

Packaging code —

**Section 21: Regenerated cellulose film,
films made of plastics, aluminium foil,
flexible multilayer structures and
metallized materials**

Committees responsible for this British Standard

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- Aluminium Federation
- Association of the British Pharmaceutical Industry
- British Aluminium Foil Rollers Association
- British Paper and Board Industry Federation
- British Plastics Federation
- Coated Paper and Board Makers Association
- Dairy Trade Federation
- Department of Health
- Department of Trade and Industry (Laboratory of the Government Chemist)
- Flexible Packaging Association
- Food and Drink Federation
- Her Majesty's Stationery Office
- Institute of Purchasing and Supply
- Milk Marketing Board
- Ministry of Defence
- Pira International
- Packaging and Industrial Films Association
- Retail Bag Manufacturers' Association
- Society of Dairy Technology
- Sterilization Packaging Materials Association

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Foreword

This Section of BS 1133 was prepared under the direction of the Packaging and Freight Containers Standards Policy Committee. It constitutes a revision of, and supersedes, BS 1133-21:1976 which is withdrawn. This revision brings Section 21 up-to-date. It includes a new clause on metallized materials and information concerning linear low density polyethylene. The clause on polystyrene film has been incorporated into the clause on films of other plastics, which now also includes information on polyvinyl alcohol and its copolymers, nitrile polymers and certain acrylonitrile polymers. Information on polyester films has been separated from the clause on films of other plastics. The commercial codes for various types of regenerated cellulose film have been aligned with European codes.

BS 1133 now consists of the following Sections all of which are published separately with the exception of Sections 1 to 3 which are published in one volume.

- Sections 1 to 3: Introduction to packaging;
- Section 4: Mechanical aids in package handling;
- Section 5: Protection against spoilage of packages and their contents by micro-organisms, insects, mites and rodents;
- Section 6: Protection of metal surfaces against corrosion during transport and storage;
 - Subsection 6.1: Cleaning and drying of metal surfaces;
 - Subsection 6.2: Temporary protectives and their application;
- Section 7: Paper and board wrappers, bags and containers;
 - Subsection 7.1: Wrapping papers;
 - Subsection 7.2: Bags and envelopes;
 - Subsection 7.3: Cartons and boxes;
 - Subsection 7.4: Fibreboard drums;
 - Subsection 7.5: Fibreboard cases and fitments;
 - Subsection 7.6: Moulded pulp packaging;
 - Subsection 7.7: Composite containers;
- Section 8: Wooden boxes, cases and crates;
- Section 10: Metal containers;
 - Subsection 10.1: Tins and cans;
 - Subsection 10.2: Metal drums;
 - Subsection 10.3: Metal collapsible tubes;
- Section 12: Methods of protection against shock (excluding cushioning devices);
- Section 13: Twines and cord for packaging;
- Section 14: Adhesive closing and sealing tapes;
- Section 15: Tensional strapping;
- Section 16: Adhesives for packaging;
- Section 18: Packaging in glass;
- Section 19: Use of desiccants in packaging;
- Section 21: Regenerated cellulose film, films made of plastics, aluminium foil, flexible multilayer structures and metallized materials;
- Section 22: Packaging in plastics containers.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 32, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Section of BS 1133 gives a general description of, and provides information on, nomenclature, availability, properties, end uses and methods of test for regenerated cellulose film, films made of plastics, aluminium foil and metallized materials, and gives general guidance on the use of these materials in flexible multilayer structures.

NOTE 1 Abbreviations for polymer names used in this Section of BS 1133 are given in Appendix A.

NOTE 2 The titles of the publications referred to in this Section of BS 1133 are listed on the inside back cover.

2 Safety aspects

2.1 Bags made of flexible plastics for toys or their parts

Under the Toys (Safety) Regulations, 1989 SI No 1275, the packaging in which toys or their parts are contained should not present risk of strangulation or suffocation. Bags made of flexible plastics, which are used for packaging toys and which have an opening perimeter greater than 380 mm, have to have an average sheet thickness not less than 0.038 mm, and their means of closing cannot be a drawstring or cord. The average thickness is determined from measurements taken at 10 places on the diagonal of a sample sheet. This requirement for thickness does not apply to the following:

- a) shrunk-on film packaging, which is normally destroyed when the packaging is opened by the user;
- b) bags made of perforated film, which makes it possible for the child to breathe through the film, and which is unable to form a vacuum and stick to the face of the child. To comply with this requirement an area of maximum dimensions 30 mm × 30 mm has to have a minimum hole area of 1 %.

