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PETROCHEMICAL INDUSTRY SERIES
MONOGRAPH No. 5

ESTABLISHING STANDARDIZATION OF PLASTICS IN DEVELOPING COUNTRIES

UNITED NATIONS

ESTABLISHING
STANDARDIZATION OF PLASTICS
IN DEVELOPING COUNTRIES

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION, VIENNA

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FOREWORD

This publication is the fifth of a series of monographs in the Petrochemical Industry Series to be published by the United Nations Industrial Development Organization. The titles of other studies in this series will be found on the back cover of this publication.

The world petrochemical industry has shown a high rate of growth during the last ten years. The industry supplies intermediate products for a number of other industries and provides substitutes for traditional materials such as steel, lumber, packaging materials, natural fibres, natural rubber and soap. It is considered to be one of the most strategic sectors of industrial development because most of its products go on to other producing sectors.

This series is designed to assist the developing countries in dealing with technical and economic problems related to the establishment and development of facilities for the manufacture of petrochemicals and consumer products. The present series is concerned with basic and intermediate petrochemicals and end products, such as plastics, synthetic rubbers and synthetic fibres. Nitrogenous fertilizers[1] and textile production based on synthetic fibres are excluded from the series.

The present monograph was prepared by Mr. Koei Maruta serving as consultant to UNIDO. The views and opinions expressed are those of the consultant and do not necessarily reflect the views of the secretariat of UNIDO.

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[1] See the Fertilizer Industry Series published by the United Nations Industrial Development Organization (ID/SER.F, Nos. 1, 2, 3, 4 and 5).

Explanatory notes

Reference to dollars ($) is to United States dollars.

The following abbreviations have been used in the report:

ASTM	American Society for Testing Materials
BS	British Standard
DIN	Deutsche Industrie Norm
JIS	Japanese Industrial Standard
ISO	International Organization for Standardization
kV	kilovolt
NF	Norme française
PVC	Polyvinyl chloride
VSM	Verein Schweizerischer Maschinenindustrieller

CONTENTS

ORGANIZATION AND FUNCTIONS OF A NATIONAL STANDARDS BODY FOR DEVELOPING COUNTRIES

Industrialization of a country must be built on a sound foundation of science and technology. In order to promote science and technology, many positive steps should be taken in the fields of education and research. Standardization and quality control in production are also regarded as important tools for industrialization.

Standardization contributes extensively to higher productivity. It avoids waste of materials during handling, processing and transport, it simplifies production procedures, reduces the different products to a minimum, permits the interchangeability of pieces, and facilitates the flow of goods and services internally as well as to foreign countries. It also helps to save on essential imported materials by substituting for them more readily available local materials. Standardization is not limited to industry, transport and commerce, it is also related to education, language, science, engineering, weights and measures, and even to the mode of living within a country. Standardization safeguards the health and the lives of the people, and protects the consumer against poor quality and inefficient products. Standardization in connexion with industrialization must be studied in the broadest sense of the term.

Every country that plans industrialization and rapid economic growth through the introduction of standardization and quality control must consider establishing a central national standards body (NSB). No single uniform pattern for this body would be suitable for all countries. The organization, administrative structure, status and working procedures of the national standards bodies in different countries vary considerably in details depending on the political, economic and social conditions of the country and the degree of industrial and technological development.

Although the national standards body is officially sponsored and supported in some countries, its administration is left to a council or board of nominees representing government, industry, trade, commerce and other branches vitally concerned with standardization. This arrangement seems to be most suitable for developing countries, because it permits the co-existence of official planning and private enterprise initiative.

In small countries standardization activity may be handled as a part of a larger composite organization encompassing industrial research, development and testing activities. Some of the existing national standards bodies limit their activities to formulating and issuing standards; they leave publication sales, translations and related jobs to other agencies and organizations. Other bodies have the added responsibility of maintaining the physical standards for weights and measures, issuing test certificates for import and export commodities, and carrying out similar duties.

Objectives and functions

The common objectives and functions of a typical national standards body are:

(a) To prepare and promote the general adoption of standards at the national level in co-operation with other interested organizations working to improve industry, agriculture, domestic and foreign trade in a country;

(b) To make continual checks to ensure that the national standards formulated under objective *(a)* are abreast of the latest scientific and technical developments, and to amend, revise or withdraw the standards so as to comply with such developments;

(c) To promote standardization as an integral yet distinct function of management, including the promotion of company standardization, quality control, simplification and allied techniques in industry and commerce;

(d) To serve as the national channel for an exchange of information and to co-ordinate standards activities with other countries at the regional and international level;

(e) To serve as a national centre or clearing house for all information on the subject of standardization.

The National Standards body should also be entrusted with one or more of the following responsibilities:

(f) To function as a metrological centre and repository for fundamental standards;

(g) To undertake tests for industry and issue certificates of compliance with standards;

(h) To implement national standards through the administration of a national certification mark scheme or the inspection of goods.

Administrative structure and status

The planning for industrial progress in a developing country is generally the direct concern and responsibility of the Government . Since the creation of a national standards body and the establishment of standards should be a part of industrial development, a high-ranking officer in the department of commerce and industry should be responsible for initiating the standardization activity. The national standards body in a developing country must have official support. In the absence of an organized industrial sector, the new organization will have to rely largely on financial support from the state.

The national standards body may be established by legislation or by executive order of the Government; either method affords firm standing and a measure of stability.

The administrative status of the NSB varies according to the social and economic conditions of the country; generally it falls into one of the following categories:

(a) A department of the Government, as in Ireland, Japan, Mexico, the Philippines, the Republic of Korea and the Union of Soviet Socialist Republics;

(b) A private organization without any official control or financial assistance from the Government, as in the Federal Republic of Germany and Switzerland;

(c) A joint venture of the Government and industry, as in Australia, India and the United Kingdom. In this case the responsibility for the management of the NSB is shared in a proportion dependent upon the degree of industrial development and government interest in the country.

Whatever the status of the NSB, the operative phase of its work must be co-ordinated and supported by government, industry, consumers, trade organizations, research bodies and academic institutions. Representatives from these public sectors should join in the administration of the NSB at both the policy-making and working level to ensure complete co-operation and agreement. It is recommended that the governing council appoint from its membership a small executive committee to deal with detailed matters relating to administration and programmes.

Charts 1 and 2 indicate possible types of national standards bodies in developing countries.

