MANUAL

NON-METALLIC MATERIALS - SELECTION AND APPLICATION

DEP 30.10.02.13-Gen.

August 1993

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

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Shell International Exploration and Production B.V. (SIEP)
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Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

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They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

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1) Operating companies having a Service Agreement with SIOP, SIEP, SIC or other Service Company. The use of DEPs by these Operating companies is subject in all respects to the terms and conditions of the relevant Service Agreement.

2) Other parties who are authorized to use DEPs subject to appropriate contractual arrangements.

3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

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Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of SIOP and SIEP, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of SIOP and SIEP. The copyright of DEPs vests in SIOP and SIEP. Users shall arrange for DEPs to be held in safe custody and SIOP or SIEP may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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1. INTRODUCTION

1.1 SCOPE

This DEP is a revision of that with the same number dated December 1984 and gives requirements and recommendations for the selection and application of non-metallic materials. The purpose is to present the advantages and limitations of non-metallic construction materials in order to promote their proper engineering and applications. However, for specific applications of these materials reference should be made to the appropriate publications, such as Manufacturers' literature/handbooks.

The included list of Manufacturer trade names cannot be fully comprehensive and the presence of a name in this list does not imply any preference or guarantee. Alternative Manufacturers may be used if approved by the Principal.

It should be checked whether there are local regulations that restrict the use or disposal of the selected materials.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorized by SIPM, the distribution of this document is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors nominated by them (i.e. the distribution code is "C" as defined in DEP 00.00.05.05-Gen.).

The DEP is intended for use in oil refineries, chemical plants, gas plants and, where applicable, in exploration and production facilities and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, installation, and commissioning or management of a project or operation of a facility. The Principal may sometimes undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorized to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (3).

2. GENERAL

2.1 MATERIAL DEFINITIONS

CARBON	-	bonded granular carbon body whose matrix has been treated at a temperature between 900 and 2400 °C.
CERAMIC	-	articles with a glazed or unglazed body of crystalline or partly crystalline structure or of glass, produced from essentially inorganic, non-metallic substances and formed either from a molten mass solidified on cooling, or simultaneously or subsequently matured by the action of heat. (ASTM C 242).
CHEMICAL-RESISTANT RESIN MORTAR	-	an intimate mixture of liquid resinous material, selected filler material and setting agent forming a trowellable mortar that hardens by chemical reaction. (ASTM C 904).
COATING	-	a liquid, liquifiable or mastic compound which, after applying as a thin layer, converts into an adherent, solid and protective, decorative or functional film. (ASTM D 16).
ELASTOMER	-	polymer material with similar properties to rubber. (ASTM D 1566). NOTE: This term should not be used in standards for rubber.
ENAMEL	-	paint characterized by the ability to form a very smooth film. (ASTM D 16). BS 2015 makes a distinction between enamel paint and vitreous enamel.
GLASS	-	inorganic fusion product that has cooled to a rigid condition without crystallizing. (ASTM C 162).
GRAPHITE	-	bonded granular carbon body whose matrix has been treated at a temperature above 2400 °C; the matrix is thermally stable below that temperature.
HYDRAULIC CEMENT	-	cement that sets and hardens by chemical interaction with water, and is capable of doing so under water.(ASTM C 219).
LACQUER	-	a coating composition forming a synthetic thermoplastic film primarily by evaporation of the organic solvent.(ASTM D 16).
PAINT	-	a pigmented coating. (ASTM D 16).
PORCELAIN	-	glazed or unglazed vitreous ceramic whiteware matured like ceramic and glazed together in the same firing operation. (ASTM C 242).
QUARTZ/SILICA	-	glass made either by flame hydrolysis of silicon tetrachloride or by melting silica, usually in the form of granular quartz, i.e. fused silica. (ASTM C 162).
REFRACTORIES	-	non-metallic materials with chemical and physical properties applicable for structures and system

components exposed to environments above 538 °C. (ASTM C 71).

RUBBER	-	a material capable of quickly and forcibly recovering from all deformations. It can be modified to be essentially insoluble, but it can swell in boiling solvents, e.g. benzene, methyl ethyl ketone and ethanol/toluene azeotrope. Rubber in its modified state, free of diluents, stretched at 18 to 29 °C and held for 1 minute before release, retracts within 1 minute to less than 1.5 or 2 times its original length. (ASTM D 1566).
STONE WARE	-	vitreous or semi-vitreous ceramics of fine texture made primarily from non-refractory fire clay. (ASTM C 242).
THERMOPLASTIC MATERIAL	-	a plastic that repeatedly will soften by heating and harden by cooling within a temperature range characteristic for the plastic. In the softened state it can be shaped by flow into articles, e.g. by moulding/extrusion. (ASTM D 883).
THERMOSETTING MATERIAL	-	a plastic which is substantially infusible and insoluble after curing by heat or other means. (ASTM D 883).
VARNISH	-	a liquid composition which, after applying as a thin layer, converts into a transparent or translucent solid film. (ASTM D 16).

2.2 ABBREVIATIONS

Abbreviations are commonly used to describe non-metallic materials. A number of abbreviations have been standardized in various codes, e.g. ASTM D1418 and D1600, ISO 1043 and ISO 1629. A number of abbreviations used in this DEP are not yet covered by these codes.

Appendix 1 gives a survey of the most common abbreviations.

2.3 CHEMICAL RESISTANCE

A survey of the chemical resistance of non-metallic construction materials in a variety of chemical environments is given in Appendix 2.

The chemical resistance can be determined by various methods and depends on factors such as exposure time, temperature, test properties and evaluation criteria. An indication of such criteria is as shown below:

Property (NOTE 1)	Unit	Resistant	Limited resistance	Not resistant
Dimensional change	%	< 1	1-3	> 3
Weight change (NOTE 2)	%	< 2	2-6	> 6
Tensile strength retention	%	> 80	80-60	< 60

NOTE 1: Exposure time: 28 days.

NOTE 2: For rubbers, respectively < 10, 10 - 25, > 25.

The effects of environmental stress cracking and permeability of foil materials have not been considered in detail. Environmental stress cracking of some thermoplastics may occur upon even only short direct contact with surface active agents, e.g. PE and PP with detergents and wetting agents, PMMA with fatty acids, and PS with alcohols.

The colours used in Appendix 2 have the following meaning:

green - resistant
yellow - limited resistance
red - not resistant
white - no data available

The maximum working temperature is determined by the nature of the material itself (i.e. without environmental, physical or chemical effects) and does not relate to the maximum working temperature when in any of the listed chemical environments.

A figure in the green squares, if multiplied by 10, indicates the maximum allowable working temperature for the material in the particular chemical environment. Only proven maximum temperatures have been included. If no figure is given, the experience thus far does not allow the stating of a fixed maximum temperature.

Shaded green squares refer to reinforced materials, for which the chemical environment may affect the reinforcing material but not affect the base material. Other reinforcing materials should be considered for these cases.

2.4 MECHANICAL AND PHYSICAL PROPERTIES

Appendix 3 lists the mechanical, thermal and other properties of a number of non-metallic construction materials.

A range of values or an average value is generally given since the reported values for the same material often vary substantially and are also influenced by the chemical environment. Hence for accurate design calculations the value for the actual material should be used.

The figures represent only the behaviour of specially prepared test samples under various standard test conditions. The influence of all parameters is not reflected, e.g. rate of extension on tensile strength. The figures are intended for comparison only.

For calculations, the figures should be corrected with an appropriate safety factor.

The design stress should be determined by the lesser value of the following criteria:

- average stress required to produce rupture in 10^5 hours at design temperature, with a safety factor of 1.5 - 2.0
- average stress required to produce a total creep strain of 2 - 3% in 10^5 hours at design temperature.

2.5 IDENTIFICATION OF PLASTICS AND RUBBERS

Appendix 4 gives a scheme for the identification of common plastics and rubbers. This scheme is based on flame tests. The best results are obtained when the tests are compared with a known sample.

The flammability characteristics of materials may change considerably by treating with flame retardant additives.

Appropriate measures should be taken to prevent the possible emission of hazardous gases.

NOTE: In using Appendix 4, a preliminary mechanical test may be made by attempting to cut a thin strip off the sample. If powdery chips are formed it indicates a thermosetting material. If a coherent sliver is obtained this indicates a thermoplastic material (this can be further confirmed by applying a hot metallic rod, which will cause melting of the sample).

2.6 ENGINEERING PLASTICS

Engineering plastics are used (relatively infrequently) in special applications for their high mechanical and physical properties.

Appendix 5 lists a number of engineering plastics with their main mechanical and physical properties. These figures may change as some of the engineering plastics become further developed.

2.7 TRADE NAMES AND MANUFACTURERS

Appendix 6 lists trade names in alphabetical order, with the Manufacturer's name and country of origin also shown. The listing is not comprehensive and a name does not imply a preference (see 1.1).

3. REFERENCES

Specific applications of non-metallic materials are dealt with in the following separate publications.

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.

AMERICAN STANDARDS

Standard terminology relating to refractories	ASTM C 71
Standard terminology relating to glass and glass products	ASTM C 162
Standard terminology relating to hydraulic cement	ASTM C 219
Standard terminology relating to ceramic whitewares and related products	ASTM C 242
Standard terminology relating to chemical-resistant non-metallic materials	ASTM C 904
Standard terminology relating to paint, varnish, lacquer and related products	ASTM D 16
Standard terminology relating to plastics	ASTM D 883
Practice for rubber and rubber latices - Nomenclature	ASTM D 1418
Standard terminology relating to rubber	ASTM D 1566
Abbreviated terms relating to plastics	ASTM D 1600

Issued by:
American Society for Testing and Materials
1916 Race St., Philadelphia
Pa. 19103, USA.

BRITISH STANDARDS

Glossary of paint terms	BS 2015

Issued by:
British Standards Institution
2 Park Street
London W1A 2BS
England.

INTERNATIONAL STANDARDS

Plastics - Symbols	ISO 1043
Rubber and lattices - Nomenclature	ISO 1629

Issued by:
Central Secretariat of ISO

1, Rue de Varembé
1211 Geneva 20
Switzerland.

APPENDICES

APPENDIX 1 ABBREVIATIONS

ABR	acrylate-butadiene rubber
ABS	acrylonitrile-butadiene-styrene
ASA	acrylonitrile-styrene-acrylate
BR	butadiene rubber
BS	butadiene-styrene
CA	cellulose acetate
CAB	cellulose acetate butyrate
CAP	cellulose acetate propionate
CFM	polychlorotrifluoroethylene
CM	chloropolyethylene
CP	cellulosepropionate
CPE	chlorinated polyethylene
CPVC	chlorinated polyvinylchloride
CR	polychloroprene rubber
CSM	chlorosulphonated polyethylene
CSP	chlorosulphonated polyethylene (preference for CSM)
DAP	diallyl phthalate
ECTFE	ethylenechlorotrifluoroethylene
EP	epoxide, epoxies
EPDM	ethylene propylene diene terpolymer
EPM	ethylene propylene rubber
EPS	expanded polystyrene
ETFE	ethylene-tetrafluoroethylene
EVA	ethylene-vinylacetate
EVAC	ethylene-vinylacetate
EVAL	ethylenevinylalcohol
FEP	fluorinated ethylene propylene
FKM	fluoro rubber of the polymethylene type
FRP	fibre reinforced plastic (thermosetting resin)
GR-A	polybutadiene acrylonitrile rubber
GRE	glass fibre reinforced epoxy
GR-I	butyl rubber, polyisobutylene isoprene rubber
GR-N	nitrile rubber, nitrile butadiene rubber, polybutadiene acrylonitrile rubber
GRP	glass fibre reinforced plastic (thermosetting resin)
GR-S	styrene butadiene rubber, polybutadiene styrene rubber
GRUP	glass fibre reinforced polyester (unsaturated)
IIR	polyisobutylene isoprene rubber, butyl rubber
IM	polyisobutene rubber
IR	polyisoprene rubber
MF	melamine-formaldehyde
NBR	polybutadiene acrylonitrile rubber, nitrile butadiene rubber, nitrile rubber
NR	natural rubber
PA	polyamide
PAI	polyaramide-imide
PAN	polyacrylonitrile
PB	polybutylene