2.2 Bags made of flexible plastics for items other than toys or their parts

It is strongly recommended that, whenever the contents of the bag allow, bags which have an opening perimeter greater than 380 mm and are made from flexible plastics having a thickness less than 0.038 mm, should be perforated (see item b) of 2.1). It is also recommended that bags which have an opening perimeter greater than 380 mm and are made from flexible plastics having a thickness less than 0.038 mm, should be conspicuously marked with a suitable warning to the effect that the bag should be kept away from babies and children to avoid risk of suffocation. The Packaging and Industrial Film Association recommend the following general warning:

PLASTIC BAGS CAN BE
DANGEROUS.

TO AVOID DANGER OF SUFFOCATION
KEEP THIS BAG AWAY FROM
BABIES AND CHILDREN.

For cot and perambulator mattresses and pillows (see BS 1877-10) the following warning is recommended:

TO AVOID DANGER OF SUFFOCATION
REMOVE THIS PLASTICS COVER
BEFORE USING THIS ARTICLE.
THIS COVER SHOULD THEN BE
DESTROYED OR KEPT AWAY FROM
BABIES AND CHILDREN.

2.3 Films made from plastics for use in contact with food

The Materials and Articles in Contact with Food Regulations, 1987 SI No 1523 specify an upper limit for the vinyl chloride monomer content of film made from plastics and an upper limit for the vinyl chloride monomer transferable to foods with which the film made from plastics comes into contact. These Regulations also specify the methods of analysis by which the vinyl chloride monomer content or the amount transferable to food is determined. The European Directive 90/128/EEC relates specifically to materials made from plastics intended to come into contact with food.

2.4 Regenerated cellulose film for use in contact with food

The Materials and Articles in Contact with Food Regulations, 1987 SI No 1523 specify requirements for regenerated cellulose film, which include requirements for transferable adhesive, colourant, bis(2-hydroxyethyl)ether, and ethanediol, and specify permitted substances from which regenerated cellulose film has to be manufactured if it is for use in contact with food.

3 Regenerated cellulose film

3.1 General description

Cellulose film is a thin, flexible, transparent material derived from wood pulp, a natural fibrous form of cellulose. The wood pulp is first converted into an alkaline solution of cellulose xanthate ("viscose"), which is subsequently extruded through a long, thin casting die into an acid bath, where it is regenerated chemically into a continuous transparent web of non-fibrous cellulose. The film may be pigmented or dyed during manufacture.

In addition to cellulose, the regenerated web contains glycerine and/or other humectant softeners, to impart flexibility to a level that is controlled by varying the proportion of chemical softener(s), in accordance with the specific end use requirements. The film also contains a small proportion of moisture, the amount of which varies with the relative humidity of the surrounding atmosphere and which exerts a considerable influence on the film performance. The film is normally made to be in equilibrium with an atmosphere having a relative humidity of 40 % to 50 % and needs to be maintained in this condition for optimum performance, which is why the manufacturers supply the film in moisture resistant wrappings and attach such importance to correct storage.

For the majority of applications, the basic cellulose film has to be further processed to give it moisture resistance and heat-sealability. For this purpose a thin coating is applied, usually to both sides of the film. A proportion of the film is sold in its original uncoated non moisture resistant form.

Three basic types of coating are in general use, based on nitrocellulose, copolymers of vinylidene chloride, and copolymers of vinyl chloride and vinyl acetate. The standard nitrocellulose coating contains paraffin wax, plasticizers and other additives, suitably compounded to give high initial moisture resistance, heat-sealing properties, printability and low surface friction. It can be modified slightly to minimize or eliminate the heat-seal properties of the film, or to reduce the degree of moisture resistance.

The vinylidene chloride copolymer coatings give more permanent moisture resistance during use, being more resistant to abrasion, creasing, heat-sealing, printing and the effect of greases and oils, including essential oils, all of which can cause a reduction in moisture resistance of nitrocellulose coatings. Two separate types of vinylidene chloride copolymer-coated film are produced, distinguished according to whether the coating is applied from a solution or from a water dispersion of the copolymer. The latter type has the higher level of moisture resistance because the method of application does not impose solubility limitations and thus enables an inherently more moisture resistant copolymer to be used.

The vinyl chloride/vinyl acetate copolymer coatings have been developed for the packaging of products requiring a moisture permeable coating whilst retaining most of the other parameters present in vinylidene chloride copolymer coatings.