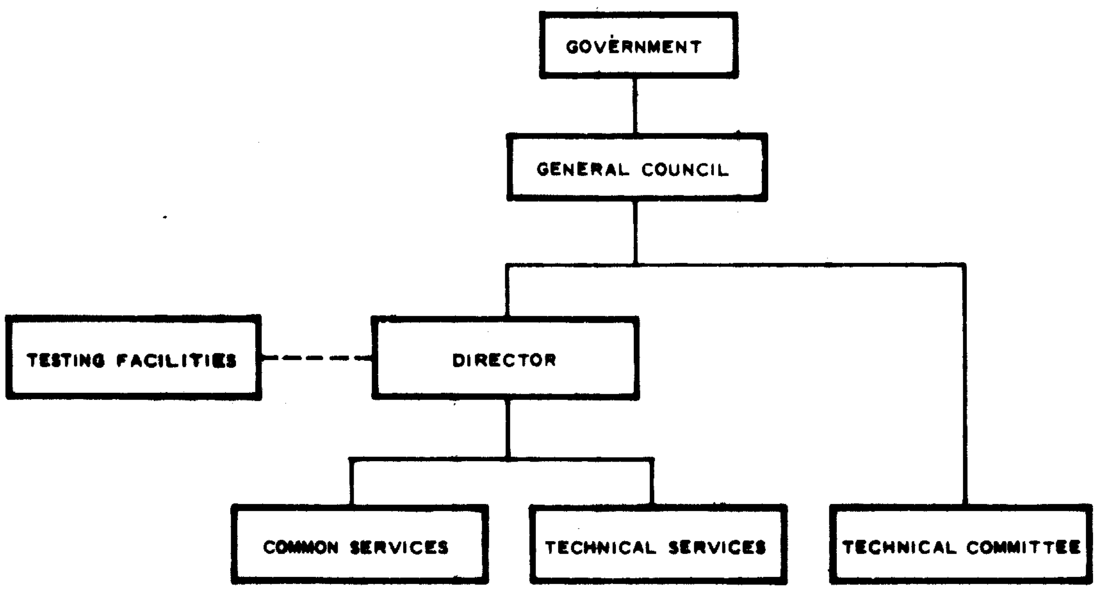
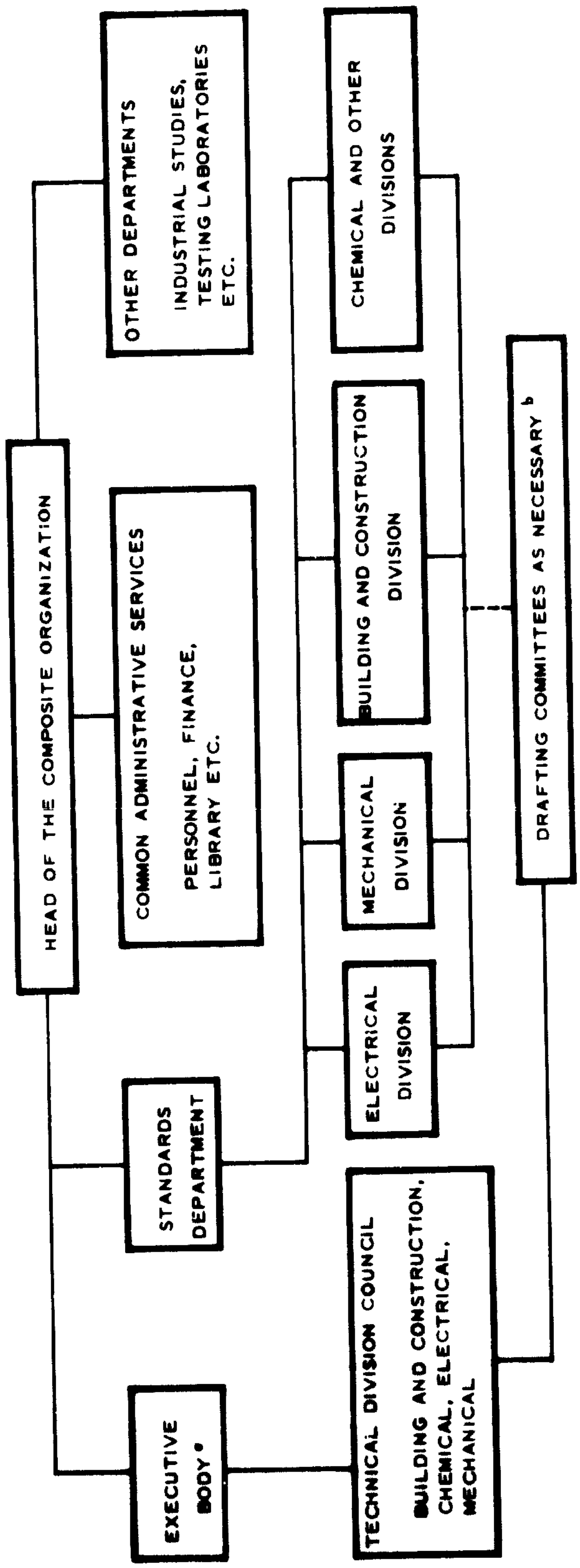


Chart 1. Recommended organization of a national standards body



[a]The executive body, consisting of qualified specialists and top men from industry and science, works in an honorary capacity and has the authority to approve drafts as national standards.

[b]The various divisions of the secretariat provide representatives for the drafting committees. The members of the drafting committee, who also work in an honorary capacity, are selected by the executive body on the recommendation of the director of the standards department.

Chart 2. Recommended organization of a composite standards body

Financial requirements

In countries where the standards body is a department of the Government, the body receives all its funds from the Government. Even in the case of independent and autonomous standards bodies, a sizeable proportion of the funds needed is generally provided by the Government.

The financial requirements for initiating a national standards programme are not demanding. In the early stages of development, the expenses are limited to staff salaries and miscellaneous expenditures. The actual figures vary from country to country, depending on the economic and social conditions, the stage of industrial development, and the actual functions entrusted to the NSB. Much of the expense of establishing and sustaining the NSB may have to be borne by the Government. In this case, the standards body should attempt to raise money of its own – through contributions from industry or other organizations participating in standardization work, through the sale of publications, or from other sources.

Special considerations for small countries

Smaller countries with limited resources of scientific manpower, funds or facilities may find it advantageous in the initial stages to handle their standardization activities through a multipurpose institution that deals with standards as well as with industrial research, development and testing. The Economic Development Board in Singapore, which looks after all the problems arising in the development of industry, including industrial research and standardization, is a good example of a multipurpose institution. Similar organizations for testing and standardization are being started in Ghana and the Philippines.

Another possibility, also economically feasible for small countries, is the joint establishment of a multinational standardization organization for two or more neighbouring countries with comparable economic environments. Such collaboration enables the participating countries to pool resources and technical know-how for mutual use and benefit, and to promote industrial integration and trade with each other. A successful example is the collaboration among six Central American countries, (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama) in setting up the Central American Research Institute for Industry (ICAITI) for the purpose of establishing standards for the participating countries.

Each country sets up a small national unit for the purpose of implementing standards, certification marking and quality control. At the same time, the multinational standards body formulates and issues standards. The national unit also evaluates each draft standard in terms of the national interests of the country and serves as the centre for standardization documentation and sales. Each unit can be organized as a part of the appropriate department of the Government.

If neither of these possibilities is feasible, a third choice might be more acceptable, i.e. the small country joins the NSB of a neighbouring country as a subscribing member. In this arrangement, the member country receives all working documents and literature issued by the national standards body, and is able to join in the consultation on various proposed standards. The officials of the small country can also gain experience by participating in the work of the NSB and availing themselves of its training facilities.

Formulating national standards

Before the technical work of a national standards body begins the programme of work must be carefully planned. In order to decide in which fields and to what extent the work should be carried out, the NSB has to choose those areas of operation, products and processes whose standardization will bring early maximization of benefits. The following standards must be considered when determining which areas should have priority:

(a) Standards for natural products and goods to be exported;

(b) Standards for locally manufactured goods, including agricultural products, foods and clothing;

(c) Standard codes for building, construction and installations, and safety codes for the operation of equipment;

(d) Standards for goods purchased from abroad, particularly machinery, vehicles, etc., for which it is desirable to maintain a reasonable level of quality.

In order to make the best use of time and available resources, it is advisable in the beginning to adopt: *(a)* non-controversial recommendations from the International Organization for Standardization (ISO) or International Electrotechnical Commission (IEC), and *(b)* standards from countries with similar economic conditions and climate.

Since standardization is applicable to all aspects of economic activity, the standards must satisfy the interests of all sectors of society, i.e. producers, consumers, traders and so on. When consumers consider the types of products they need or want, they tend to over-specify and expect qualities which, although theoretically desirable, may not be economical or practicable. Producers, on the other hand, usually press for lower specifications to achieve the greatest margin of benefit. Standards should not be drafted unilaterally, therefore, but should be based on a synthesis of both views, well co-ordinated through expert technical advice.

The usual and almost universally adopted procedure for formulating national standards has been the committee method, in which all interested parties, e.g. manufacturers, consumers, technologists, government departments, laboratories and research organizations, are appropriately represented. The objective of the committee is to obtain a consensus and a full measure of acceptance from the committee participants. This makes the standard truly national.

Usually a preliminary draft of the proposed standards is made available at the first committee meeting. It may be prepared by a member of the committee or by the technical staff of the standards body. The draft standard that emerges from the committee as acceptable is then publicly issued in order to elicit views and comments from all possible interested sources. The committee takes these comments into consideration when finalizing the draft standard, which is then published as a national standard with the approval of the executive authorities. The entire process of preparing and publishing standards based on the committee method and consensus principle is usually time consuming, but it should not, under normal circumstances, be subject to undue haste.

National standards are not only important tools for industrialization, but are also related to various fields of science and engineering, transport, commerce, and even to the daily life of the people. The scope and sphere of national standards should therefore include:

(a) Technical terms, notations, definitions, symbols and dimensions;

(b) Kind, shape, quality and properties of mineral, industrial and agricultural products;

(c) Testing, analysis, inspection and methods of measurement;

(d) Methods of design, manufacture, use and packing;

(e) Codes of practice for installation and maintenance, and safety requirements.