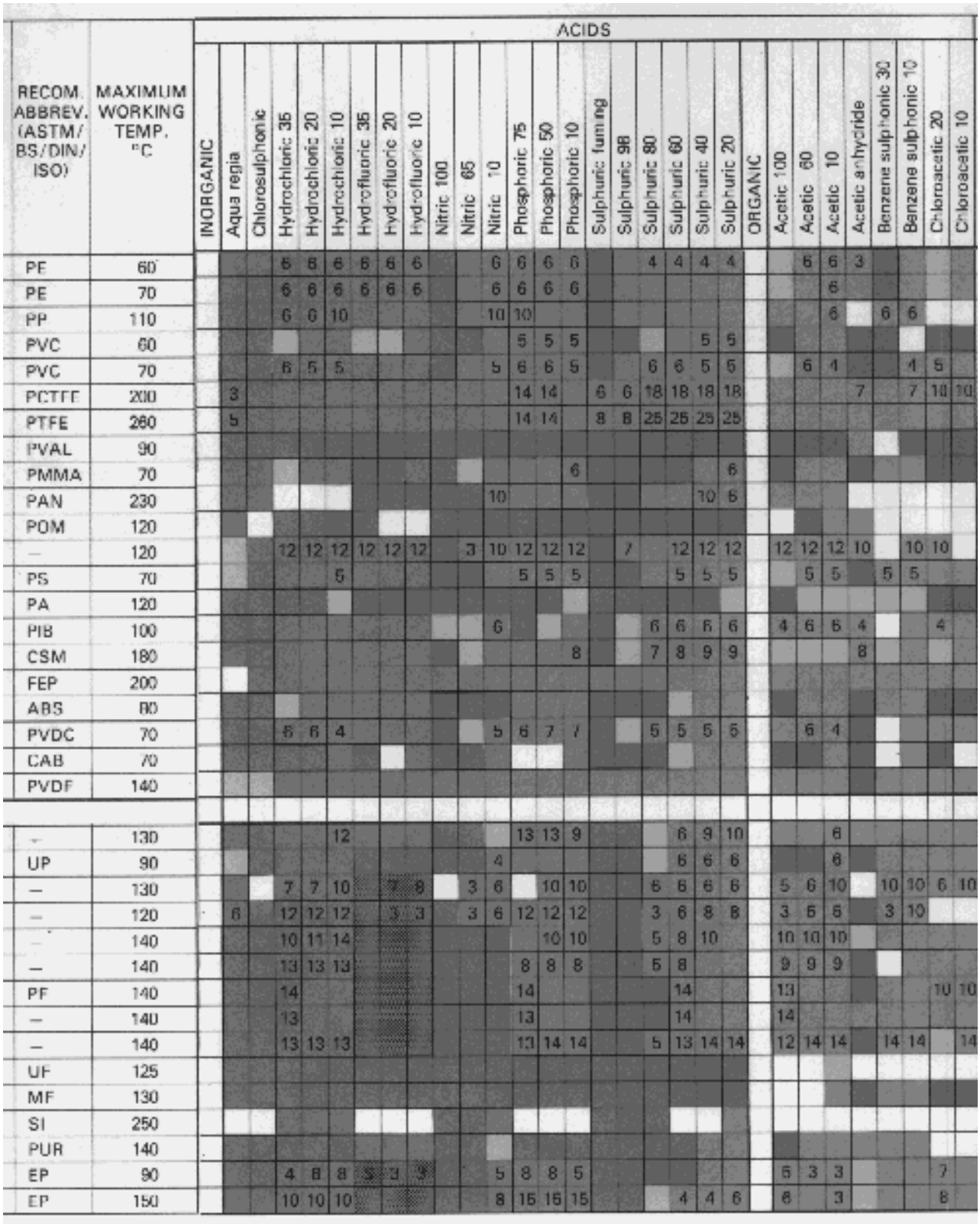
PBTP	polybutylene terephthalate
PC	polycarbonate
PCTFE	polyethylenechlorotrifluoroethylene
PE	polyethylene
PEEK	polyetheretherketone
PEI	polyetherimide
PES	polyethersulfone
PESU	polyethersulfone (prefered abbreviation is PES)
PETP	polyethylene terephthalate
PF	phenol formaldehyde
PFA	perfluoroalkoxy copolymer
PFEP	fluorinated ethylene propylene
PI	polyimide
PIB	polyisobutylene
PMMA	polymethyl methacrylate
POM	polyoxymethylene, polyformaldehyde
PP	polypropylene
PPO	polyphenylene oxide
PPS	polyphenylene sulfide
PS	polystyrene
PSU	polysulfone
PTFE	polytetrafluoroethylene
PUR	polyurethane
PVAC	polyvinyl acetate
PVAL	polyvinyl alcohol
PVC	polyvinyl chloride
PVCC	chlorinated polyvinyl chloride
PVDC	polyvinylidene chloride
PVDF	polyvinylidene fluoride
PVF	polyvinyl fluoride
SAN	styrene acrylonitrile
SB	styrene butadiene
SBR	styrene butadiene rubber, polybutadiene styrene rubber
SI	silicone
TFE	polytetrafluoroethylene
TPE	thermoplastic elastomers
TPU	thermoplastic polyurethane
UF	ureum-formaldehyde
UP	unsaturated polyester
VAC	vinylacetate
VC	vinylchloride
XPS	extruded polystyrene

APPENDIX 2 CHEMICAL RESISTANCE OF NON-METALLIC MATERIALS
(see section 2.3 for legend and explanation)

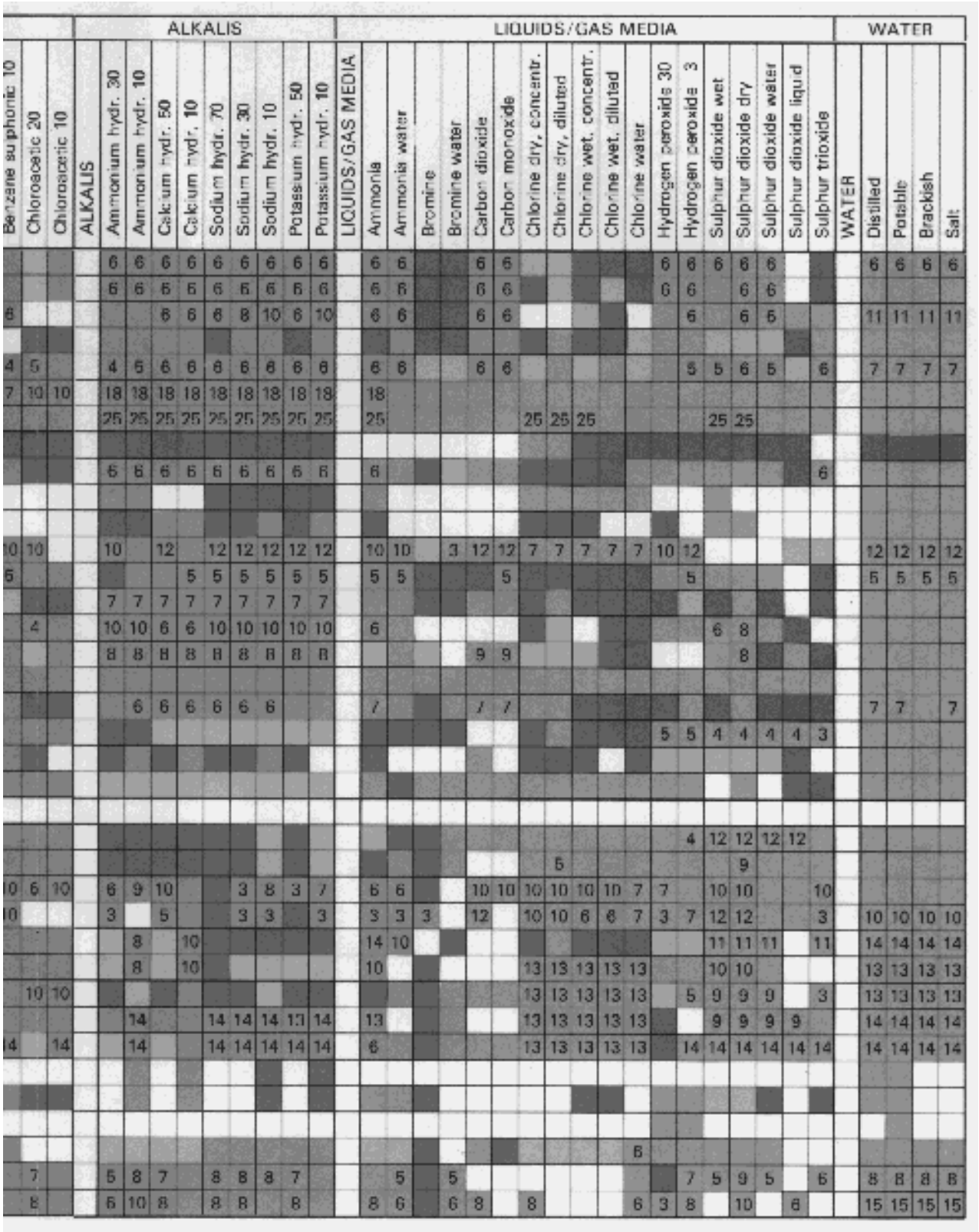
CLASS	No.	CHEMICAL CLASSIFICATION	SOME TRADE NAMES	RE AB (A BS
THERMOPLASTIC MATERIALS	1.1	Polyethylene, low density	Carlona, Lupolen	P
	.2	Polyethylene, high density	Carlona, Lupolen	P
	.3	Polypropylene	Carlona P, Moplen, Propathene	P
	.4	Polyvinyl chloride, plasticized	Mipolam	P
	.5	Polyvinyl chloride, rigid	Carina, Vinidur, Geon	P
	.6	Polychlorotrifluoroethylene	Kel-F, Hostaflon-C	P
	.7	Polytetrafluoroethylene	Teflon TFE, Hostaflon, Fluon	P
	.8	Polyvinyl alcohol	Elvanol, Mowiol	P
	.9	Polymethyl methacrylate	Perspex, Plexiglas	P
	.10	Polyacrylonitrile	Orlon, PAN	P
	.11	Polyoxymethylene/Polyformaldehyde	Delrin, Celcon	P
	.12	Polydichloromethyloxetane	Penton*	–
	.13	Polystyrene	Carinex, Polystyrol	P
	.14	Polyamide	Akulon, Nylon, Rilsan	P
	.15	Polyisobutylene	Rhepanol, Oppanol	P
	.16	Chlorosulphonated polyethylene	Hypalon	C
	.17	Fluorinated ethylene propylene	Teflon FEP	F
	.18	Acrylonitrile butadiene styrene	Cycolac, Kralastic	A
	.19	Polyvinylidene chloride	Saran	P
	.20	Cellulose acetate butyrate	Cellidor B, Tenite butyrate	C
	.21	Polyvinylidene fluoride	Solef, Kynar	P
THERMOSETTING MATERIALS	2.1	Polyesters, saturated	Terylene, Dacron	–
	.2	Polyesters, unsaturated, gen. purp.	Palatal, Lamellon	U
	.3	Polyesters, unsaturated, spec. purp.	Atlac, Crystic	–
	.4	Polyesters, unsaturated, chlorinated	Hetron, H.E.T.	–
	.5	Phenolics	Kera **, Bornum Harz 5102/6101, Keebush M/G	–
	.6	Phenolics, modified	Haveg 31, Bornum Harz 5104, Kera A	–
	.7	Phenol formaldehydes	Haveg 41	P
	.8	Phenol furfurals	Haveg 60, Keebush H	–
	.9	Furanes	Haveg 61, Bornum Harz 6201, Kera FU	–
	.10	Ureas	Plastopal, Plaskon	U
	.11	Melamines	Formica, Ultrapas	M
	.12	Silicones	Baysilon	S
	.13	Polyurethanes	Durethan U	P
	.14	Epoxies, cold cured	Epikote (Epon), Araldit	E
	.15	Epoxies, hot cured	Epikote (Epon), Araldit	E

