FILM	PHENOLPHTHALEIN-BISPHENOL A POLYCARBONATE COPOLYMER (PH-BPAPC)	
31	70% MOLE PHENOLPHTHALEIN, FILM		
55	FILLED WITH 10% Al_2O_3, 5% TiO_2; FILM	PHENOLPHTHALEIN POLY-CARBONATE (PHPC)	

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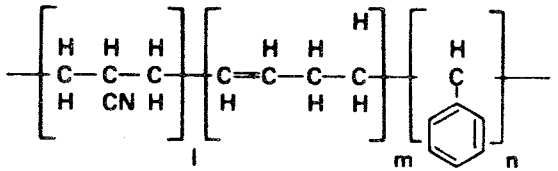
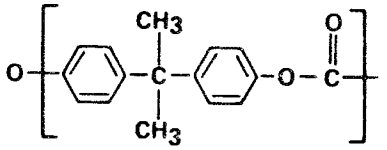
18	SHEET	ACRYLONITRILE BUTADIENE STYRENE (ABS)	
14	SHEET	BISPHENOL A POLY-CARBONATE (BPAPC)	
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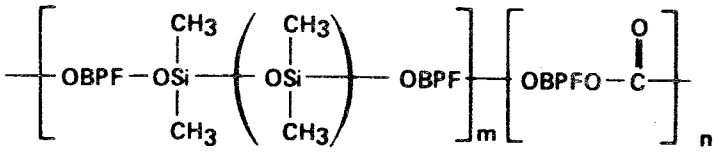
21	FILM; SOLVENT CAST FROM CHLOROFORM, 21% DMS	9,9 BIS (4-HYDROXYPHENYL) FLUORENE POLYCARBONATE-POLY (DIMETHYLSILOXANE) BLOCK POLYMER (BPFC-DMS)	
23	INJECTION MOLDED DISCS, 10.16 cm. DIA. by 0.3175 cm, 15% DMS		
27	UNCURED, MOLDING POWDER		
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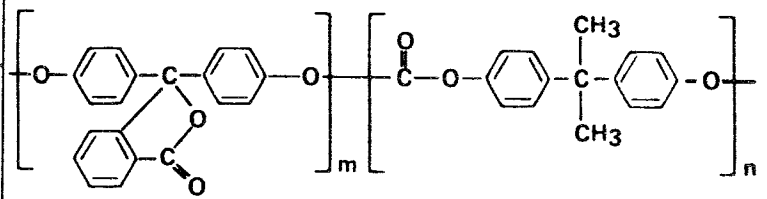
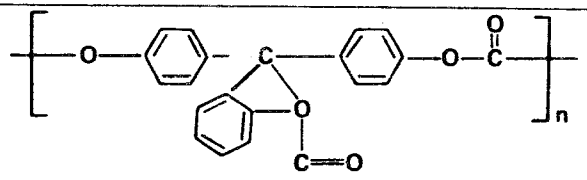
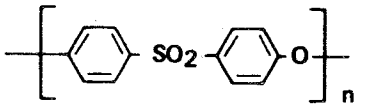
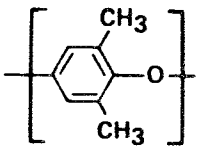
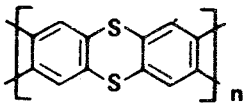
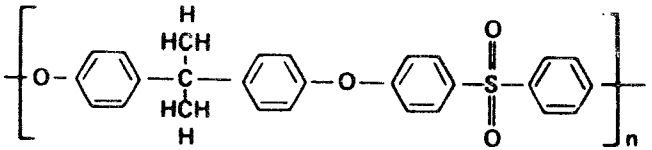
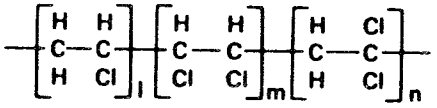
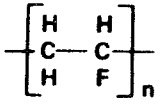
30	80% MOLE PHENOLPHTHALEIN, FILM	PHENOLPHTHALEIN-BISPHENOL A POLYCARBONATE COPOLYMER (PH-BPAPC)	
31	70% MOLE PHENOLPHTHALEIN, FILM		
55	FILLED WITH 10% Al_2O_3, 5% TiO_2; FILM	PHENOLPHTHALEIN POLY-CARBONATE (PHPC)	

TYPICAL CHEMICAL STRUCTURES OF POLYMERS

SAMPLE NUMBER	SAMPLE DESCRIPTION	POLYMER	POLYMER STRUCTURE
12 13 22	MOLDING PELLETS MOLDING PELLETS 0.0127 cm FILM	POLYETHER SULFONE (PES)	
16	MODIFIED; SHEET	POLYPHENYLENE OXIDE (PPO) (POLY-2,6-DIMETHYL-PHENYLENE OXIDE)	
11 20 24	MOLDING PELLETS MOLDED PART SECTION, 0.3175 cm THICK 0.3175 cm SHEET	POLYPHENYLENE SULFIDE (PPS)	
10 15	MOLDING PELLETS MODIFIED; SHEET	POLYARYLSULFONE (PAS)	
17 25	SHEET SHEET	CHLORINATED POLYVINYL CHLORIDE HOMOPOLYMER (CPVC)	 (l>m>n)
32	0.0051 cm FILM	POLYVINYL FLUORIDE (PVF)	
58	0.0127 cm FILM	POLYVINYLIDENE FLUORIDE (PVF_2)