Chapter Two

LABORATORY FOR TESTING PLASTICS

Functions

The establishment of a standards organization presupposes the existence of a minimal infrastructure in science and technology, which is provided by the science and engineering faculties of the universities and by the laboratories of the government technical departments. The efficient operation of a national standards body is not feasible without laboratory facilities in the country. Through suitable tests and investigations, the laboratories provide technical support and indispensable data for:

(a) Selecting and ranking subjects for standardization;
(b) Determining the specific characteristics and limits of requirements to be included in the standard;
(c) Adopting the most appropriate test method;
(d) Keeping the standard up-to-date through amendments and revisions so that it conforms to the latest technological developments;
(e) Inspecting goods or administering a national certification marking scheme.

The plastics industry has become one of the most important sectors of industry not only in industrially advanced countries but also in developing countries. Plastics are made abundantly from chemicals derived from such underground resources as petroleum, natural gas and coal. Plastics have many excellent characteristics that natural organic materials do not have. For example, natural materials are limited in processability, but plastics can be moulded freely and easily.

Plastics can be coloured to give clear, beautiful products. Possessing such properties, they provide a wide range of items that make daily life more enjoyable. Because plastics have other excellent properties, they are also important for building and construction materials, electrical and mechanical parts, agriculture, packaging and so forth.

The progress of civilization has substantially increased the demand for plastics in the past ten years, and future demand should continue to expand considerably year by year.

It is not an exaggeration to say that the establishment and promotion of a plastics industry should be the most important consideration in planning industrialization in developing countries. The introduction and adoption of standards for plastics materials, products and testing methods, and the establishment of appropriate laboratories and testing facilities for high polymers would help to ensure the smooth development of the plastics industry in these countries.

Personnel, space, equipment and funds

The necessary organization, personnel and cost estimates for land, buildings, testing equipment, etc. for a laboratory for testing plastics in developing countries are presented in tables 1, 2, 3 and 4. The laboratory should provide not only the various standardization services mentioned above, but should also be used to offer encouragement and instruction in: *(a)* research and development of private enterprises; *(b)* training of technical personnel; and *(c)* information and publication services.

TABLE 1. RECOMMENDED SPACE, PERSONNEL AND ORGANIZATION IN A LABORATORY FOR TESTING PLASTICS

Space	
Land	15,000 m^2
Floor space	4,000 m^2
Personnel	
Engineers and technicians	60
Clerical employees	20

Organization

Chief
- Research division
- Processing and testing division
- Information and publications division
- General affairs division

TABLE 2. RECOMMENDED MACHINES AND EQUIPMENT IN A LABORATORY FOR TESTING PLASTICS

Equipment	*Number*	*Unit price* (US dollars)[a]	*Total cost* (US dollars)[a]
Tension testing instrument (tensile, flexural, compressive)			
general purpose	2	7,780	15,560
with thermo-hygrostat	1	23,610	23,610
Impact testing instrument			
for films	3	556	1,668
for mouldings	3	1,110	3,330

Table 2 *(continued)*

Equipment	*Number*	*Unit price* *(US dollars)*[a]	*Total cost*
Tear testing instrument	3	278	834
Cutting testing instrument	2	6,940	13,880
Rubbing testing instrument	3	3,610	10,830
Instron tensile testing instrument	1	38,900	38,900
Creep testing instrument			
small	10	4,170	41,700
large	5	6,940	34,700
Hardness tester	3	556	1,668
Deflexion tester	2	3,060	6,120
Weather meter	2	6,940	13,880
Fade meter	3	1,110	3,330
Plastograph	2	12,500	25,000
Melt indexer	5	1,110	5,550
Ageing test apparatus	1	7,500	7,500
Absorption test apparatus	3	1,390	4,170
Heat resistance apparatus	2	278	556
Flammability test apparatus	2	278	556
Arc resistance testing instrument	1	4,170	4,170
Voltage power resistance testing instrument	1	13,880	13,880
Dielectric constant testing instrument	2	4,170	8,340
Thermal conductivity testing instrument	2	2,780	5,560
Permeability meter	2	2,780	5,560
Transparency meter	3	1,110	3,330
Gloss meter	3	1,390	4,170
Refractive indexer	3	833	2,499
Colorimeter	3	1,390	4,170
Colour difference meter	2	8,330	16,660
Electric insulation meter	2	2,220	4,440
Gas chromatograph	1	4,170	4,170

Table 2 *(continued)*

Equipment	*Number*	*Unit price* (US dollars)[a]	*Total cost*
Spectrophotometer	1	8,330	8,330
Nucleus magnetic resonance absorption apparatus	1	38,900	38,900
Molecular weight distribution determination apparatus	1	27,800	27,800
X-ray diffraction apparatus	1	22,200	22,200
Microscope	5	1,390	6,950
Electron microscope (150 kV)	1	38,900	38,900
Electron microscope attached apparatus	1	13,900	13,900
High frequency testing instrument	1	27,800	27,800
Test reactor			
1,500 litre	1	8,330	8,330
500 litre	3	4,170	12,510
Combustion test furnace	1	13,900	13,900
Low temperature tank	1	278	278
Manufacturing machines (with automatic recorders), including machines for:			
Compression moulding		5,560	
Injection moulding		35,550	
Extrusion		12,500	
Blow moulding		25,000	
Vacuum forming		10,560	
Foam plastics		11,660	
Extruded film		50,000	
Inflation film		12,500	
Calendered sheeting		8,330	
		171,660	171,660
Jigs etc.	1 set	13,900	13,900
Roll mill	2	2,220	4,440
Apparatus for chemical analysis	1 set	13,900	13,900
Other miscellaneous testers and apparatus (balance, dessicator etc.)	1 set	27,800	27,800
TOTAL			781,789

[a]Prices have been converted from Japanese yen (360 yen = $1.00).

TABLE 3. RECOMMENDED FACILITIES IN A LABORATORY FOR TESTING PLASTICS

	Cost (US dollars)[a]		
Laboratory			
Installation of electrical facilities including:			
Light and power	21,550		
Transformer	13,900		
Others	3,440	38,890	
Installation of other facilities including:			
Water supply	6,440		
Drain system	6,560		
Gas supply	16,350		
Air conditioning	116,600		
Others	6,780	152,730	
		191,620	191,620
Office			
Installation of electrical facilities	23,620		
Installation of other facilities	37,500	61,120	61,120
TOTAL			252,740

[a]Prices have been converted from Japanese yen (360 yen = $1.00).

TABLE 4. INVESTMENT COSTS FOR A LABORATORY FOR TESTING PLASTICS

		Investment cost (US dollars)[a]
Land (15,000 m^2)		417,000
Construction, including:		
Laboratory (3,000 m^2)	417,000	
Office (1,000 m^2)	125,000	
Land readjustment	12,000	554,000
Testing machines and equipment[b]		781,789
Installation of electrical and other facilities[c]		252,740
Miscellaneous construction		55,600
Miscellaneous fixtures		30,550
TOTAL		2,091,679

[a]Prices have been converted from Japanese yen (360 yen = $1.00).
[b]Data from table 2.
[c]Data from table 3.

Chapter Three

CLASSIFICATION OF STANDARDS FOR PRODUCTS AND TESTING METHODS, WITH EMPHASIS ON PLASTICS

Items to be standardized may be considered individually or they may be grouped according to the system or classification of standards, their relationship to other standards or their content.

Style manual for standards

The establishment of a style manual for standards aims at uniformity of style and form for standards not only for plastics but in all fields. General rules on such matters as scope, wording, style and form of the text, reference number, and composition and order of sections, should be covered in the style manual.

The composition and general arrangement of the style manual for standards is indicated below.

Specifications for products

Title. The titles of the items being specified are clearly indicated.

Scope. The categories of products dealt with by the specification are defined as clearly and briefly as possible. The definition, construction, applications, conditions of use and principal contents of standards are stated.

Terms and their definitions. Common terms for each division in industry are defined in one standard, and special terms are listed in each separate specification.

Type and grade. Since the specification is made to rationalize industry, simplify trade, and ensure the satisfactory use of the material, each specification must have sufficient types and grades. The points below should be taken into consideration:

(a) The basic properties by which the material is classified (by type and by grade) must be chosen from those characteristics appropriate and applicable to the specification and selection of the material or product;

(b) The materials or products specified are first separated by types, based on some major property, composition or application of the material. Further sub-divisions are designated by grades according to other pertinent properties. If necessary, grades can be divided further into classes;

(c) A large number of types and grades should be avoided.