* Production has been ceased

** SP/F/V



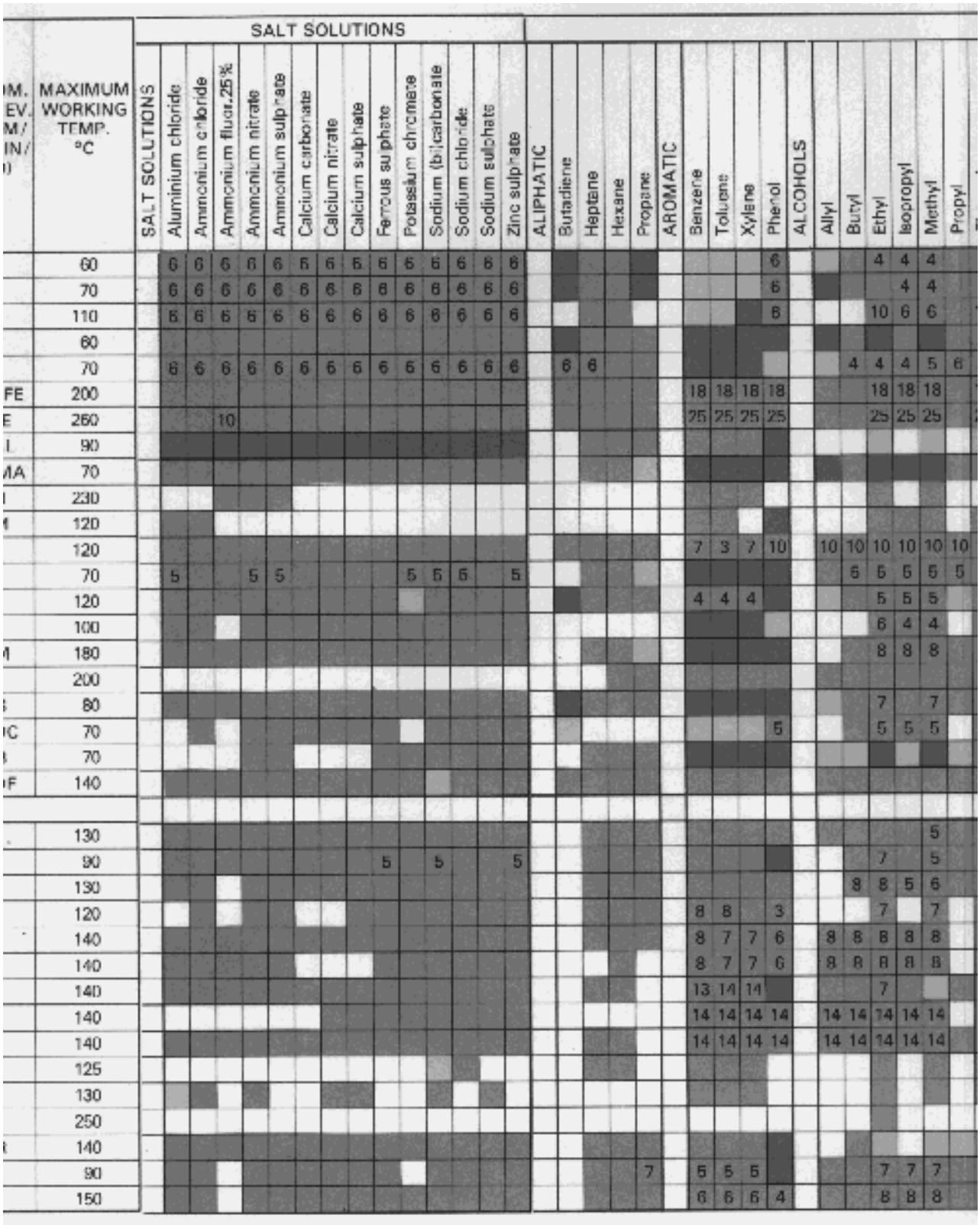
RECOM. ABBREV. (ASTM/ BS/DIN/ ISO)	MAXIMUM WORKING TEMP. °C	ACIDS																																				
		INORGANIC																							ORGANIC														
			Aqua regia	Chlorosulphonic	Hydrochloric 35	Hydrochloric 20	Hydrochloric 10	Hydrofluoric 35	Hydrofluoric 20	Hydrofluoric 10	Nitric 100	Nitric 65	Nitric 10	Phosphoric 75	Phosphoric 50	Phosphoric 10	Sulphuric fuming	Sulphuric 98	Sulphuric 80	Sulphuric 60	Sulphuric 40	Sulphuric 20		Acetic 100	Acetic 60	Acetic 10	Acetic anhydride	Benzene sulphonic 30	Benzene sulphonic 10	Chloroacetic 20	Chloroacetic 10								
PE	60				6	6	6	6	6	6			6	6	6	6			4	4	4	4			6	6	3												
PE	70				6	6	6	6	6	6			6	6	6	6										6												
PP	110				6	6	10						10	10												6		6	6									
PVC	60													5	5	5					5	5																
PVC	70				6	5	5						5	6	6	5			6	6	5	5			6	4			4	5							
PCTFE	200		3											14	14		6	6	18	18	18	18					7		7	10	10						
PTFE	260		5											14	14		8	8	25	25	25	25															
PVAL	90																																					
PMMA	70															6						6																
PAN	230												10								10	6															
POM	120																																					
—	120				12	12	12	12	12	12		3	10	12	12	12		7		12	12	12		12	12	12	10		10	10								
PS	70						5							5	5	5				5	5	5			5	5		5	5									
PA	120																																					
PIB	100												6						6	6	6	6		4	6	6	4			4								
CSM	180															8			7	8	9	9					8											
FEP	200																																					
ABS	80																																					
PVDC	70				6	6	4						5	6	7	7			5	5	5	5			6	4											
CAB	70																																					
PVDF	140																																					
—	130						12							13	13	9				6	9	10				6												
UP	90												4							6	6	6				6											
—	130				7	7	10		7	8		3	6		10	10			6	6	6	6		5	6	10		10	10	6	10							
—	120		6		12	12	12		3	3		3	6	12	12	12			3	6	8	8		3	6	5		3	10								
—	140				10	11	14								10	10			5	8	10			10	10	10											
—	140				13	13	13							8	8	8			5	8				9	9	9											
PF	140				14									14						14				13						10	10						
—	140				13									13						14				14													
—	140				13	13	13							13	14	14			5	13	14	14		12	14	14		14	14		14						
UF	125																																					
MF	130																																					
SI	250																																					
PUR	140																																					
EP	90				4	8	8	5	3	3			5	8	8	5								5	3	3				7							
EP	150				10	10	10						8	15	15	15				4	4	6		8		3				8							

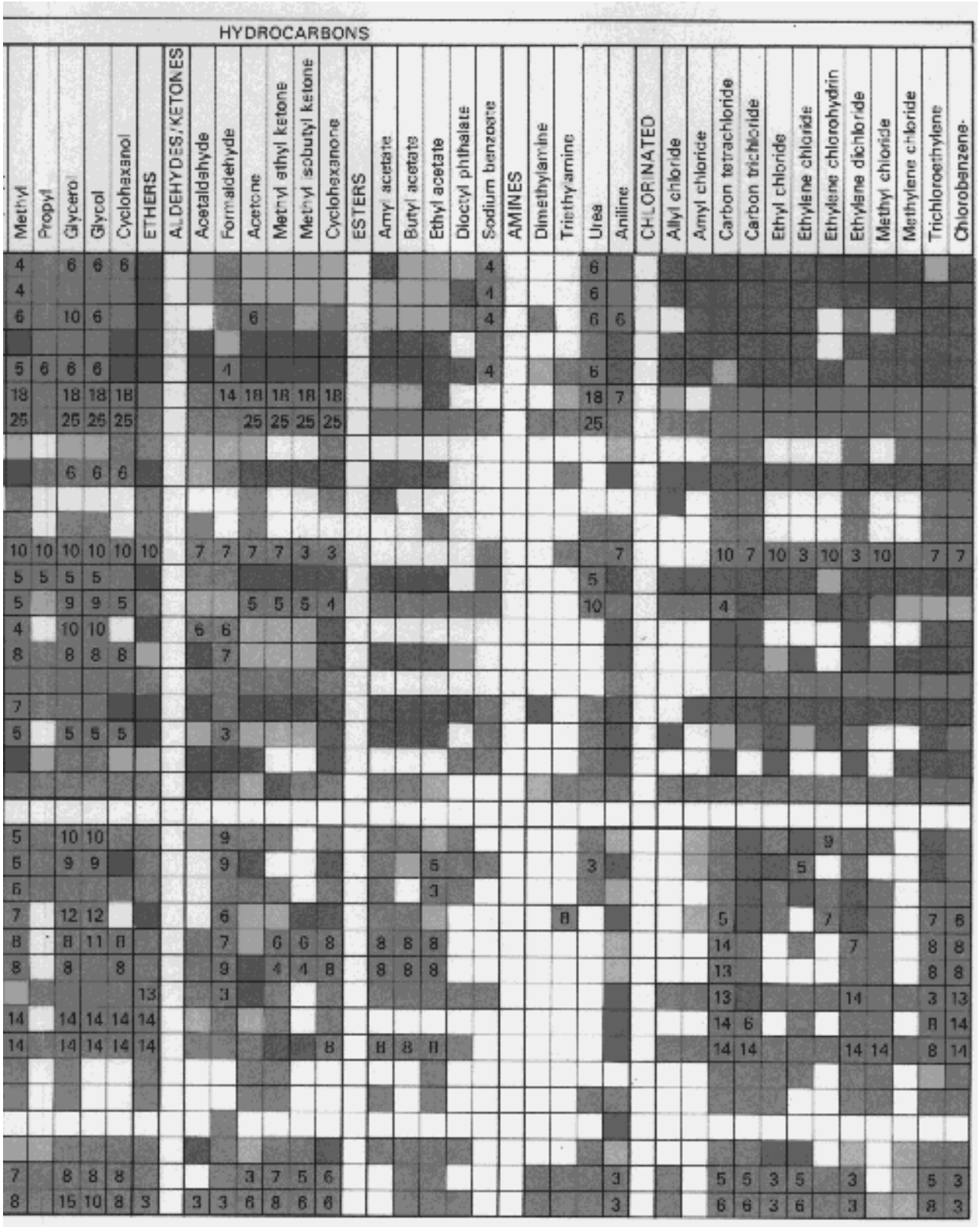

ALKALIS
LIQUIDS/GAS MEDIA
WATER
Benzene sulphonic 10
Chloroacetic 20
Chloroacetic 10
ALKALIS
Ammonium hydr. 30
Ammonium hydr. 10
Calcium hydr. 50
Calcium hydr. 10
Sodium hydr. 70
Sodium hydr. 30
Sodium hydr. 10
Potassium hydr. 50
Potassium hydr. 10
LIQUIDS/GAS MEDIA
Ammonia
Ammonia water
Bromine
Bromine water
Carbon dioxide
Carbon monoxide
Chlorine dry, concentr.
Chlorine dry, diluted
Chlorine wet, concentr.
Chlorine wet, dilutad
Chlorine water
Hydrogen peroxide 30
Hydrogen peroxide 3
Sulphur dioxide wet
Sulphur dioxide dry
Sulphur dioxide water
Sulphur dioxide liquid
Sulphur trioxide
WATER
Distilled
Potable
Brackish
Salt

APPENDIX 2 CHEMICAL RESISTANCE OF NON-METALLIC MATERIALS (cont'd)
(see section 2.3 for legend and explanation)

CLASS	No.	CHEMICAL CLASSIFICATION	SOME TRADE NAMES	RECOM. ABBREV. (ASTM/ BS/DIN/ ISO)
THERMOPLASTIC MATERIALS	1.1	Polyethylene, low density	Carlona, Lupolen	PE
	.2	Polyethylene, high density	Carlona, Lupolen	PE
	.3	Polypropylene	Carlona P, Moplen, Propathene	PP
	.4	Polyvinyl chloride, plasticized	Mipolam	PVC
	.5	Polyvinyl chloride, rigid	Carina, Vinidur, Geon	PVC
	.6	Polychlorotrifluoroethylene	Kel-F, Hostaflon-C	PCTFE
	.7	Polytetrafluoroethylene	Teflon TFE, Hostaflon, Fluon	PTFE
	.8	Polyvinyl alcohol	Elvanol, Mowiol	PVAL
	.9	Polymethyl methacrylate	Perspex, Plexiglas	PMMA
	.10	Polyacrylonitrile	Orlon, PAN	PAN
	.11	Polyoxymethylene/Polyformaldehyde	Delrin, Celcon	POM
	.12	Polydichloromethyloxetane	Penton*	—
	.13	Polystyrene	Carinex, Polystyrol	PS
	.14	Polyamide	Akulon, Nylon, Rilsan	PA
	.15	Polyisobutylene	Rhepanol, Oppanol	PIB
	.16	Chlorosulphonated polyethylene	Hypalon	CSM
	.17	Fluorinated ethylene propylene	Teflon FEP	FEP
	.18	Acrylonitrile butadiene styrene	Cycolac, Kralastic	ABS
	.19	Polyvinylidene chloride	Saran	PVDC
	.20	Cellulose acetate butyrate	Cellidor B, Tenite butyrate	CAB
	.21	Polyvinylidene fluoride	Solef, Kynar	PVDF
THERMOSETTING MATERIALS	2.1	Polyesters, saturated	Terylene, Dacron	—
	.2	Polyesters, unsaturated, gen. purp.	Palatal, Lamellon	UP
	.3	Polyesters, unsaturated, spec. purp.	Atlac, Crystic	—
	.4	Polyesters, unsaturated, chlorinated	Hetron, H.E.T.	—
	.5	Phenolics	Kera **, Bornum Harz 5102/6101, Keebush M/G	—
	.6	Phenolics, modified	Haveg 31, Bornum Harz 5104, Kera A	—
	.7	Phenol formaldehydes	Haveg 41	PF
	.8	Phenol furfurals	Haveg 60, Keebush H	—
	.9	Furanes	Haveg 61, Bornum Harz 6201, Kera FU	—
	.10	Ureas	Plastopal, Plaskon	UF
	.11	Melamines	Formica, Ultrapas	MF
	.12	Silicones	Baysilon	SI
	.13	Polyurethanes	Durethan U	PUR
	.14	Epoxies, cold cured	Epikote (Epon), Araldit	EP
	.15	Epoxies, hot cured	Epikote (Epon), Araldit	EP