Film coated on one side only, with either nitrocellulose or copolymer, are also produced, mainly for laminating and extrusion coating applications.

3.2 Nomenclature

The basic coated and uncoated cellulose films described in 3.1 are all available in many grades, which, although superficially very much alike, vary significantly in thickness, base film flexibility and/or coating composition, to satisfy different end use requirements. A system of nomenclature is used to designate these different types by means of commercial codes comprising combinations of letters and numbers made up of three or four separate elements as follows.

a) A number indicating the approximate substance of the finished film, in mg/dm^2 to the nearest 5 mg/dm^2 (subject to a manufacturing tolerance, see 3.6.3).

b) One or more letters denoting the basic type of film:

P	non-moisture resistant;
M	nitrocellulose-coated on both sides;
QM	nitrocellulose-coated on both sides but less moisture resistant than M;
DM	nitrocellulose-coated on one side;
MXXT/W	polyvinylidene chloride (PVDC) copolymer-coated by aqueous dispersion on both sides;
XS	PVDC copolymer-coated by solvent process on both sides;
MXDT/W	PVDC copolymer-coated by aqueous dispersion on one side;
DXS	PVDC copolymer-coated by solvent process on one side;
W	polyvinyl chloride (PVC)/polyvinyl acetate copolymer-coated on both sides.

c) One or more additional letters indicating special characteristics:

B	opaque;
C	coloured (followed by the name of the colour);
F	for twist wrapping;
S	heat-sealable;
T	for cigarette overwrapping;
U	unsized (film for adhesive tape manufacture);
V	high surface slip (uncoated film only).

d) A suffix number may be included, indicating special features of manufacture and/or specific end use:

- 28 enhanced twist retention;
- 30 increased low-temperature flexibility for use on frozen foods;
- 36 increased flexibility for exceptionally abrasive products;
- 37 enhanced heat seal strength;
- 41 formulated to meet the USA Food and Drug Administration (FDA) requirements;
- 43 as 41, but also suitable for deep freeze applications.

Typical commercial code designations include:

- 325 P colourless, non moisture resistant film with a substance of approximately 325 mg/dm²;
- 350 MS colourless, nitrocellulose type moisture resistant heat-sealing film with a substance of approximately 350 mg/dm²;
- 365 MXXB/W white, opaque, dispersion copolymer-coated film with a substance of approximately 365 mg/dm²;
- 365 XS colourless, solution copolymer-coated film with a substance of approximately 365 mg/dm²;
- 325 PFC Amber amber non moisture resistant film with the increased flexibility required for twist wrapping, with a substance of approximately 325 mg/dm²;
- 445 MXXT/W colourless, dispersion copolymer-coated film with a substance of approximately 445 mg/dm²;
- 525 PU unsized, colourless non moisture resistant film for adhesive tape manufacture, with a substance of approximately 525 mg/dm².

3.3 Availability

Cellulose film is available coloured, colourless or opaque in uncoated form and coloured, colourless, opaque or metallized in coated form. It is normally supplied in reels or in cut-to-size sheets and, with certain restrictions, in a series of agreed standard substances ranging from 280 mg/dm² to 650 mg/dm².

In general, reels up to 1 450 mm wide are commercially available, on cores of internal diameter 70 mm to 152 mm and in standard overall reel diameters of 240 mm, 330 mm and 457 mm. A few grades of uncoated film are available in reel widths up to 2 180 mm.

Sheet sizes normally range up to 1 220 mm × 1 220 mm. Discs, ovals and other special shapes can usually be supplied to specification.

3.4 Properties

Amongst the most important properties of cellulose film are its high gloss and transparency. The film is strong for a thin, lightweight material, with high tensile and bursting strengths, but tears, once started, propagate easily.

Cellulose film has high resistance to a wide range of chemicals and to grease, oil and dust and is impervious to bacteria. Only suitably coated grades are good barriers to water vapour, but under dry conditions all grades are highly impermeable to gases and odours. Coatings, particularly of the copolymer type, ensure that this property is retained under conditions of high humidity.

Cellulose film does not deteriorate, discolour or perish during normal use or on extended storage under the recommended conditions, but degrades fairly rapidly when buried in the soil, or under typical rubbish tip conditions. All grades can be printed by all the common techniques, and at high speeds by the flexographic and rotogravure processes.