Material. The product is certified according to its characteristics and properties; a certain material is only specified if:

(a) The values of the characteristics and properties cannot serve thoroughly as a guarantee of quality;

(b) The specification is concerned with human safety or preservation of life;

(c) Interchangeability is required;

(d) Some political purpose is involved in the specification.

Manufacture. The product is certified according to its properties; a certain method of manufacturing is only specified if:

(a) The quality cannot be sufficiently assured by any inspecting method;

(b) The specification can only be clearly and exactly stated when the method of manufacturing is also specified;

(c) The important characteristics of the products cannot be indicated at the present stage by any determining method;

(d) It is too expensive to inspect the product for quality.

Composition, form and size. The product is certified according to its properties; the composition, form and size of a product are only specified if:

(a) It is necessary in view of interchangeability, durability, simplification, manufacturing method and use;

(b) A better understanding of the specification can be gained when composition, form and size are specified.

Performance. The product is defined, if possible, by its performance. In specifying performance, the following features are important:

(a) Only required practical performance should be taken into consideration;

(b) When substitute characteristics are to be defined , the relationship of these to practical performance must be clearly stated;

(c) At the same time, testing methods for determining the performance should also be considered.

Ingredients, chemical and physical properties. The ingredients and essential chemical and physical properties that can be determined are specified if:

(a) They are important for the performance and suitable for the specification;

(b) The quality of the product cannot otherwise be sufficiently defined.

Tests. This section covers all instructions needed to carry out the tests for determining the characteristics listed above under "performance" and "ingredients, chemical and physical properties".

Inspection. The objects and standards of judgement for inspection are clearly defined.

Packaging. The units and styles of packaging are defined.

Terms. If there are many types of the product and it is necessary to distinguish one from another, names and terms are defined.

Marking. Items, such as name, manufacturer, date of manufacture, code number, etc. are defined, and the place and method of indication and the description order are listed.

Specifications for testing methods

Title. (See specifications for products above.)

Scope. (See specifications for products above.)

Steps. The essential steps of the method used are briefly indicated, excluding procedural details.

Terms and their definitions. (See specifications for products above.)

Apparatus. A brief description of the essential features of the apparatus and equipment required for the test is included, as well as schematic drawings or photographs for clarifying the information given in the text. Important features and requirements for the apparatus are covered in separate paragraphs.

Materials and reagents. The essential characteristics of the needed reagents, particularly their dilution, density and degree of purity, are stated. The precautions to be taken for the storage of reagents and the length of time they may be stored are indicated.

Samples and test specimens. The number of specimens to be tested is stated and detailed requirements as to the size of test specimens are given.

Conditioning. The conditioning atmosphere to be used, the length of time for conditioning specimens prior to testing, and the atmosphere required during the test are specified.

Procedure. Directions for performing the test should be given in proper sequence, describing in detail the successive steps of the procedure and grouping related operations into logical paragraphs.

Expression of results. Directions for calculating the results of the test are given. Any equations used are included with a description of the letter symbols immediately under the equation.

Reporting results. Detailed information required in reporting the results of the test is included.

Standards for plastics materials, products and testing methods

Plastics materials and products

Of the many kinds of plastics materials and products, the plastics below have been selected as those consumed in the largest quantity. These materials and products should be specified one after another, according to the conditions and circumstances of each country.

Classification by resin	Products and applications
Thermosetting resins	
Urea	Moulding material, sheet, pipe, rod adhesives
Phenolic	Moulding material, sheet, pipe, rod, adhesives
Alkyd	Paint
Polyurethane	Soft urethane foam, rigid urethane foam

Unsaturated polyester	Moulding material, corrugated sheet
Melamine	Moulding material, decorative sheet, adhesives
Epoxy	Sheet, paint, adhesives
Thermoplastic resins	
Polyethylene	Moulding material, sheet, pipe and fittings, film, hose, cellular plastics
Polyvinyl chloride (PVC)	Moulding compound, sheet, pipe and fittings, film, hose, corrugated sheet, cellular plastics
Polystyrene	Moulding material, sheet, cellular plastics
Polypropylene	Moulding material, pipe, film
Methacrylate	Moulding material, sheet
Polyamide	Moulding material, sheet, pipe, rod
Cellulose acetate	Moulding material, sheet, film
Nitrocellulose	Moulding material, sheet, film
Polyvinylidene chloride	Film
Polyvinyl acetate	Paint, adhesives
Acrylonitrile–butadiene-styrene (ABS)	Moulding material, sheet, pipe
Polycarbonate	Moulding material
Polytetrafluoroethylene	Moulding material, tape, sheet, pipe, rod

Testing methods for plastics

Testing methods, including testing conditions, apparatus and machines, procedures, etc., should be unified in order to be commonly applicable to all plastics and products, making it possible to compare one material with another and to save testing time and money. The various properties of plastics to be tested are listed below.

Mechanical properties. Tensile strength, compressive strength, flexural strength, torsion strength, creep, fatigue, impact strength, hardness, rubbing strength, abrasion resistance and workability (moulding, cutting, punching, etc.).

Electrical properties. Electric strength, insulation resistance, dielectric constant, dielectric loss angle, dielectric breakdown voltage, corona resistance, arc resistance.

Physical properties. Specific gravity, specific volume, dilute solution viscosity, fusion viscosity, acoustical quality, water vapour transmission and permeability, surface phenomenon, specific heat, thermal conductivity, linear expansion, cubical expansion, brittleness temperature, softening point, decomposition temperature, flammability, refractive index, transparency, lustre.

Chemical properties. Resistance to chemical substances (acids, alkalis, organic solvents, etc.), resistance to oil, water absorption, volatile matter, moisture content, resin content, stress-cracking, effect of sunlight and daylight, resistance to radiation, resistance to fungi.

NATIONAL AND INTERNATIONAL STANDARDS FOR PLASTICS MATERIALS, PRODUCTS AND TESTING METHODS

Abstract of standards for plastics materials and products

Plastics materials claim many important properties, such as good workability, good colouring and low specific gravity. They provide good thermal and electrical insulation and are anticorrosive. Nevertheless, they are weak with respect to mechanical strength, dimensional stability, heat resistance and resistance to weathering. In establishing a standard for plastics, these special features should be taken into consideration so that the content of the standard is suitable for the conditions of final use.

Various standardization organizations have specified the properties for plastics materials and products used in large quantities. These are listed below. The full title for each organization is given in the list of abbreviations.

Plastics materials and products	*Property specified*
Non-rigid vinyl chloride polymer and copolymer, moulded and extruded compounds	Type, class, colour fastness in daylight, tensile strength, volume resistivity, softness, cold flexure temperature, deformation under heat, electric strength, water absorption, colour bleeding, elongation after heating, elongation at break, effect on polyethylene, cold-flex temperature, cold flexure after ageing, loss on heating, water soluble matter *(Standard: BS)*
Polyethylene, moulded and extruded	Type, grade, class, tensile strength, elongation, brittleness temperature, environmental stress-crack resistance, dissipation factor, dielectric constant, volume resistivity *(Standard: ASTM)*
Polystyrene, moulded and extruded	Type, softening point, temperature of deflexion under load, tensile strength, flexural strength, melt-flow index, specific gravity, refractive index, dissipation factor, dielectric constant, impact strength *(Standard: ISO)*