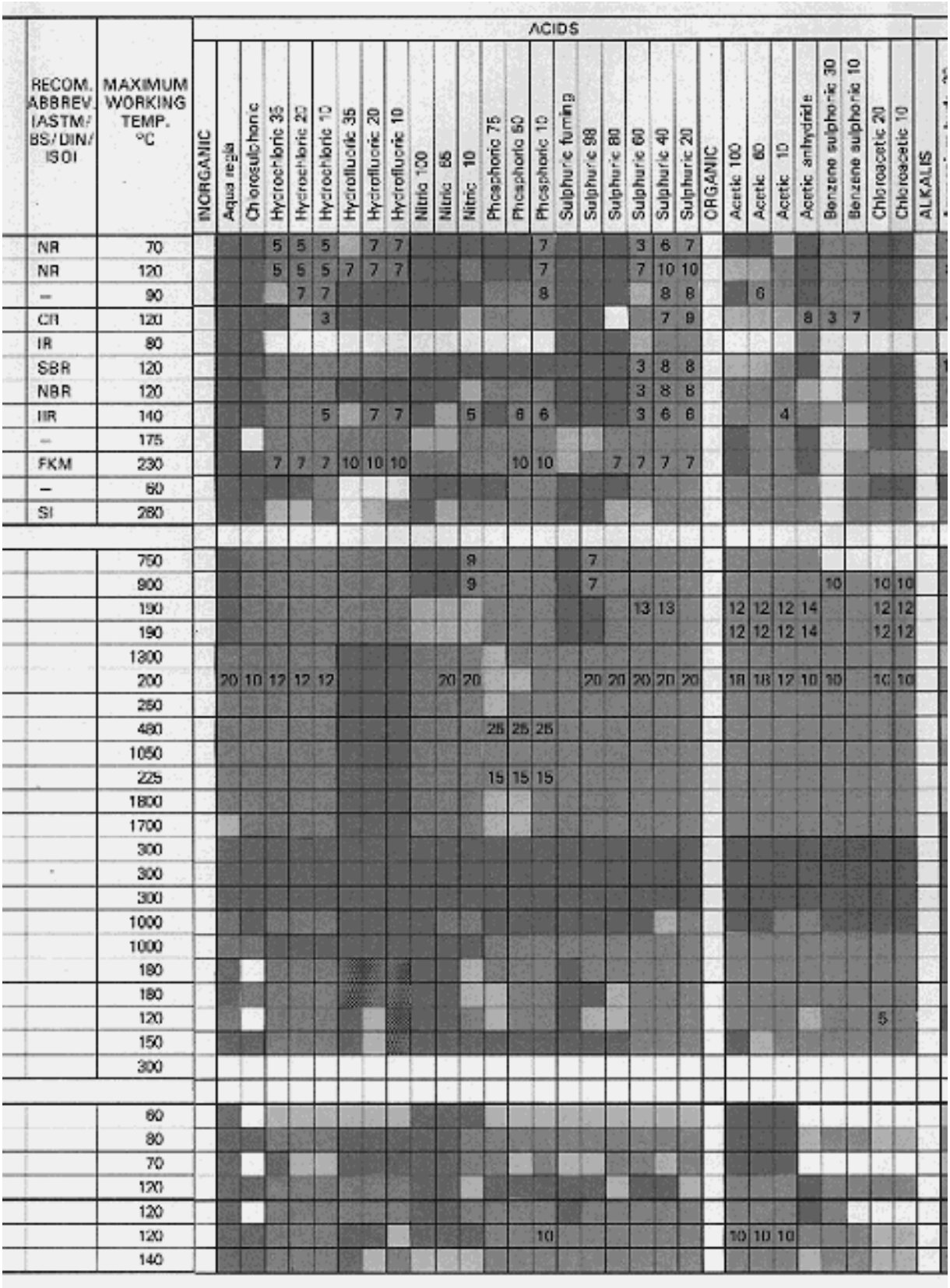
* Production has been ceased
** SP/F/V

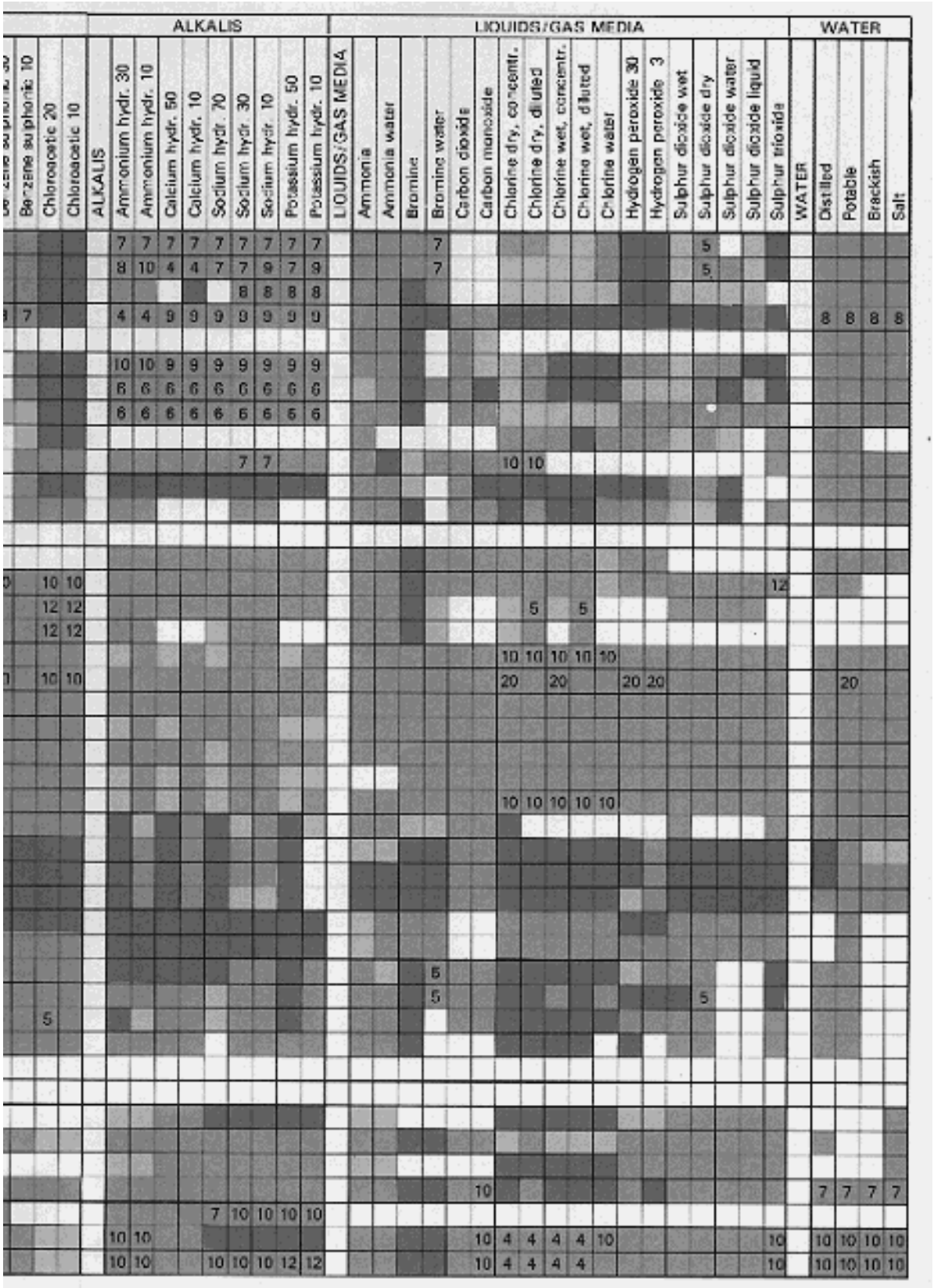

SALT SOLUTIONS
MAXIMUM WORKING TEMP. °C
SALT SOLUTIONS
Aluminium chloride
Ammonium chloride
Ammonium fluor.25%
Ammonium nitrate
Ammonium sulphate
Calcium carbonate
Calcium nitrate
Calcium sulphate
Ferrous sulphate
Potassium chromate
Sodium (bi)carbonate
Sodium chloride
Sodium sulphate
Zinc sulphate
ALIPHATIC
Butadiene
Heptene
Hexane
Propane
AROMATIC
Benzene
Toluene
Xylene
Phenol
ALCOHOLS
Allyl
Butyl
Ethyl
Isopropyl
Methyl
Propyl


HYDROCARBONS
Methyl
Propyl
Glycerol
Glycol
Cyclohexanol
ETHERS
ALDEHYDES/KETONES
Acetaldehyde
Formaldehyde
Acetone
Methyl ethyl ketone
Methyl isobutyl ketone
Cyclohexanone
ESTERS
Amyl acetate
Butyl acetate
Ethyl acetate
Dioctyl phthalate
Sodium benzoate
AMINES
Dimethylamine
Triethylamine
Urea
Aniline
CHLORINATED
Allyl chloride
Amyl chloride
Carbon tetrachloride
Carbon trichloride
Ethyl chloride
Ethylene chloride
Ethylene chlorohydrin
Ethylene dichloride
Methyl chloride
Methylene chloride
Trichloroethylene
Chlorobenzene

APPENDIX 2 CHEMICAL RESISTANCE OF NON-METALLIC MATERIALS (cont'd)
(see section 2.3 for legend and explanation)