The plain base film is not inherently fusible and joints between uncoated surfaces have to be made with suitable adhesives (normally based on gelatine, dextrin or polyvinyl acetate dispersions) or with pressure-sensitive tape. The heat-sealing grades are obtained by coating, usually both sides, with fusible lacquers, which also confer the desired degree of moisture resistance. The relative rigidity, controllable to a degree, of the infusible base, together with a slippery surface, enables these films to be handled satisfactorily on a wide range of automatic packaging and bagmaking machines, and this factor has been largely responsible for their wide acceptance in mechanical wrapping operations on simple machines.

Cellulose film is sensitive to changes in humidity (because of its hygroscopic nature and the presence of hygroscopic softeners) and to change in temperature. It becomes less durable at low temperatures and humidities, and for this reason it is advisable to avoid temperatures below 20 °C and relative humidities below 30 % when using the film on automatic machines.

The basic properties as described above are inherent in the uncoated film, but properties obtained through application of standard coatings are equally important. In addition to heat-sealing and water vapour barrier properties, the coatings also impart increased stability to changing humidities and some resistance to liquid water, and are formulated to retain gloss, transparency, printability and other surface properties including high surface slip and resistance to blocking.

3.5 Applications

Regenerated cellulose films used for food packaging are controlled by the Materials and Articles in Contact with Food Regulations, 1987 SI No 1523 (see 2.4).

The versatility of cellulose film, due to the modifications possible to both the base film and the coatings to meet specific requirements, results in a very wide range of uses. Most of these involve the coated moisture resistant grades, but uncoated film is nevertheless used.

Main uses for uncoated cellulose film are for the manufacture of pressure-sensitive tape, as a carrier backing for pigmented transfer coatings, for twist-wrapping chocolates, as a wet-shrink individual or multiwrap on bottles and jars, and for general wrapping or bagging applications where moisture protection is not required.

The nitrocellulose-coated moisture resistant grades can be regarded as the standard general purpose cellulose films, and are used where heat-sealing is desirable and protection against moisture is required. Major uses are for wrapping cigarettes, sugar confectionery, baked goods, groceries, quick-frozen foods and for general carton overwrapping and multi-wrapping. Modified nitrocellulose-coated grades with reduced moisture resistance are used for wrapping high moisture food products such as sausages, meat pies and crusty bread, on which some controlled drying of the surface is desirable to avoid premature bacterial spoilage and/or loss of crispness. Another modification of the standard nitrocellulose coating retains the moisture resistance but is non-sealing, for use on sweets that are wrapped whilst still hot.

The PVDC copolymer-coated grades of cellulose film are used where even better moisture protection is required, particularly on hygroscopic products such as biscuits, potato crisps and other snack foods, sugar confectionery, pharmaceutical products, cigarettes and tobacco. They are also used, particularly in multilayer structures, for their improved resistance to permeation by gases. However, two-side and one-side coated types of both nitrocellulose-coated and copolymer-coated grades are used for multilayer structures (see clause 10).

The vinyl chloride/vinyl acetate copolymer coated grades of cellulose film have been developed to give a reduced degree of moisture resistance whilst retaining the other properties of machineability and appearance associated with PVDC copolymer coated film.

3.6 Methods of test

3.6.1 General

The physical properties of regenerated cellulose films vary in accordance with the uses for which they are specifically designed. The property levels indicated from the various tests referred to in 3.6.4 to 3.6.6 and 3.6.8 to 3.6.14 should be attained by the more commonly used grades of film.

3.6.2 Preparation of samples

Samples selected for testing should be kept flat and free from folds and wrinkles, and they should not be taken from the outer layer of the reel or from the outer sheets of a package.

With the exception of the tests for water vapour permeability, residual solvents, coating anchorage, pH of aqueous extract, chemical impurities, and in some cases substance (which may need to be determined on the film as received), samples should be conditioned in a controlled atmosphere of 23 ± 2 °C and 50 ± 5 % r.h. prior to testing. Conditioning of uncoated films should be for at least 16 h and of coated films for at least 72 h, with both surfaces of the sample exposed to the conditioning atmosphere. The samples should be protected from exposure to direct sunlight and, in the case of uncoated film, from prolonged contact with paper or other absorbent material.

All the tests, with the exception of those mentioned above, should be carried out in a controlled atmosphere similar to that used for conditioning the samples.

3.6.3 Substance

The test should be carried out in accordance with section one of BS 2782-6:Method 631A:1982 but the test result should be expressed in mg/dm².

When testing a consignment of film, the above measurement should be repeated on several samples drawn from different slit rolls or packets of sheets, taken randomly throughout the consignment.