Unplasticized PVC pipe for cold water supply	Type, class composition, size, wall thickness, opacity, effect on water, hydraulic test, reversion test, colour, freedom from defects, length *(Standard: BS)*
PVC garden hose	Size, composition, wall thickness, hydraulic test, cold-flex temperature before ageing, cold-flex temperature after ageing, loss on heating, colour bleeding, minimum bend radius *(Standard: BS)*
Rigid PVC sheets	Grade, size, specific gravity flexural stress, coefficient of expansion, thermal conductivity, modulus of elasticity, hardness, tensile strength, elongation, impact strength, Vicat softening point *(Standard: DIN)*
Decorative laminated sheets	Type, grade, size, tensile strength, impact strength, resistance to cigarettes, thermal resistance, resistance to boiling water, resistance to water vapour, dimensional stability, colour fastness in sunlight, stain resistance, workability *(Standard: DIN)*
Non-rigid vinyl chloride plastic sheets	Type, thickness, size, tensile strength, elongation at break, external and internal tear resistance, volatile loss, water extraction, low-temperature impact, flammability, cracking, shrinkage at elevated temperature *(Standard: ASTM)*
Rigid urethane foam	Type, compressive strength, flammability, porosity, water absorption, water vapour permeability, dimensional stability, flexural strength *(Standard: ASTM)*
Cellulose nitrate plastic sheets, rods and tubes	Type, residue, volatile matter, fuming-off temperature, acidity, specific gravity, tensile strength, elongation, impact strength, hardness (Rockwell), haze value, water absorption, deflexion temperature *(Standard: ASTM)*
Acrylonitrile-butadiene-styrene (ABS) plastic pipe	Size, materials, wall thickness, sustained pressure, burst pressure, extrusion quality *(Standard: ASTM)*
Polyethylene pipes for water works service	Type, size, weight, tensile strength, resistance to hydrostatic pressure, thermal internal pressure, creep, ash, effect on water *(Standard: JIS)*
Polyethylene films for agriculture	Type, grade, size, thickness, tensile strength, elongation, tear strength *(Standard: JIS)*

Polystyrene sheets	Type, size, thickness, tensile strength, impact strength, thermal deflexion temperature, elongation or shrinkage after heating *(Standard: JIS)*
Polyvinyl chloride-metal laminated sheets	Type, size, adhesive strength, bending test, resistance to low temperature, resistance to boiling water, resistance to erosion, flammability, resistance to chemical substances, colour fastness in sunlight, workability *(Standard: JIS)*
Laminated thermo-setting sheets	Type, grade, class, size, thickness, flexural strength, compressive strength, impact strength, fragility test, thermal resistance, water absorption, resistance to acetone, electric strength, insulation resistance, dielectric constant, dielectric loss *(Standard: JIS)*
Urea resin adhesives for wood	Type, volatile matter, preservativity, water tolerance, polyvinyl acetate tolerance, adhesive strength, pH-value, viscosity, gelation time, free formaldehyde content *(Standard: JIS)*
Foam polystyrene thermal insulating material	Type, raw materials, manufacturing process, size, apparent density, thermal conductivity, flexural strength, compressive strength, water absorption, flammability *(Standard: JIS)*
Acetyl cellulose sheets	Type, size, thickness, raw material, tensile strength, elongation, water absorption, loss on heating, flammability *(Standard: JIS)*

Summary of selected methods of testing plastics

The ISO has prepared many recommendations and drafts dealing with methods of testing plastics. These methods should be incorporated as much as possible into the national standards of various countries.

In the following paragraphs, selectedtypical procedures for testing plastics properties are summarized. For further information, reference can be made to the national standards and recommendations listed below each summary. It is very difficult to compare national standards (ASTM, BS, DIN, JIS, NF, VSM) because the organizations use varied testing procedures, different basic units (metric system and inch system) and room temperatures (20°C in DIN, JIS, NF and 23°C in ASTM, BS), and different specimen sizes, testing loads and testing speeds.

Tensile and compression tests

A testing machine of the constant-rate-of-cross-head-movement type (e.g. Olsen, Instron, Zwick, Amsler) is commonly used. A specimen is stretched or compressed depending on the test. The load under which the specimen breaks is used to determine the tensile strength or compressive strength.

Tensile strength: ASTM D 638, BS 2782 method 301, DIN 53455, VSM 77 101
Compressive strength: ASTM D 695, DIN 53454, VSM 77 102

Flexure test

Bar resting on two supports

A specimen bar is placed on two supports, separated by a specified span. The load is applied by means of the loading nose of a testing machine (e.g. Amsler) midway between the supports. The load under which the specimen breaks determines the flexural strength.

Cantilever beam

A stiffness tester is used. A specimen is fixed horizontally to the cantilever beam of the tester. The flexural strength is calculated from the angle that results from the bending of the specimen when a constant load is applied. This method permits the determination of the flexural strength of plastic films with a thickness less than 0.05 mm.

ASTM D 790, BS 2782 method 304, DIN 53 452, VSM 77 103, ISO R 178

Warp and twist rate

Warp rate

A sheet is suspended perpendicularly by holding the centre of one side of the sheet. The departure of the surface of the sheet from a straight-edge laid parallel to the horizontal side of the sheet is measured at several points. Then the departure of the surface of the sheet from a straight-edge laid parallel to the vertical side of the sheet is measured at several points. The warp rate is the ratio of the largest departure to the square length of its side.

Twist rate

A sheet is suspended by holding a corner of the sheet. The departure of the surface of the sheet from a straight-edge laid upon it in the direction of the diagonal joining the other two corners is measured at several points. The twist rate is calculated in the same manner as the "warp rate" described above.

Tensile creep test

A tensile creep testing apparatus is used. A specimen is subjected to tensile stress at a constant load. The elongation of the specimen is measured at specified intervals. The test should be carried out in a room in which constant temperature and humidity are maintained.

Impact test

Charpy test

A Charpy impact machine (pendulum type) is used. A prism-shaped notched specimen bar is laid horizontally on a support with its notched surface facing the support. The specimen is struck sharply with the striker on the surface opposite the notch. The Charpy impact strength of the specimen can be calculated from the energy expended in breaking the specimen.

Izod test

An Izod impact machine (pendulum type) is used. A prism-shaped notched specimen is clamped vertically in a vice, so that half of the specimen extends out of the vice and the notched surface faces the direction of the striker. The specimen is struck sharply with the striker. The Izod impact strength of the specimen can be calculated from the energy expended in breaking the specimen.

ASTM D 256, BS 2782 method 306, DIN 53453, VSM 77103, ISO R 179, ISO R 180

Indentation hardness test

Brinell hardness test

A steel ball, selected according to the hardness of the material to be tested, is forced into the surface of the specimen by means of a hardness tester (e.g. Tukon). The Brinell hardness number is defined as the ratio of the force applied to the area of the indentation.

Rockwell hardness test

A steel ball, selected according to the thickness of the material to be tested, is forced into the surface of the specimen in two operations by means of a Rockwell hardness tester. The Rockwell hardness number is the difference in depth of the impression under the specified conditions of minor and major loads.

ASTM D 785, BS 2782 method 307, DIN 53456, ISO R 180 (agrees with BS 2782 method 306)

Melt flow index

An extrusion plastometer is used. A definite quantity of the specimen is placed in the cylinder of the plastometer, which has been brought to a constant temperature. The sample is extruded through the test die. The extrudate is cut off along the opening of the die at set intervals. Each cut-off sample is weighed and the weight is compared to other samples extruded in intervals of 10 minutes. The melt flow index is the dimensionless number (value of weight in grams) of the extrudate.

The ASTM standard D 1238 gives more details of the test procedures as they are applied in the United States.

Flow test (disc method)

Using a cylinder, a definite quantity of the specimen is heaped in a cone-shape in the centre of the mould cavity, which has been heated to a specified temperature. The material is compressed under specified conditions of pressure and time. The flow property of the material is expressed as the mean of the long and the short diameter of the entire area of the moulded disc.

A similar flow test is described in ASTM standard D 569.

Mouldability

The mouldability of a material is evaluated with respect to the facility of removing the material from the mould cavity and by the appearance of the material i.e. smoothness, warping, wrinkles or specks, when it is compression moulded into the shape of a cup.

According to ASTM standard D 731, the moulding index of thermosetting moulding powder can be determined by producing a moulded cup under controlled pressure and temperature. The moulding index is expressed as the total minimum force in pounds required to close the mould, with the closing time in seconds as a subscript.

Mould shrinkage test

A specimen is moulded with a specified mould under certain conditions of pressure, temperature, time, etc. After the moulded specimen has been removed from the mould, both specimen and mould are allowed to stand at constant room temperature and humidity for a specified number of hours. The rate of the mould shrinkage is calculated from the difference between the size of the mould and the size of the moulded specimen after the specified number of hours.

ASTM D 955, BS 2782 method 106, DIN 7734

Hydrostatic pressure test (on pipe)

A piece of pipe is subjected to a specified internal hydrostatic water pressure at room temperature. The specimen is examined for evidence of leaking, breaking or other failures.