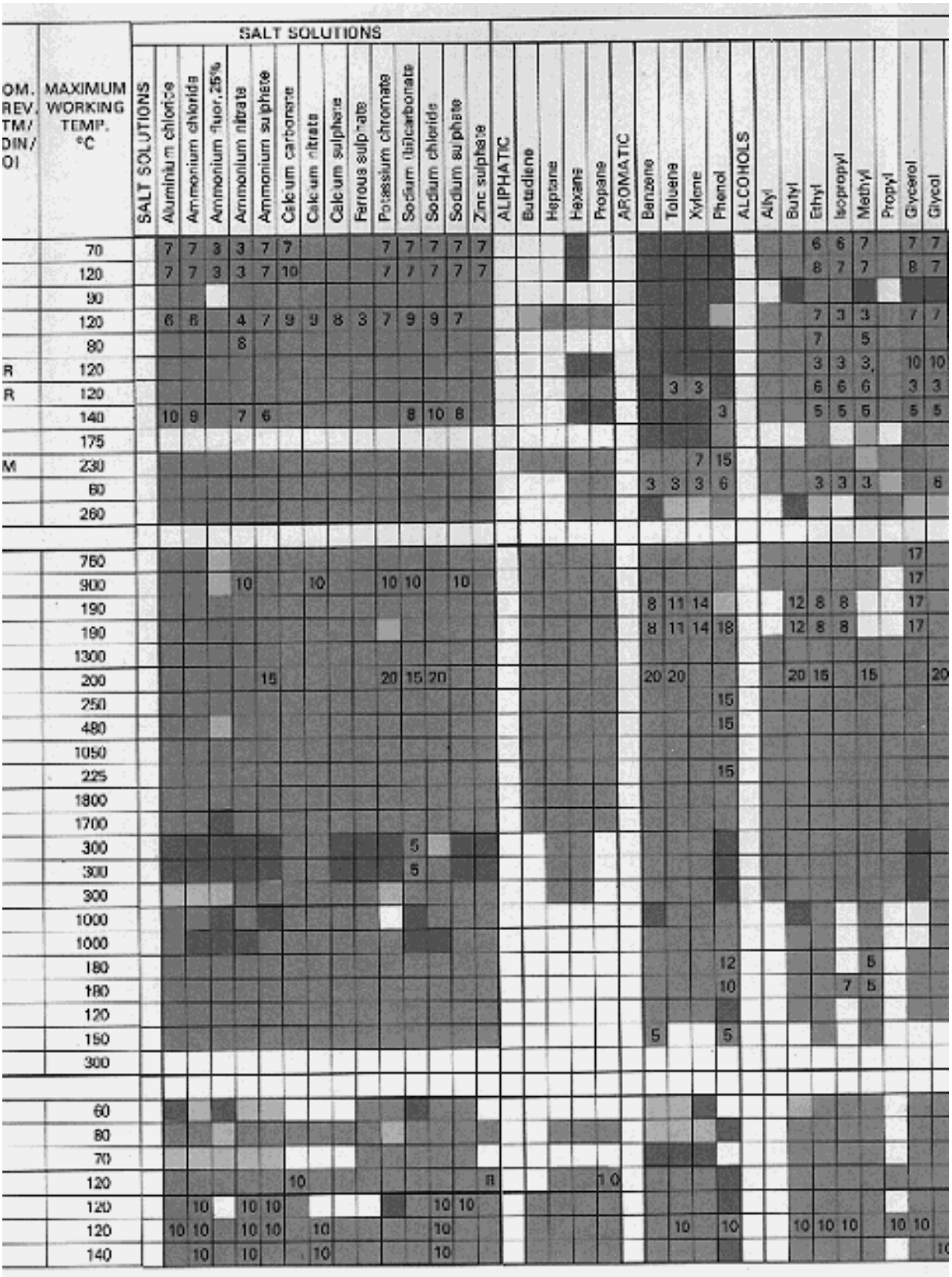
CLASS	No.	CHEMICAL CLASSIFICATION	SOME TRADE NAMES	RECO ABBRI (AST BS/DI ISO
RUBBERS/ELASTOMERS	3.1	Natural rubber, soft	Linatex	NR
	.2	Natural rubber, hard	Vulcoferran, Vulkodurit	NR
	.3	Depolymerized rubber		—
	.4	Polychloroprene	Neoprene, Baypren, Vulkodurit WR	CR
	.5	Polyisoprene	Cariflex I	IR
	.6	Polybutadiene styrene	Cariflex S, Buna SL, Hycar OS, GRS	SBR
	.7	Polybutadiene acrylonitrile	Perbunan N, GRA, Buna N, Vulkodurit WT	NBR
	.8	Polyisobutylene, isoprene	Butyl, GRI, Vulkodurit W50	IIR
	.9	Vinylidene fluoride - chlorotrifluoroethylene	Kel-F elastomer	—
	.10	Vinylidene fluoride - hexafluoropropylene	Viton, Fluorel	FKM
	.11	Polysulphides	Thiokol	—
	.12	Silicone rubbers	Silastic, Rhodorsil, Silopren	SI
CERAMICS/CARBONACEOUS MATERIALS	4.1	Carbon, non-impregnated	Durabon	
	.2	Graphite, non-impregnated	Diabon	
	.3	Graphite, phenolic resin impregnated	Graphilor BS/HB, Diabon	
	.4	Graphite, furane impregnated	Graphilor F	
	.5	Acid resistant bricks/tiles		
	.6	Stoneware		
	.7	Porcelain		
	.8	Glass		
	.9	Quartz/silica		
	.10	Glass lined steel		
	.11	Fire resistant bricks		
	.12	Silicon carbide		
	.13	Cement, Portland		
	.14	Cement, blast furnace		
	.15	Cement, alumina		
	.16	Cement, sodium silicate	Vitrex, Acalor 7, SWD	
	.17	Cement, potassium silicate	Vitrex, Acalor 7K, HFR	
	.18	Cement, phenolic	Asplit CN, Acalor 9	
	.19	Cement, furane	Asplit FN, Acalor 12, Furacin	
	.20	Cement, polyester	Asplit O	
	.21	Cement, epoxy	Asplit ET Wapex, Acalor 5	
	.22	Concrete (see cements)		
PAINTS/LACQUERS cold cured	5.1	Alkyd		
	.2	Vinyl		
	.3	Chlorinated rubber		
	.4	Epoxy		
hot cured	.5	Epoxy		
	.6	Phenolic		
	.7	Epoxy-phenolic		


ACIDS
RECOM. ABBREV. (ASTM/ BS/ DIN/ ISO)
MAXIMUM WORKING TEMP. °C
INORGANIC
Aqua regia
Chlorosulphonic
Hydrochloric 35
Hydrochloric 20
Hydrochloric 10
Hydrofluoric 35
Hydrofluoric 20
Hydrofluoric 10
Nitric 100
Nitric 65
Nitric 10
Phosphoric 75
Phosphoric 50
Phosphoric 10
Sulphuric fuming
Sulphuric 98
Sulphuric 80
Sulphuric 60
Sulphuric 40
Sulphuric 20
ORGANIC
Acetic 100
Acetic 60
Acetic 10
Acetic anhydride
Benzene sulphonic 30
Benzene sulphonic 10
Chloroacetic 20
Chloroacetic 10
ALKALIS
NR 70
NR 120
– 90
CR 120
IR 80
SBR 120
NBR 120
IIR 140
– 175
FKM 230
– 60
SI 280
750
900
190
190
1300
200
250
480
1050
225
1800
1700
300
300
300
1000
1000
180
180
120
150
300
60
80
70
120
120
120
140


ALKALIS
LIQUIDS/GAS MEDIA
WATER
Benzene sulphonic 10
Chloroacetic 20
Chloroacetic 10
ALKALIS
Ammonium hydr. 30
Ammonium hydr. 10
Calcium hydr. 50
Calcium hydr. 10
Sodium hydr. 70
Sodium hydr. 30
Sodium hydr. 10
Potassium hydr. 50
Potassium hydr. 10
LIQUIDS/GAS MEDIA
Ammonia
Ammonia water
Bromine
Bromine water
Carbon dioxide
Carbon monoxide
Chlorine dry, concentr.
Chlorine dry, diluted
Chlorine wet, concentr.
Chlorine wet, diluted
Chlorine water
Hydrogen peroxide 30
Hydrogen peroxide 3
Sulphur dioxide wet
Sulphur dioxide dry
Sulphur dioxide water
Sulphur dioxide liquid
Sulphur trioxide
WATER
Distilled
Potable
Brackish
Salt

APPENDIX 2 CHEMICAL RESISTANCE OF NON-METALLIC MATERIALS (cont'd)
(see section 2.3 for legend and explanation)

CLASS	No.	CHEMICAL CLASSIFICATION	SOME TRADE NAMES	RECOM. ABBREV. (ASTM/ BS/DIN/ ISO)	MAX WO TE
RUBBERS/ELASTOMERS	3.1	Natural rubber, soft	Linatex	NR	
	.2	Natural rubber, hard	Vulcaferran, Vulkodurit	NR	
	.3	Depolymerized rubber		—	
	.4	Polychloroprene	Neoprene, Baypren, Vulkodurit WR	CR	
	.5	Polyisoprene	Cariflex I	IR	
	.6	Polybutadiene styrene	Cariflex S, Buna SL, Hycar OS, GRS	SBR	
	.7	Polybutadiene acrylonitrile	Perbunan N, GRA, Buna N, Vulkodurit WT	NBR	
	.8	Polyisobutylene, isoprene	Butyl, GRI, Vulkodurit W50	IIR	
	.9	Vinylidene fluoride - chlorotrifluoroethylene	Kel-F elastomer	—	
	.10	Vinylidene fluoride - hexafluoropropylene	Viton, Fluorel	FKM	
	.11	Polysulphides	Thiokol	—	
	.12	Silicone rubbers	Silastic, Rhodorsil, Silopren	SI	
CERAMICS/CARBONACEOUS MATERIALS	4.1	Carbon, non-impregnated	Diabon		
	.2	Graphite, non-impregnated	Diabon		
	.3	Graphite, phenolic resin impregnated	Graphilor BS/HB, Diabon		
	.4	Graphite, furane impregnated	Graphilor F		
	.5	Acid resistant bricks/tiles			
	.6	Stoneware			
	.7	Porcelain			
	.8	Glass			
	.9	Quartz/silica			
	.10	Glass lined steel			
	.11	Fire resistant bricks			
	.12	Silicon carbide			
	.13	Cement, Portland			
	.14	Cement, blast furnace			
	.15	Cement, alumina			
	.16	Cement, sodium silicate	Vitrex, Acalor 7, SWD		
	.17	Cement, potassium silicate	Vitrex, Acalor 7K, HFR		
	.18	Cement, phenolic	Asplit CN, Acalor 9		
	.19	Cement, furane	Asplit FN, Acalor 12, Furacin		
	.20	Cement, polyester	Asplit O		
	.21	Cement, epoxy	Asplit ET Wepex, Acalor 5		
	.22	Concrete (see cements)			
PAINTS/LACQUERS cold cured	5.1	Alkyd			
	.2	Vinyl			
	.3	Chlorinated rubber			
	.4	Epoxy			
hot cured	.5	Epoxy			
	.6	Phenolic			
	.7	Epoxy-phenolic			


SALT SOLUTIONS
OM. REV. TM/ DIN/ OI
MAXIMUM WORKING TEMP. °C
SALT SOLUTIONS
Aluminium chloride
Ammonium chloride
Ammonium fluor.,25%
Ammonium nitrate
Ammonium sulphate
Calcium carbonate
Calcium nitrate
Calcium sulphate
Ferrous sulphate
Potassium chromate
Sodium (bi)carbonate
Sodium chloride
Sodium sulphate
Zinc sulphate
ALIPHATIC
Butadiene
Heptane
Hexane
Propane
AROMATIC
Benzene
Toluene
Xylene
Phenol
ALCOHOLS
Allyl
Butyl
Ethyl
Isopropyl
Methyl
Propyl
Glycerol
Glycol
70
120
90
120
80
120
120
140
175
230
60
260
750
900
190
190
1300
200
250
480
1050
225
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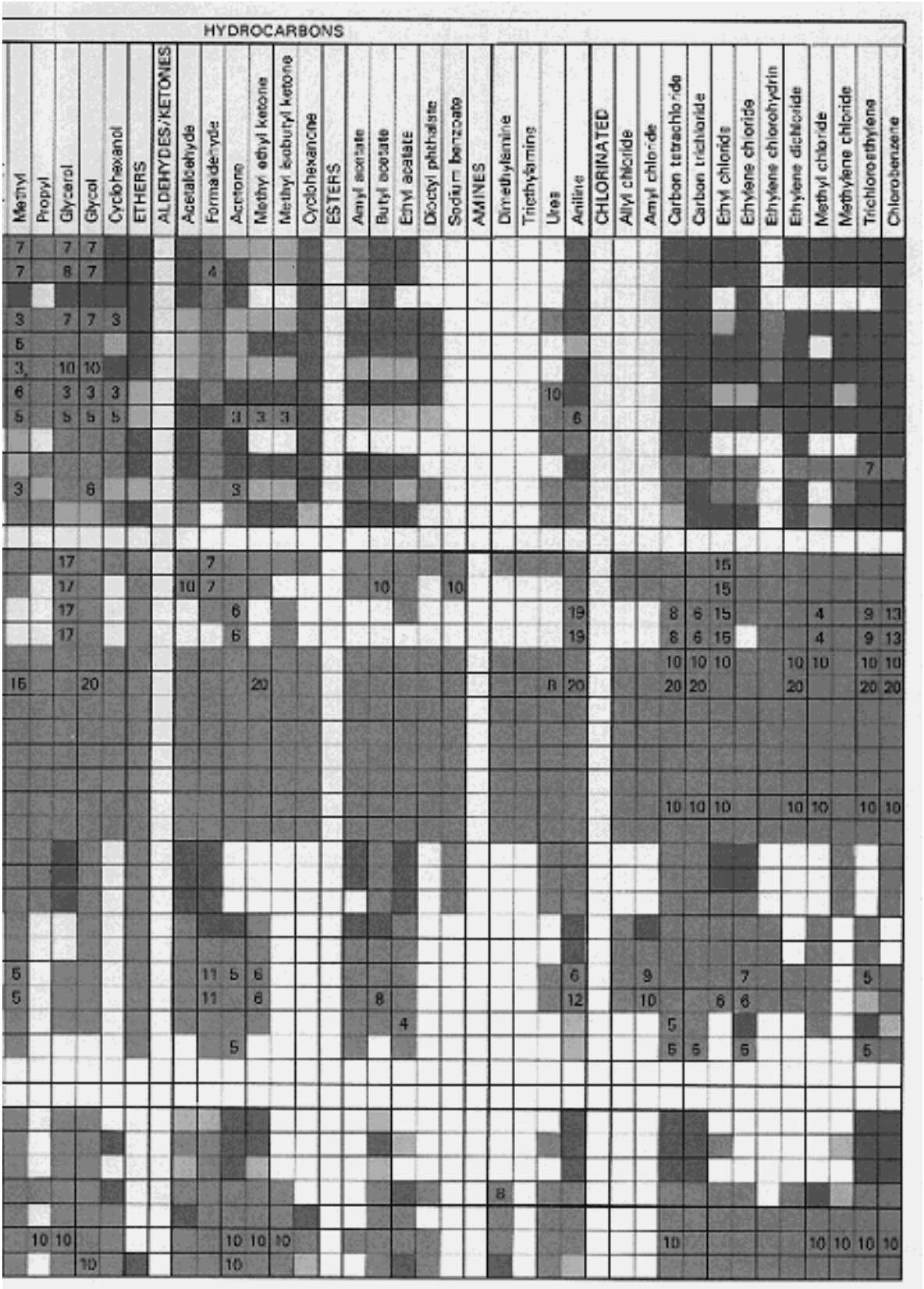
HYDROCARBONS
Methyl
Propyl
Glycerol
Glycol
Cyclohexanol
ETHERS
ALDEHYDES/KETONES
Acetaldehyde
Formaldehyde
Acetone
Methyl ethyl ketone
Methyl isobutyl ketone
Cyclohexanone
ESTERS
Amyl acetate
Butyl acetate
Ethyl acetate
Dioctyl phthalate
Sodium benzoate
AMINES
Dimethylamine
Triethylamine
Urea
Aniline
CHLORINATED
Allyl chloride
Amyl chloride
Carbon tetrachloride
Carbon trichloride
Ethyl chloride
Ethylene chloride
Ethylene chlorohydrin
Ethylene dichloride
Methyl chloride
Methylene chloride
Trichloroethylene
Chlorobenzene