ASTM D 1785, BS 3505, DIN 8061

Flattening test (on pipe)

A piece of pipe is placed between two flat steel plates and is subjected to pressure in a direction perpendicular to the length of the pipe at a specified speed. The specimen is flattened until the initial diameter of the pipe is reduced by one half. After the load is removed, the specimen is examined for evidence of splitting, cracking or breaking.

ASTM D 1785

Determination of specific gravity and density

The specific gravity or the density of a material is determined by any of the following methods:

Displacement method (immersion method)

The specific gravity or the density of a solid plastic is calculated from the weight of the test piece in the air as compared to its weight in water or another liquid.

Pycnometer method

This method is suitable for determining the specific gravity or density of powdered or granulated plastics materials. The immersed specimen is weighed in a pycnometer. The specific gravity or density is calculated by comparing the weight of the empty pycnometer, the weight of the pycnometer filled with water or other liquid, the weight of the specimens, and the weight of the pycnometer containing the specimen filled with liquid.

Sink-float method

A specimen is put into each of two cylinders containing solutions with different densities. If the specimen sinks, the density of the material is heavier than that of the solution; if it floats, the density of the material is lighter than that of the solution. The density of a material is determined approximately using a set of liquids with a narrow range of densities.

Density-gradient tube method

Two density-gradient columns are prepared. Each contains a solution of previously defined density. Two liquids with different densities are used, e.g. ethyl alcohol-carbon tetrachloride, ethyl alcohol-water, isopropyl alcohol-water or a similar combination of two liquids. Samples of the materials to be tested are gently placed into the different columns. After equilibrium is reached, the density of the material can be determined graphically or by calculation from the levels to which the samples settle.

ASTM D 792 (displacement and pycnometer methods), ASTM D 1505 (density-gradient tube method), BS 718, DIN 53479

Determination of apparent density

Material that can be poured from a funnel

A specimen is poured from a metal funnel of specified design into a specified metal measuring cylinder. The apparent density is calculated as the ratio of the weight of the contents of the measuring cylinder to the volume of the cylinder.

Material that cannot be poured from a funnel

A quantity of 60 grams ±0.2 grams of material is loosely dropped into the specified measuring cylinder until the sample's surface is level with the top of the cylinder. A plunger with a weight of 2,300 grams ±20 grams is lowered slowly into the measuring cylinder until it is entirely supported by the material. The apparent density of the material is calculated by dividing the weight of the sample by the volume occupied by the material in the measuring cylinder.

ASTM D 1895, BS 2782, DIN 53468, ISO R 60, ISO R 61

Determination of dilute solution viscosity

The viscosity of a dilute solution prepared by dissolving the sample in a specified solvent to a definite concentration is determined by means of a viscosimeter (capillary type, e.g. Ostwald or Ubbelohde).

ISO R 174 determines the viscosity of polyvinyl chloride resin in solution. It covers apparatus, solvent, procedure and calculation of results. The content of the standard agrees with BS 2782 method 404.

Thermal stability test (on plasticized polyvinyl chloride compound)

A definite quantity of the specimen is placed in a test tube. A Congo-red paper moistened with glycerine is inserted into the test tube so that an end of the paper is attached to the opening of the test tube with a cotton stopper. The test tube is immersed in an oil bath maintained at a definite temperature. It is observed whether the Congo-red paper changes to blue within a definite time after immersion.

ISO R 182 covers the significance of test, test portion, apparatus and materials, procedure and report of the Congo-red method; the content of the standard agrees substantially with BS 2782 method 109.

Vicat softening point test

The equipment consists of: immersion bath, heat-transfer liquid, specimen support, weights, penetration indicator, temperature indicator and Vicat needle. The specimen, which is at room temperature, is centred under the needle. The needle is gently lowered so that it rests on the surface of the specimen and holds it in position. The load is applied and the temperature is increased. The Vicat softening point is the temperature at which the indicator reads 1 mm penetration.

ASTM D 1525, BS 2782 method 102

Brittleness temperature test

The apparatus consists of specimen clamps, a member that can strike the specimen at a specified speed, and a thermostatic bath. A preparatory test determines the different test temperatures to be used, i.e. a range of temperatures at which 10 to 90 per cent failure is expected. For the main test, several specimens are clamped to the apparatus and immersed in the bath for a specified number of minutes. After the specimens have attained temperatures equivalent to each of the test temperatures, the specimens are struck and examined for breaks. The brittleness temperature of a material is the temperature at which 50 per cent of the specimens would break in a specified test.

ASTM D 746

Deflexion temperature test

Tensile heat distortion temperature

The testing apparatus includes a fixed member carrying one grip, a movable member carrying a second grip, an extension indicator, a heating bath and weights. A specimen is mounted in the grips and is subjected to a specified stress applied through the movable member by means of weights. The specimen is placed in the bath and the bath temperature is increased at a specified rate. The readings of the extension indicator and the bath temperature are recorded at appropriate intervals until the specimen has elongated approximately 50 per cent or until the temperature has reached 250°C. The tensile heat distortion temperature is the temperature at which 2 per cent extension or 2 per cent shrinkage occurs.

ASTM D 1637

Deflexion temperature under load

The test apparatus consists of a metal frame, a loading rod, weights, and an immersion bath provided with heat transfer medium and dial gauge. The specimen bar is placed on two supports and a specified load is applied vertically with the loading rod to the specimen midway between the supports. The assembly is immersed in the oil bath, and the bath temperature is increased at a constant rate until the bar has deflected to the specified strain. Deflexion temperature is the temperature at which the deflexion of specified value is reached.

ASTM D 648, DIN 53461

Torsion stiffness test

A Clash-Barg type of torsion tester is used. The specimen is mounted in the apparatus. The temperature of water contained in the Dewar flask is increased to a specified degree. The retaining pin is lifted and torque is applied for a definite period of time, after which the angle of deflexion is measured. In the same way the angle of deflexion is measured at various temperatures and intervals. The stiffness of the material at each temperature is obtained from the readings.

ASTM D 1043

Elongation under low temperature

The necessary apparatus consists of grips, an automatic level regulation device, balance weights, a load indicator dial and a low-temperature bath. A specimen is mounted in the grips and immersed in the bath which is controlled at a constant low temperature. The specimen is subjected to tensile stress for the time defined and its elongation is determined.

Flammability test

A flat specimen bar is clamped vertically on one end of the laboratory stand. The flame of a Bunsen burner with air-ports open is brought in contact with the free end of the bar for the time specified. After removing the flame, the burning rate of the material is determined.

ASTM D 568, BS 2782 method 508 E, ISO R 181

Refractive index test

Refractometric method

An Abbé refractometer with a source of white light and a contacting liquid is used to measure the refractive indices of transparent cast, moulded or sheet materials.

Microscopic method (Becke test)

The microscopic method is used to determine the refractive indices of powdered or granulated transparent materials by means of a microscope. Monochromatic light is generally used to avoid dispersion effects. A small amount of liquid with a known refractive index is placed on a slide. Particles of the materials to be tested are immersed in the liquid. After the microscope has been focused on the centre of the preparation, the microscope is moved upward and focused on the upper part of the specimen, where a reading is taken. Then the microscope is focused on the lower part of the specimen and another reading is taken. The determination is continued with preparations of other immersion liquids with known refractive indices, and the refractive index of the material is calculated on the basis of the various readings.

ASTM D 542

Transparency test

The transmittance of transparent plastics is determined by means of the spectrophotometer. It consists of a source of light, condensing lens, an integration sphere, a light trap, a detecting photocell, a galvanometer and a scale.

ASTM D 1746

Resistance to chemical substances test

Specimens are immersed in chemical solutions for a specified period of time. The temperature, types and concentrations of reagents, and test duration are specified. Changes in weight, dimension, mechanical strength, and appearance of the materials are examined.

ASTM D 543, ISO R 175

Resistance to oil test

A specimen equal in size to the specimen used for determining tensile strength is used in this test. After being immersed in oil for a definite period of time, the specimen is subjected to tensile stress, and its tensile strength and elongation are determined.

Water absorption test

A specimen is immersed in distilled water for a definite period of time. The water absorption of a material is measured by the increase in the weight of the specimen during the test.

ASTM D 570, BS 2782 method 502, DIN 53472, ISO R 62

Determination of volatile matter

A definite quantity of sample material is placed in a container. In an oven maintained at a constant temperature, the container is heated until the weight of the container is constant.