APPENDIX 3 TYPICAL MECHANICAL AND PHYSICAL PROPERTIES OF NON-METALLIC MATERIALS

CHEMICAL CLASSIFICATION	No.	Density kg/dm^3	Tensile strength N/mm^2	Flexural (bending) strength N/mm^2	Compressive strength N/mm^2	Modulus of elasticity N/mm^2	Thermal conductivity Wm^{-1} K^{-1}	Coefficient of linear expansion 10^{-6} K^{-1}	Specific heat kJ kg^{-1} K^{-1}	Impat strength notched (Charpy) kJ/m^2	Porosity % vol.
Polyethylene, low densisty	1.1	0.910 - 0.940	8 - 10	7 - 10		200 - 300	0.32	200 - 225	2.1	40	
Polyethylene, high densisty	1.2	0.941 - 0.965	20 - 30	30 - 40		1000	0.40	150 - 200	1.8	No break	
Polypropylene	1.3	0.908	30 - 40	40 - 50		9000	0.22	110 - 170	1.7	8 - 10	
Polyvinyl chloride, rigid	1.5	1.38 - 1.40	50 - 60	70 - 110		3000	0.16	70 - 80	0.9	2 - 5	
Fluorinated polymers	1.6/.7/.17	2.1 - 2.3	20 - 40	18 - 20		450 - 1 300	0.16 - 0.23	90 - 150	0.9 - 1.0	16	
Polymethyl methacrylate	1.9	1.18 - 1.20	80	140		3000	0.18	70 - 80	1.8	5 - No break	
Chlorinated polyether	1.12	1.4	40 - 45	24		1000	0.13	80		8	
Polyamide	1.14	1.07 - 1.14	40 - 50	50 - 70		1400	0.23 - 0.29	70 - 100	1.7 - 2.1	5 - 30	
Polyesters, glass reinforced	2.2 - 2.4	1.4 - 1.9	350	450		2000	0.30	23	1.3	20	
Epoxies, glass reinforced	2.14 - 2.15	1.5 - 2.2	400	500		2500	0.36	20	1.1	15	
Phenolics/furanes	2.5 - 2.9	1.4 - 1.8	20 - 45	50 - 75		3 000 - 9000	0.23 - 0.38	15 - 40	1.3 - 1.7	5 - 15	
Rubbers, solid	3.1 - 3.12	1.10 - 1.75	5 - 35	60 - 110		3 000 - 3 500	0.13 - 0.26	10 - 60	1.3 - 1.9	3 - 8	
Rubbers, linings	3.1 - 3.12	1.12 - 1.38	10 - 65	20 - 100		3 000 - 3 500	0.29 - 1.44	20	1.4 - 1.9		
Carbon, non - impregnated	4.1	1.4 - 1.6	6 - 8	20 - 50	50 - 80	10 000 - 15 000	4.0 - 5.4	3 - 5	0.7 - 0.8		10 - 30
Carbon, impregnated		1.7 - 1.9	10 - 20	20 - 45	70 - 150	10 000 - 22 000	4.3 - 6.4	3.5 - 5	0.8		~ 0
Graphite, non - impregnated	4.2	1.5 - 1.7	6 - 10	15 - 25	20 - 75	7 000 - 9 000	95 - 150	1.8 - 2.8	0.7 - 0.8		10 - 30
Graphite, impregnated	4.3 - 4.4	1.8 - 1.9	12 - 22	15 - 50	50 - 100	13 000 - 16 000	95 - 150	3.5 - 4.1	0.8		~ 0
Acid resistant bricks/tiles	4.5	2.2 - 2.6	10		50 - 160	28 000 - 35 000	1.5 - 1.8	4.5 - 6	0.8 - 1.1		4 - 20
Stoneware/porcelain	4.6 - 4.7	2.2 - 2.7	25 - 50	25 - 40	200 - 500	35 000 - 70 000	1.3 - 2.1	3 - 5	0.8		0.1 - 1.2
Glass	4.8	2.2 - 2.3	30 - 90	30 - 90	700 - 900	60 000 - 75 000	1.0 - 1.5	2.8 - 4.2	0.8		~ 0
Quartz/silica	4.9	2.0 - 2.2	5 - 70	70	1 200 - 2 000	70 000 - 72 000	1.3 - 1.6	0.5 - 0.8	0.7 - 1.0		
Fire resistant bricks	4.11	1.8 - 3.8		6 - 17	15 - 80	12 900 - 33 500	0.2 - 1.0	0.5 - 1.2	0.8 - 1.1		15 - 30
Silicon carbide	4.12	2.6 - 2.9	25 - 55	70	550	12 000	16 - 26	4.4	1.2		8 - 15
Cements	4.13 - 4.21	1.4 - 2.2	2 - 20	28 - 85	25 - 110	15 000 - 25 000	0.13 - 1.3	4.5 - 20			0 - 8

APPENDIX 4 IDENTIFICATION OF PLASTICS AND RUBBERS

THERMOPLASTIC MATERIALS

CHEMICAL CLASSIFICATION	No.	FLAMMABILITY	FLAME CHARACTERISTICS AND RESULTS OF HEATING	ODOUR	REMARKS
Polyethylene, low density	1.1	Flammable	Blue flame, yellow at top. Melts and drips	Paraffin odour similar to burning candle	More flexible and waxy to touch than PE (hd) and PP. Floats in water
Polyethylene, high density	1.2	Flammable	Blue flame, yellow at top. Melts and drips	Paraffin odour similar to burning candle	Harder, more rigid than PE (ld) Floats in water
Polypropylene	1.3	Flammable	Melts and drips more readily than polyethylene	Sweeter odour than polyethylene	Rigidity similar to PE (hd) but more difficult to scratch. Floats in water
Polyvinyl chloride, plasticized	1.4	Self-extinguishing	Ignites with difficulty. Yellow flame, green spurts	Acrid odour	Flexible. Copper wire test [1)]
Polyvinyl chloride, rigid	1.5	Self-extinguishing	Ignites with difficulty. Yellow flame, green spurts Spurts less than PVC, plasticized	Acrid odour	Hard. Copper wire test [1)]
Fluorinated polymers	1.6/.7/.17	Non-flammable	No burning or carbonizing		
Polyvinyl alcohol	1.8	Flammable	Yellow flame with smoke	Irritating odour	Soluble in water
Acrylics	1.9 - 1.10	Flammable	Blue/white flame	Fruity	
Polyoxymethylene, Polyformaldehyde	1.11	Flammable	Blue flame, melts	Formaldehyde	
Chlorinated polyether	1.12	Self-extinguishing	Sputtering. Green/yellow flame, black smoke. Carbon in air	Characteristic odour	Copper wire test [1)]
Polystyrene	1.13	Flammable	Yellow/white flame. Smoke	Illuminating gas	
Polyamide	1.14	Self-extinguishing	Ignites with difficulty. Blue/yellow flame Melts and drips	Burning hair	
Polyisobutylene	1.15	Flammable			
Acrylonitrile butadiene styrene	1.18	Flammable	Yellow flame, black smoke. Drips	Acetic odour	
Polyvinylidene chloride	1.19	Self-extinguishing	Yellow flame, green spurts. Ignites with difficulty	Hydrochloric acid	Copper wire test [1)]
Cellulose acetate butyrate	1.20	Flammable	Blue/yellow flame. Melts and drips	Rancid butter	

NOTE: 1) Copper wire test is very well suited for detecting chlorine. A chlorine-containing material gives a bright green colour when burnt in contact with clean, thoroughly heated copper wire.

APPENDIX 4 (cont'd) IDENTIFICATION OF PLASTICS AND RUBBERS

THERMOSETTING MATERIALS

CHEMICAL CLASSIFICATION	No.	FLAMMABILITY	FLAME CHARACTERISTICS AND RESULTS OF HEATING	ODOUR	REMARKS
Polyesters	2.1 - 2.4	Flammable to self-extinguishing	Yellow flame, blue at edges. Material cracks and breaks	Characteristic odour	
Phenolics	2.5 - 2.8	Flammable to self-extinguishing	Difficult to ignite. Yellow flame	Carbolineum/phenol	
Furanes	2.9	Flammable			
Ureas	2.10	Self-extinguishing	Difficult to ignite. Burns with blue/green-edged pale yellow flame	Formaldehyde and fish	Can be scuffed with a fingernail
Melamines	2.11	Self-extinguishing	Charring at 150 °C. Difficult to ignite	Formaldehyde and fish	Cannot be scuffed with a fingernail
Silicones	2.12	Non-flammable	White ash		
Polyurethanes	2.13	Flammable to self-extinguishing	Charring. Smoke	Disagreeable, stinging	
Epoxies	2.14 - 2.15	Flammable to self-extinguishing	Black smoke. Yellow/green flame	Sharp acrid odour	

RUBBERS AND ELASTOMERS

CHEMICAL CLASSIFICATION	No.	FLAMMABILITY	FLAME CHARACTERISTICS AND RESULTS OF HEATING	ODOUR	REMARKS
Natural rubber	3.1-3.2	Flammable	Smoky flame	Characteristic odour	
Depolymerized rubber	3.3	Flammable	Smoky flame	Characteristic odour of natural rubber	
Polychloroprene	3.4	Self-extinguishing		Hydrogen chloride	Copper wire test [1]
Polyisoprene	3.5	Flammable	Smoky flame	Characteristic odour	
Polybutadiene styrene	3.6	Flammable	Smoky flame	Characteristic odour	
Polybutadiene acrylonitrile	3.7	Flammable	Yellow flame, spurts	Acetic odour, additional smell of rubber	
Polyisobutylene isoprene	3.8	Flammable	Clear smokeless flame	Characteristic odour	
Vinylidene fluoride-chlorotrifluoroethylene	3.9	Non-flammable			Copper wire test [1]
Vinylidene fluoride-hexafluoropropylene	3.10	Non-flammable			
Polysulphides	3.11	Flammable	Blue smokeless flame	Strong sulphurous smell	
Silicone rubbers	3.12	Non-flammable			

1) Copper wire test is very well suited for detecting chlorine. A chlorine-containing material gives a bright green colour when burnt in contact with clean, thoroughly heated copper wire.