Rate of water vapour transmission test

A specimen film or thin sheet is placed over the opening of a circular dish which contains the desiccant; the specimen is sealed with paraffin wax to prevent water vapour leakage. The dish is placed in a room maintained at constant temperature and humidity. The weight of the assembly is recorded every 24 hours. Weighing is repeated until the weight of the assembly is constant. The weight gain is used to calculate the rate of water vapour transmission through the sheet material.

In the case of cellular plastics, a specimen is inserted firmly into the opening of a beaker containing anhydrous calcium chloride and is sealed with melted paraffin. The beaker is placed into a desiccator which contains the saturated solution of potassium nitrate. The desiccator with the beaker is kept in the chamber at a constant temperature and is weighed every 24 hours. The rate of water vapour transmission of the material is determined as stated above.

ASTM E 96

Dielectric strength test

A specimen is centred between a brass sphere electrode and a brass disc electrode, and the entire body is immersed in a vessel containing an insulating oil. Voltage is applied to the specimen for a specified number of minutes and the resistance of the sample is examined.

ASTM D 149, BS 2782 method 201, DIN 53481, VSM 77108

Insulation resistance tests

Two holes are bored to a definite depth in or through a piece of material. The specimen is placed on an insulation board. Acting as electrodes, mercury or graphite is filled into the holes, or tapered pins are bored through the holes. The insulation tester applies 500 volts of direct current for a specified length of time. The insulation resistance of the material is the ratio of the direct voltage applied to the electrodes to the total current between them.

ASTM D 257, BS 2782 method 204, DIN 53482

Electric resistivity test

A sample of sheet is placed on mercury in a suitable container. Three metal rings, the sizes of which are specified, are placed concentrically on the test piece. Acting as electrodes, an appropriate amount of mercury is poured into the outer and inner spaces formed by the rings. The volume resistivity and the surface resistivity of the material are determined by connecting the circuits in each of the possible ways.

ASTM D 257, BS 2782 method 202 (volume resistivity) and method 203 (surface resistivity), DIN 53482

Dielectric constant and dielectric loss factor

Both surfaces of the specimen are coated with metal foil or high-conductivity silver paint. The dielectric constant and dielectric loss factor of the material are determined from the capacitance of the condenser at the time the measure bridge becomes balanced, by controlling the measure condenser and the variable resister, having connected the specimen to the measure bridge in the specified circuits.

ASTM D 150, DIN 53483, BS 2782 method 205

Arc resistance test

Two tungsten rods are used as the electrodes. A test piece is placed horizontally and the electrodes are attached to face the specimen in the position specified. Electric current is applied (12,500 V) for one minute at one-minute intervals. The length of time is recorded that elapses from the start of the test to the breakdown of the specimen and the disappearance of the arc.

ASTM D 495, DIN 53484 (the two standards are not comparable)

Chapter Five

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

Origin, creation and membership

The International Federation of the National Standardization Associations (ISA) was established in 1926 and was made up of the national standardization associations of approximately twenty countries. It had to cease work officially in 1942. In 1944 the United Nations Standards Co-ordinating Committee (UNSCC), comprised of the national organizations of eighteen allied countries, succeeded the former ISA.

In 1946 the representatives of the member states of UNSCC met in London, together with representatives of the standardization bodies of other non-member countries. The discussion that took place among the 64 delegates from 25 countries resulted in 1947 in the establishment of the International Organization for Standardization (ISO).

The ISO members represent the national bodies responsible for standardization, all of which have agreed to abide by the organization's constitution and rules of procedure. Only one organization in each country may be admitted to membership. As of 1967 there were 55 national bodies enrolled as members of ISO, plus ICAITI, representing six Central American countries.

Objectives

According to article 2 of its constitution, the objectives of the ISO are to "promote the development of standards in the world with a view to facilitating international exchange of goods and services and to developing co-operation in the sphere of intellectual, scientific, technological and economic activity.

"As a means to these ends, *inter alia*, it may:

(a) Take action to facilitate co-ordination and unification of national standards and issue necessary recommendations to member bodies for this purpose;

(b) Set up international standards provided, in each case, no member body dissents;

(c) Encourage and facilitate, as occasion demands, the development of new standards having common requirements for use in the national or international sphere;

(d) Arrange for exchange of information regarding work of its member bodies and of its technical committees;

(e) Co-operate with other international organizations interested in related matter, particularly by undertaking at their request studies relating to standardization projects.[2]

The ISO is at the disposal of every country in the world. By bringing together technicians with similar interests to discuss common problems, the ISO encourages an exchange of ideas which can lead to universal quality, increased production, lower prices, expansion of exchange and the re-organization of markets. The ISO is also useful in furthering international understanding.

Activities of the ISO technical committees

Division of work

The standardization work of the ISO is handled in its technical committees (ISO/TC..). The scope of each technical committee is strictly limited and can only be altered with the approval of the ISO council. Within such boundaries, each technical committee determines its own programme of work. One hundred and twenty-seven technical committees have been set up (as of October 1968), including TC 61 (Plastics). The scope of TC 61 as adopted in 1954 is:

"Standardization of nomenclature, methods of test, and specifications applicable to materials and products in the field of plastics.[3]

Participation in the work

Each member body interested in a subject has the right to be represented on the corresponding technical committee. The member bodies that take an active part in the work of a technical committee are participating (P) members of the committee. They have the right to attend meetings and to vote. Member bodies wishing only to be kept informed of the workings of a technical committee are called observer (0) members of that committee. They have the right to attend meetings, but are not permitted to vote. At the time of writing (1967), twenty-six member bodies participated as participating members and fifteen member bodies as observer members in TC 61 (Plastics).

Working groups

A technical committee may set up working groups (ISO/TC../WG..) as necessary for their work. Normally these are appointed only for the study of particular questions of limited range, and their appointment is of limited duration.

The working groups are responsible only to the technical committees under which they have been set up and to which they report. Such reports are preferably in the form of preliminary draft proposals. The members of a working group may correspond and discuss directly with each other in order to prepare their reports to the technical committees.

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[2] International Organization for Standardization (1962) *Constitution and Rules of Procedure*, Geneva, pp. 2–3.

[3] International Organization for Standardization (1968) *Information on the ISO Technical Committees*, Geneva, p.30.

The ten working groups that have been set up in TC 61 (Plastics) are listed below.

Working group	*Subject*
1	Nomenclature and definitions
2	Mechanical strength properties
3	Standard laboratory atmospheres and conditioning procedures
4	Thermal properties
5	Physical chemical properties
6	Ageing, chemical and environmental resistance
7	Preparation of test specimens
8	Electrical properties
9	Specifications
10	Cellular plastics

Draft proposals

Any draft submitted to the participating members of a technical committee for study with the intention of becoming an ISO recommendation is called a draft proposal. A certain subject may be the topic of several consecutive draft proposals.