APPENDIX 5 ENGINEERING PLASTICS

CHEMICAL CLASSIFICATION	Recommended abbreviation	Absolute maximum working temperature °C	Density Kg/dm^3	Tensile strength N/mm^2	Bending strength N/mm^2	Modulus of elasticity N/mm^2	Coefficient of linear expansion $10^{-6}\ K^{-1}$	Some trade names
Polyarylene	-	300						Elmac, Parylene
Polyphenylene oxide	PPO	130	1.06	45 - 65	85 - 100	2400	60 - 70	Noryl, Xyron
Polyetheretherketone	PEEK	200	1.32	91		3800		Peek
Polysulfone	PSU	200	1.24	70	106	2500	56	Ultrason S, Udel
Polyethersulfone	PES	200	1.37	84-94	129	3200	55	Ultrason E, Victrex PES
Polyarylether	-	160	1.14	52	77	2100	65	Arylon
Polyphenylene sulfide	PPS	260	1.35	70 - 135	120 - 200	15000	22 - 28	Ryton, Supec, Tedur
Polyarylate	-	190	1.21	62	81	2100	62	Arylef, Ardel, Carodel, Durel
Polyaramide	-	275	1.44	270	180	10000	40	Arenka, Kevlar, Twaron
Polyimide	PI	360	1.43	91	120	3500	45 - 56	Kapton, Vespel, Kermel
Polyamide-imide	PAI	260	1.40	186	212	4600	36	Torlon
Polyetherimide	PEI	170	1.27	105	145	3000	62	Ultem 1000

APPENDIX 6 TRADE NAMES, WITH MANUFACTURER'S NAME AND COUNTRY OF ORIGIN

TRADE NAME	CHEMICAL CLASSIFICATION	MANUFACTURER
ACALOR		Acalor, England
5	Epoxy cement	
7	Sodium silicate cement	
7K	Potassium silicate cement	
9	Phenolic cement	
12	Furane cement	
ADIPRENE	Polyurethane rubber	Du Pont, USA
AKULON	Polyamide	AKZO, Netherlands
ALATHON	Polyethylene	Du Pont, USA
ALBERTOL	Saturated polyesters	Hoechst, Germany
ALGOFLON	Polytetrafluoroethylene	Montedison, Italy
ALNOVOL	Phenolics	Hoechst, Germany
ALPOLIT	Unsaturated polyesters	Hoechst, Germany
ALRESEN	Phenolic, modified	Hoechst, Germany
ALTUGLAS	Polymethyl metacrylate	Elf ATochem, France
AMILAN	Polyamide	Toray Industries, Japan
AMPAL	Unsaturated polyesters	Ciba-Geigy, Switzerland
AMPCOFLEX	Polyvinyl chloride	Atlas Plastics, USA
ARALDIT	Epoxies	Ciba-Geigy, Switzerland
ARDEL	Polyarylate	Amoco, USA
ARENKA	Polyamide	AKZO, Netherlands
ARNITE	Unsaturated polyesters	AKZO, Netherlands
ARNITEL	Saturated polyester	AKZO, Netherlands
ARYLON	Polyarylether, Polyarylates	Du Pont, USA
ASPLIT		Hoechst, Germany
CN	Phenolic cement	
CS	Phenolic cement	
CV	Phenolic cement	
ET	Epoxy cement	
FN	Furane cement	
O	Polyester cement	
ASTRALON	Polyvinyl chloride	Hüls, Germany
ATLAC	Unsaturated polyesters	DSM, Netherlands

BAKELITE	Phenolics, Phenolics modified	Bakelite, Germany
BAYDUR	Polyurethanes	Bayer, Germany
BAYFLEX	Polyurethanes	Bayer, Germany
BAYMER	Polyisocyanurate	Bayer, Germany
BAYPREN	Polychloroprene	Bayer, Germany
BAYSILON E	Silicones	Bayer, Germany
BECKOCOAT	Polyurethanes	Hoechst, Germany
BECKOPOX	Epoxies	Hoechst, Germany
BECKUROL	Ureas	Hoechst, Germany
BEETLE	Unsaturated polyesters, phenolics	BIP Chemicals, England
BENVIC	Polyvinylchloride	Solvay, Belgium
BONDSTRAND	Reinforced epoxies and unsaturated polyesters	Ameron, USA
BORNUM HARZ		Harzer Achsenwerke,Germ.
5102	Phenolics, graphite filled	
5104	Phenolics, modif., graphite filled	
6101	Phenolic lining, graphite filled	
6201	Furanes	
BREON	Polybutadiene acrylonitrile	Zeon, Germany
BUDENE	Polybutadiene	Goodyear, USA
BUNA AP	Ethylene propylene, diene terpolymer	Hüls, Germany
BUNA EM	Polybutadiene styrene	Hüls, Germany
BUNA CB	Polybutadiene	Bayer, Germany
BUNA N	Polybutadiene acrylonitrile (Nitrile rubber)	-
BUTYL	Polyisobutylene isoprene	-
CAPRON	Polyurethanes	Allied Corp., USA
CARADATE	Isocyanates for polyurethanes	Shell
CARADOL	Polyols for polyurethanes	Shell
CARBOFRAX	Silicon carbide	Carborundum, USA
CARIFLEX		Shell
I	Polyisoprene	
S	Polybutadiene styrene	
TR	Styrene butadiene, styrene rubber	

CARILON	Polyketone	Shell
CARINA	Polyvinyl chloride	Shell
CARINEX	Polystyrene	Shell
CARLONA	Polyethylene	Shell
CARLONA P	Polypropylene	Shell
CARODEL	Polyarylate	ICI, USA
CASOCRYL	Polymethyl methacrylate	Elf Atochem, France
CELCON	Polyformaldehyde	Hoechst, Germany
CELLIDOR B	Cellulose acetate butyrate	Albis Plastics, Germany
CIBAMIN	Ureas, Melamines	Ciba-Geigy, Switzerland
CONAPOXY	Melamines	Conap, USA
COROPLAST	Polyvinylchloride	Coroplast, Germany
CORVIC	Polyvinylchloride	ICI, England
COURTELLE	Polyacrylonitrile	Courtaulds, England
CRYLOR	Polyacrylonitrile	Rhone Poulenc, France
CRYSTIC	Unsaturated polyesters	Scott Bader Co., England
CYCOLAC	Acrylonitrile butadiene styrene	General Electric, USA
DACRON	Saturated polyesters	Du Pont, USA
DAPLEN	Polypropylene	PCD Linz, Austria
DARVIC	Polyvinylchloride	Weston Hyde, England
DEGALAN	Polymethyl methacrylate	Degussa, Germany
DELPET	Polymethyl methacrylate	Asahi Chem., Japan
DELRIN	Polyformaldehyde	Du Pont, USA
DER	Epoxies	DOW, USA
DERAKENE	Unsaturated polyesters, vinylester type	DOW, USA
DESMODUR	Isocyanates for polyurethanes	Bayer, Germany
DESMOPHEN	Polyols for polyurethanes	Bayer, Germany
DESMOPAN	Polyurethane rubber	Bayer, Germany
DEWOGLAS	Polymethyl methacrylate	Degussa, Germany
DIABON	Graphite	Sigri, Germany
DIAKON	Polymethyl methacrylate	ICI, England
DOBECKAN	Unsaturated polyesters, polyurethanes	BASF, Germany
DOLAN	Polyacrylonitrile	Hoechst, Germany
DORIX	Polyamide	Bayer, Germany
DORLASTAN	Polyurethane rubber	Bayer, Germany
DRAKAFLEX	Polyurethanes	Draka, Netherlands

DRALON	Polyacrylonitrile	Bayer, Germany
DUALOY	Fibres reinforced epoxies	Ameron, USA
DURABON	Carbon	Sigri, Germany
DURAN 50	Glass	Jena Glaswerk Schott, Germany
DUREL	Polyarylate	Hoechst, Germany
DURETHAN	Polyamide	Bayer, Germany
DUROPHEN	Phenolics, modified	Hoechst, Germany FR
DYLENE	Polystyrene, styrene acrylonitrile	ARCO Polymers, USA
DYNAPOL	Saturated polyesters	Hüls, Germany
EDISTIR	Polystyrene	Enichem, Italy
EKAVYL	Polyvinylchloride	Elf Atochem, France
ELASTOLLAN	Polyurethanes	Elastogran, Germany
ELASTOSIL	Silicone rubber	Wacker-Chemie, Germany
ELEXAR	Styrene butadiene, styrene rubber	Shell
ELTEX	Polyethylene	Solvay, Belgium
ELTEX P	Polypropylene	Solvay, Belgium
ELVANOL	Polyvinylalcohol	Du Pont, USA
EPIKOTE	Epoxies	Shell
EPOCRYL	Unsaturated polyesters, vinylester type	Ashland Chem., USA
EPON	Epoxies	Shell
ESCORENE	Polyethylene	Exxon, USA
FIBERCAST	Fibre reinforced epoxies and	Fibercast, USA/Germany
FINATHENE	Polyethylene	Fina, Belgium
FLUON	Polytetrafluoroethylene	ICI, England
FLUOREL	Vinylide fluoride - hexafluoropropylene	3 M Co., USA
FLUOROFLEX	Fluorinated polymers	Resistoflex, USA/Germany
FLUOROGREEN	Fluorinated polymers	Peabode Dore, USA
FLUOROLINE	Fluorinated polymers	BTR, England
FLUOROSINT	Fluorinated polymers	Polypenco, Germany
FORAFLON	Polyvinylidene fluoride	Elf Atochem, France
FORMICA	Melamines	Formica Corp., USA
FURACIN	Furane cement	Prodorite, England
GAFLON	Polytetrafluoroethylene	Plastic Omnium, France

GEMON	Polyimide	General Electric, USA
GEON	Polyvinylchloride	B.F. Goodrich, USA
GLAD	Polyethylene	Union Carbide, USA
GORETEX	Polytetrafluoroethylene	W.L. Gore, USA
GRAPHILOR		Le Carbone-Lorraine, France
B/BS/HB	Phenolic resin impregnated graphite	
F	Furane impregnated graphite	
T	PTFE impregnated graphite	
GRA	Polybutadiene acrylonitrile	
GRI	Polyisobutylene isoprene	
GRN	Nitrile butadiene	
GRS	Polybutadiene styrene	
GRILAMID	Polyamide	EMS-Chemie, Switzerland
GRILLODUR	Unsaturated polyesters	Grillo-Werke, Germany
HALAR	Polytrifluoroethylene	Ausimont., USA
HALON	Polytetrafluoroethylene	Ausimont., USA
HAVEG		Haveg, USA

31	Modified phenolics	
41	Phenol formaldehydes	
43	Phenolics	
60	Phenol furfurals	
61	Furanes	
HEROX	Polyamide	Du Pont, USA
H.E.T.	Chlorinated unsaturated terpolymer	Ashland Chem., USA
HETRON	Chlorinated unsaturated polyesters	Ashland Chem., USA
HFR CEMENT	Potassium silicate cement	Hoechst, Germany
HOSTAFLEX	Polyvinylchloride	Hoechst, Germany
HOSTAFLON	Polytetrafluoroethylene	Hoechst, Germany
HOSTAFLON-C	Polychlorotrifluoroethylene	Hoechst, Germany
HOSTALEN	Polyethylene	Hoechst, Germany
HOSTALEN-PP	Polypropylene	Hoechst, Germany
HOSTALIT	Polyvinylchloride	Hoechst, Germany
HOSTYREN	Polystyrene	Hoechst, Germany
HYCAR		BF Goodrich, USA
OR	Polybutadiene acrylonitrile	
OS	Polybutadiene styrene	
HYPALON	Chlorosulphonated polyethylene	Du Pont, USA
HYTREL	Saturated polyesters	Du Pont, USA
HYVIS	Polyisobutylene	BP Chem., England
ICDAL	Polyimide	Hüls, Germany
IMIPEX	Polyimide	General Electric, USA
IMPOLEX	Unsaturated polyesters	ICI, England
IXAN	Polyvinylidene chloride	Solvay, Belgium
KALREZ	Perfluoro elastomer	Du Pont, USA
KAMAX	Polyimide	Rohm and Haas, USA
KAPTON	Polyimide	Du Pont, USA
KARBATE 22	Phenolic resin impregnated graphite	Union Carbide, USA
KARBATE 26	Furane impregnated graphite	Union Carbide, USA
KEEBUSH		APV-Kester, England
G	Phenolics, filled	