Draft ISO recommendations

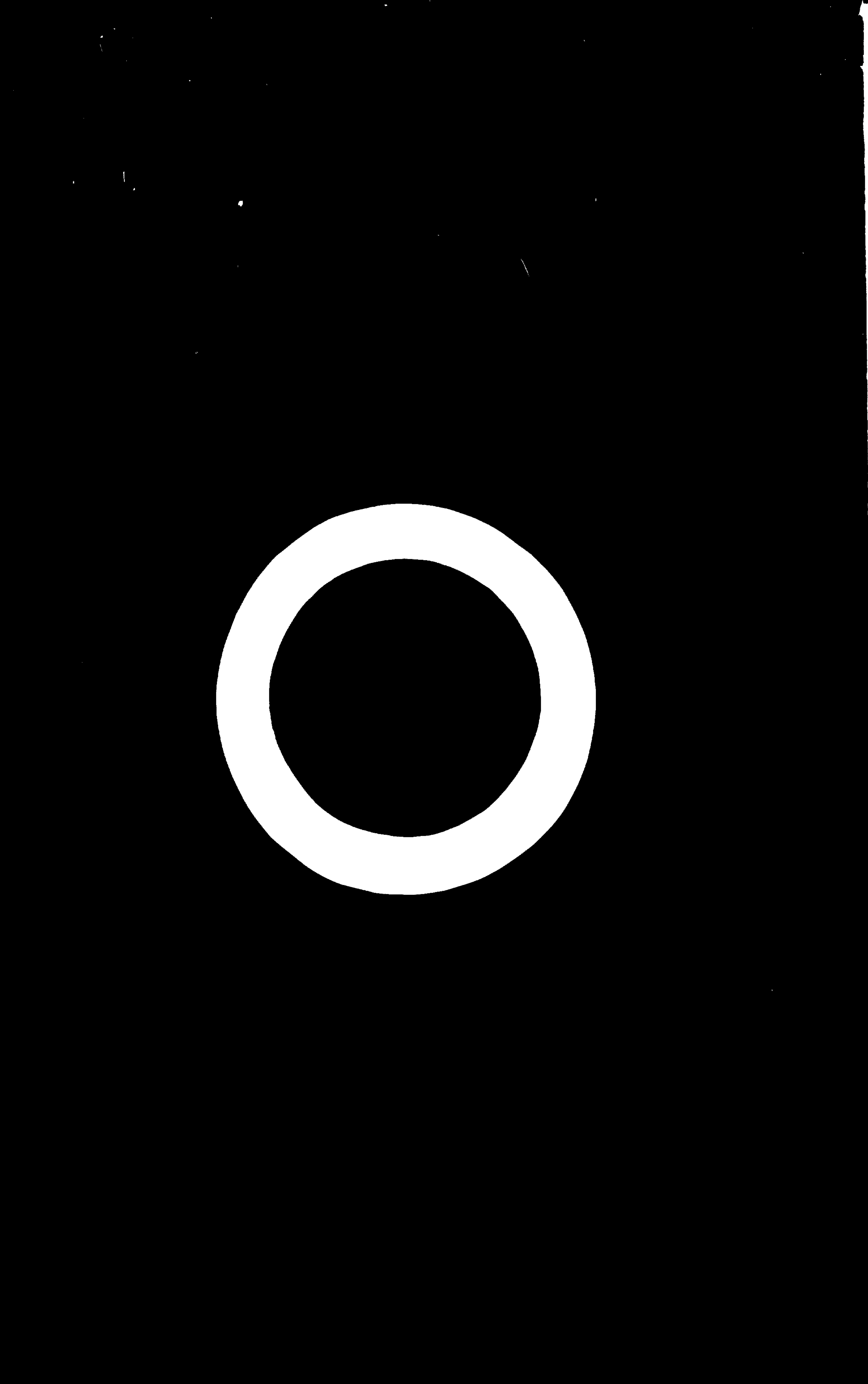
When a draft proposal has received substantial support by the participating members of the technical committee, it is sent to the general secretariat to be registered as a draft ISO recommendation and circulated among the participating members for final letter ballot and presented to all the member bodies for approval.

ISO recommendations

When a draft ISO recommendation has been adopted by a majority of the participating members of the technical committee and approved by 60 per cent of the voting member bodies (positive and negative votes are counted), it is submitted to the ISO council for acceptance as an ISO recommendation. Publishing the ISO recommendations is the task of the ISO general secretariat. Annex I lists the ISO recommendations that have been enacted in TC 61 (Plastics).

ISO standards

In order to change an ISO recommendation into an ISO standard, the recommendation must be re-submitted to ISO member bodies, who inform the general secretariat whether they agree with the proposed change. If no member body opposes the proposal, the recommendation becomes an ISO standard.



ANNEX I

List of ISO recommendations for plastics

R 194–1961	List of equivalent terms used in the plastics industry (English, French, Russian)
R 194/Pl–1963	Appendix Pl: Corresponding Polish terms
R 194/Cs–1964	Appendix Cs: Corresponding Czech terms
R 194/D–1964	Appendix D: Corresponding German terms
R 472–1966	Plastics. Definitions of terms
R 472–1968	Plastics. Definitions of terms, 2nd edition
R 291–1963	Standard atmospheres for conditioning and testing
R 293–1963	Compression moulding test specimens of thermoplastic materials
R 294–1963	Injection moulding test specimens of thermoplastic materials
R 295–1963	Compression moulding test specimens of thermosetting materials
R 483–1966	Plastics. Methods for maintaining constant relative humidity in small enclosures by means of aqueous solutions
R 60–1958	Determination of apparent density of moulding material that can be poured from a specified funnel
R 61–1958	Determination of apparent density of moulding material that cannot be poured from a specified funnel
R 75–1958	Determination of temperature of deflection under load
R 171–1961	Determination of bulk factor of moulding materials
R 174–1961	Determination of viscosity number of polyvinyl-chloride resin in solution
R 292–1963	Plastics. Determination of the melt flow index of polyethylene and polyethylene compounds
R 306–1963	Determination of the Vicat softening point of thermoplastics
R 306–1968	Determination of the Vicat softening point of thermoplastics, 2nd edition
R 307–1963	Determination of the viscosity number of polyamides resins in dilute solution
R 489–1966	Plastics. Determination of the refractive index of transparent plastics
R 527–1966	Plastics. Determination of tensile properties

R 537–1966	Testing of plastics with the torsion pendulum
R 59–1958	Determination of the percentage of acetone soluble matter in phenolic mouldings
R 62–1958	Determination of water absorption
R 62/A1–1965	Amendment 1 to ISO recommendation R 62–1958
R 117–1959	Determination of boiling water absorption
R 118–1959	Determination of methanol-soluble matter in polystyrene
R 176–1961	Determination of the loss of plasticizers from plastics by the activated carbon method
R 177–1961	Determination of migration of plasticizers from plastics
R 181–1961	Determination of incandescence resistance of rigid self-extinguishing thermosetting plastics
R 182–1961	Determination of the thermal stability of polyvinyl chloride and related copolymers and their compounds by the Congo-red method
R 183–1961	Determination of the bleeding of colourants from plastics
R 305–1963	Determination of the thermal stability of polyvinyl chloride and related copolymers and their compounds by the discoloration method
R 308–1963	Determination of the acetone soluble matter (resin content of material in the unmoulded state) of phenolic moulding materials
R 462–1965	Recommended practice for the determination of change of mechanical properties after contact with chemical substances
R 119–1959	Determination of free phenols in phenol-formaldehyde mouldings
R 120–1959	Determination of free ammonia and ammonium compounds in phenol-formaldehyde mouldings
R 172–1961	Detection of free ammonia in phenol-formaldehyde mouldings (qualitative method)
R 173–1961	Determination of the percentage of styrene in polystyrene with Wijs solution
R .75–1961	Determination of the resistance of plastics to chemical substances
R 178–1961	Determination of flexural properties of rigid plastics
R 179–1961	Determination of the Charpy impact resistance of rigid plastics (Charpy impact flexural test)
R 180–1961	Determination of the Izod impact resistance of rigid plastics (Izod impact flexural tests)
R 458–1965	Determination of stiffness in torsion as a function of temperature
R 584–1967	Determination of the maximum temperature and the rate of increase of temperature during the setting of unsaturated polyester resins
R 585–1967	Plastics. Determination of the moisture content of non-plasticized cellulose acetate

R 599–1967	Plastics. Determination of the percentage of extractable materials in polyamides
R 600–1967	Determination of the viscosity ratio of polyamides in concentrated solution
R 604–1967	Determination of compressive properties of plastics
R 800–1968	Plastics. Basis for specification for phenolic moulding materials
R 844–1968	Plastics. Compression test of rigid cellular materials
R 845–1968	Plastics. Determination of apparent density of cellular materials
R 846–1968	Plastics. Recommended practice for the evaluation of the resistance of plastics to fungi by visual examination
R 877–1968	Plastics. Determination of resistance of plastics to colour change upon exposure to daylight
R 878–1968	Plastics. Determination of resistance of plastics to colour change upon exposure to light of the enclosed carbon arc
R 879–1968	Plastics. Determination of resistance of plastics to colour change upon exposure to light of a xenon lamp
R 899–1968	Determination of tensile creep of plastics
R 922–1969	Plastics. Determination of soluble matter of crystalline polypropylene by boiling *n*-heptane

ANNEX II

List of Japanese Industrial Standards for plastics

K6700	1958	Celluloid pipe for water works service
K6701	1958	Celluloid base
K6702	1960	Testing method for camphor used in celluloid industry
K6703	1964	Industrial nitrocellulose
K6714	1958	Methacrylate sheet for aircraft
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