H	Phenol furfurals, filled	
M	Phenolics, filled	
KEL-F	Polychlorotrifluoroethylene	3 M Co., USA
KEL-F-elastomer	Vinylidene fluoride-chlorotrifluoroethylene	3 M Co., USA
KELTAN	Ethylene propylene diene terpolymer	DSM, Netherlands
KERANOL		Keramchemie, Germany
FU	Furanes cement	
E	Epoxy cement	
PM	Phenolics cement	
KERIMID	Polyimide	Rhone-Poulenc, France
KERMEL	Polyimide	Rhone-Poulenc, France
KEVLAR	Polyaramide	Du Pont, USA
KINEL	Polyimide	Rhone-Poulenc, France
KRALASTIC	Acrylonitrile butadiene styrene	Uniroyal, Japan
KRATON G	Styrene butadiene styrene rubber	Shell
KYDEX	Polyvinylchloride	Rohm and Haas, USA
KYNAR	Polyvinylidene fluoride	Elf Atochem, France
LACQTENE	Polyethylene	Elf Atochem, France
LAMELLON	Unsaturated polyesters	-
LAROFLEX	Polyvinylchloride	BASF, Germany
LEACRIL	Polyacrylonitrile	-
LEGUPREN	Unsaturated polyesters	Bayer, Germany
LEGUVAL	Unsaturated polyesters	DSM, Netherlands
LEKUTHERM	Epoxies	Bayer, Germany
LEVEPOX	Epoxies	Bayer, Germany
LEXAN	Polycarbonate	General Electric, USA
LINATEX	Natural rubber, soft	Wilkinson Rubber Linatex, England
LUCITE	Polymethyl methacrylate	Du Pont, USA
LUCOREX	Polyvinylchloride	Elf Atochem, France
LUPOLEN	Polyethylene	BASF, Germany
LURAN	Styrene acrylonitrile	BASF, Germany
LUSTRAN	Styrene acrylonitrile	Monsanto, USA
LUSTREX	Polystyrene	Monsanto, USA

LYCRA	Polyurethanes	Du Pont, USA
MADURIT	Melamines	Hoechst, Germany
MAKROLON	Polycarbonate	Bayer, Germany
MAPRENAL	Melamines	Hoechst, Germany
MARANYL	Polyamides	ICI, England
MELBRITE	Melamines	Montedison, Italy
MELINEX	Saturated polyesters	ICI, England
MELMEX	Melamines	BIP Chemicals, England
MELOPAS	Melamines	Ciba-Geigy, Switzerland
MENZOLIT	Epoxies and unsaturated polyesters	Menzolit-Werke, Germany
MINLON	Polyamides	Du Pont, USA
MIPOLAM	Polyvinylchloride	Hüls, Germany
MOLTAPREN	Polyurethane foam	Bayer, Germany
MOPLEN	Polypropylene	Himont, Italy
MOWILITH	Polyvinylacetate	Hoechst, Germany
MOWIOL	Polyvinylalcohol	Hoechst, Germany
MYLAR	Saturated polyesters	Du Pont, USA
NANDEL	Polyacrylonitrile	Du Pont, USA
NAPRYL	Polypropylene	Elf Atochem, France
NATENE	Polyethylene	Elf Atochem, France
NATSYN	Polyisoprene	Goodyear, USA
NEOPRENE	Polychloroprene	Du Pont, USA
NITRIL	Polybutadiene acrylonitrile	-
NOMEX	Polyaramide	Du Pont, USA
NORDEL	Ethylene-propylene diene terpolymer	
NORYL	Polyphenylene oxide	General Electric, USA
NOVODUR	Acrylonitrile butadiene styrene	Bayer, Germany
NOVOLEN	Polypropylene	BASF, Germany
NOVOLUX	Polyvinylchloride	Weston Hyde, England
NYLON	Polyamide	Du Pont, USA
NYRIM	Polyamide	DSM, Netherlands
OPPANOL-B	Polyisobutylene	BASF, Germany
ORBITEX	Epoxies	Ciba-Geigy, Switzerland
ORGATER	Polycarbonate	Elf Atochem, France
ORGAVYL	Polyvinylchloride	Elf Atochem, France

ORLON	Polyacrylonitrile	Du Pont, USA
OROGLAS	Polymethyl methacrylate	Rohm and Haas, USA
PALATAL	Unsaturated polyesters	BASF, Germany
PAN	Polyacrylonitrile	Bayer, Germany
PARAPLEX	Unsaturated polyesters	Rohm and Haas, USA
PARYLENE	Polyarylene	Union Carbide, USA
PEEK	Polyetheretherketone	ICI, England
PENTON	Polydichloromethyloxetane	-
PERBUNAN N	Polybutadiene acrylonitrile	Bayer, Germany
PERLON	Polyamide	Perlon, Germany
PERSPEX	Polymethyl methacrylate	ICI, England
PLASKON	Ureas	Plaskon, USA
PLASTOPAL	Ureas	BASF, Germany
PLEXIDUR	Polymethyl methacrylate	Rohm and Haas, USA
PLEXIGLAS	Polymethyl methacrylate	Rohm and Haas, USA
PLIOFLEX	Polybutadiene styrene	Goodyear, USA
POCAN	Saturated polyesters	Bayer, Germany
POLYDUR	Unsaturated polyesters	Hüls, Germany
POLYLITE	Unsaturated polyesters	Reichhold Chem., USA
POLYSTYROL	Polystyrene	BASF, Germany
POLYVIOL	Polyvinyl alcohol	Wacker-Chemie, Germany
PROPATHENE	Polypropylene	ICI, England
PYREX	Glass	Sovirel, France
QUACORR	Furanes	PO Chemicals, USA
QUICKFIT	Glass	Corning, England
RADEL	Polyarylether	Amoco, USA
RENOLIT	Polyvinylchloride	Renolit-Werke, Germany
RESAMIN	Ureas	Hoechst, Germany
RHENOFLEX	Polyvinylchloride	Hüls, Germany
RHEPANOL	Polyisobutylene sheet	-
RHODORSIL	Silicone rubbers	Rhone-Poulenc, France
RIGIDEX	Polyethylene	BP Chemicals, England
RILSAN	Polyamide	Elf Atochem, France
RULON	Filled PTFE	Dixon Corp., USA
RUTAPOX	Epoxies	Bakelite, Germany
RYTON	Polyphenylene sulfide	Phillips Petr., Belgium

SARAN	Polyvinylidene chloride	DOW, USA
SETAL	Unsaturated polyesters	Synthese, Netherlands
SETAPOL	Unsaturated polyesters	Synthese, Netherlands
SHELL PB	Polybutene	Shell
SILASTIC	Silicone rubbers	DOW, USA
SILCOSET	Silicone rubbers	ICI, England
SILOPREN	Silicone rubbers	Bayer, Germany
SOLEF	Polyvinylidene fluoride	Solvay, Belgium
SOLVIC	Polyvinyl chloride	Solvay, Belgium
SOREFLON	Polytetrafluoroethylene	Elf Atochem, France
STAMYLAN	Polyethylene	DSM, Netherlands
STAMYLAN P	Polypropylene	DSM, Netherlands
STANYL	Polyamide	DSM, Netherlands
STYROCELL	Polystyrene foam	Shell
STYRODUR	Polystyrene foam	BASF, Germany
STYROFOAM	Polystyrene foam	DOW, USA
STYRON	Polystyrene	DOW, USA
STYROPOR	Polystyrene foam	BASF, Germany
SWD CEMENT	Sodium silicate cement	Hoechst, Germany
SYNOLITE	Unsaturated polyesters	DSM, Netherlands
TECHNYL	Polyamides	Rhone-Poulenc, France
TEDLAR	Polyvinylfluoride	Du Pont, USA
TEFLON	Polytetrafluoroethylene	Du Pont, USA
TEFLON FEP	Fluorinated ethylene propylene	Du Pont, USA
TENAX	Carbon fibre	Tenax, Germany
TENITE BUTYRATE	Cellulose acetate butyrate	Eastman Chem. Prod., USA
TENITE CAB	Cellulose acetate butyrate	Eastman Chem. Prod., USA
TENITE PE	Polyethylene	Eastman Chem. Prod., USA
TERGAL	Saturated polyesters	Rhone-Poulenc, France
TERLENKA	Saturated polyesters	ENKA, Germany
TERLURAN	Acrylonitrile butadiene styrene	BASF, Germany
TERYLENE	Saturated polyesters	ICI, England
THERBAN	Polybutadiene acrylonitrile rubber	Bayer, Germany
THIOKOL	Polysulphides	Thiokol Corp., USA

TORLON	Polyamide-imide	Amoco Corp., USA
TREVIRA	Saturated polyesters	Hoechst, Germany
TROCAL	Polyvinylchloride	Hüls, Germany
TROGAMID	Polyamides	Hüls, Germany
TROVIDUR	Polyvinylchloride	Hüls, Germany
TROVIDUR PP	Polypropylene	Hüls, Germany
TUFNOL	Phenolics, Furanes	Tufnol, England
TUFSYN	Polybutadiene	Goodyear, USA
TWARON	Polyaramide	AKZO, Netherlands
TYNEX	Polyamides	Du Pont, USA
UDEL	Polysulfone, Polyether sulfone	Amoco, USA
UFORMITE	Ureas	Reichold, USA
UGIKAPON	Unsaturated polyesters	Elf Atochem, France
UKAPOR	Polystyrene	Elf Atochem, France
ULTEM	Polyetherimide	General Electric, USA
ULTRADUR	Saturated polyesters	BASF, Germany
ULTRAMID	Polyamides	BASF, Germany
ULTRAPAS	Melamines	Hüls, Germany
ULTRASON S	Polysulfone	BASF, Germany
ULTRASON E	Polyethersulfone	BASF, Germany
URALAM	Unsaturated polyesters	Synthetic Resins Ltd., England
UREPAN	Polyurethanes	Bayer, Germany
VALOX	Saturated polyesters	General Electric, USA
VARLAN	Polyvinylchloride	DSM, Netherlands
VESPEL	Polyimide	Du Pont, USA
VESTAMID	Polyamides	Hüls, Germany
VESTAN	Saturated polyesters	Bayer, Germany
VESTODUR	Saturated polyesters	Hüls, Germany
VESTOLEN A	Polyethylene	Hüls, Germany
VESTOLEN P	Polypropylene	Hüls, Germany
VESTOLIT	Polyvinylchloride	Hüls, Germany
VESTOPAL	Unsaturated polyesters	Hüls, Germany
VICTREX	Polysulfone, Polyethersulfone	ICI, England
VINIDUR	Polyvinylchloride	BASF, Germany
VINNOL	Polyvinylchloride	Wacker-Chemie, Germany
VIPLA	Polyvinylchloride	Enichem, Italy
VITON		Du Pont, USA

A	Copolymer of vinylidene fluoride-hexafluoropropylene	
B	Terpolymer of vinylidene fluoride-hexafluoropropylene-tetrafluoroethylene	
G	Tetrapolymer of vinylidene fluoride-hexafluoropropylene-tetrafluoroethylene-perfluoromethyl vinyl ether	
VITREOSIL	Quartz/silica	-
VITREX	Silicate cement	Atlas Mineral Products, USA
VOLTALEF	Polytrifluorochloroethylene	Elf Atochem, France
VULCATHENE	Polyethylene, low density	-
VULKODURIT		Keramchemie, Germany
D	Hard rubber	
WN	Polychloroprene	
WT	Polybutadiene acrylonitrile	
W 50	Polyisobutylene isoprene	
VULCOFERRAN		Harzer Achsenwerke, Germany.
2100/2107	Styrene butadiene rubber	
2105/2154	Hard natural rubber	
2190/2194	Hard natural rubber	
2202	Polyisobutylene isoprene rubber	
2512	Chlorosulphonated polyethylene rubber	
VULKOLLAN	Polyurethane rubber	Bayer, Germany
VYCOR	Quartz/Silica	Corning Glass, USA
WAPEX	Epoxy cement	AKZO, Netherlands
WAVISTRONG	Fibre reinforced epoxies	Wavin, Netherlands
WELVIC	Polyvinylchloride	ICI, England
XYLON	Polyamides	AKZO, Netherlands
XYRON	Polyphenylene oxide	ASAHI, Japan
ZYTEL	Polyamides	Du Pont, USA