The nominal substance is normally subject to a manufacturing tolerance of ± 5 %.

3.6.4 Tensile properties

The test should be carried out in accordance with BS 2782-3:Method 326, except that test pieces 25.0 ± 0.5 , -0.0 mm wide should be used and the grips of the tensile testing machine should be 100 mm apart at the start of the test and should separate at the rate of 200 ± 100 mm/min.

At least 10 specimens cut in each direction (machine and transverse) should be tested, and the average tensile strength and elongation of the test pieces calculated. The minimum values to be expected are given in Table 1.

Table 1 — Tensile strength and elongation at break of cellulose film

	Tensile strength at break	Elongation at break
	MPa	%
Machine direction	≥ 60	≥ 15
Transverse direction	≥ 30	≥ 30

3.6.5 Bursting strength

The test should be carried out in accordance with section 2 of BS 3137:1972. The average value of at least 10 tests should be obtained. The minimum values to be expected are given in Table 2.

Table 2 — Bursting strength of cellulose film

Substance	Minimum bursting strength
mg/dm ²	kPa
280 to 320	120
325 to 365	140
400 to 450	175
600 to 650	260

3.6.6 Permeability to water vapour

Static water vapour permeability should be determined in accordance with the relevant test procedure in BS 3177 or BS 2782-5:Method 513. Dynamic water vapour permeability may be determined using a suitable dynamic test instrument, in which case moisture resistant grades of film should be allowed to equilibrate under the test conditions for at least 24 h.

The two-side coated moisture resistant films, when tested in their uncreased state by these methods will normally have values not greater than the following:

temperate test conditions	(25 °C, 75 % r.h.): 6 g/(m ² .d);
tropical test conditions	(38 °C, 90 % r.h.): 20 g/(m ² .d).

Corresponding values for the partially moisture resistant grades of cellulose film will usually be at least 30 times higher than those quoted above.

3.6.7 Permeability to gases

The permeability of cellulose films to gases, especially oxygen and carbon dioxide, should be determined in accordance with BS 2782 8:Method 821A. Alternatively, gas permeability may be determined using a suitable test instrument. As the oxygen transmission of cellulose film can vary with moisture levels in the film it is necessary to quote the humidity conditions under testing.

3.6.8 Heat-sealing properties

Where heat-sealing properties are intended, in films coated on both sides with either nitrocellulose or copolymer, the heat-seal strength may be determined by sealing the film between an unheated rubber jaw and a heated metal jaw at 125 °C to 135 °C, using a 1 s dwell time, and pressure of 100 ± 10 kPa. Under these conditions, the average heat-seal strength when the sealed samples are tested on a suitable tensile testing machine should be not less than 1 N per 30 mm.

3.6.9 Jawstick properties

Where the film has heat-sealing properties and is intended to be used as such, then its adherence to a flat circular metal surface of area 500 mm² heated to 130 ± 5 °C with a dwell time of 0.5 s and pressure of 22.5 kPa, should be not greater than 0.2 N for copolymer films, and not greater than 0.5 N for all other films.

A diagram of the apparatus is given in Figure 1.

3.6.10 pH of aqueous extract and chemical impurities

An aqueous extract of the film is prepared by boiling 10 g of the sample, cut into pieces approximately 25 mm square, for 1 h with 500 mL of distilled or deionized water, pH 6.0 to 7.0, in a flask of chemically-resistant glass fitted with a reflux condenser of similar glass connected by a ground glass joint. The pH value of this extract after cooling, as measured on a pH meter complying with BS 3145, shall be within the range 5.0 to 8.0.

The extract may then be used for the determination of chlorides and sulphates by standard volumetric and gravimetric methods which may include those for paper and board described in BS 2924. Chlorides expressed as NaCl should not exceed 0.2 %, and sulphates expressed as Na₂SO₄ should not exceed 0.75 % of the film weight.

3.6.11 Retained coating solvents

In standard unprinted coated (nitrocellulose or copolymer) grades, the level of retained coating solvents, when determined chromatographically in accordance with BS 6455, should not exceed 20 mg/m^2 .

3.6.12 Anchorage of the coating

The film should show no blistering or separation of the coating from the base after immersion in water at a temperature of 20°C for 7 days.

NOTE This test is applicable only to two-side coated films.

3.6.13 Oil resistance

The film (coated or uncoated) should be resistant to mineral oil for a minimum period of 7 days when tested by the following procedure.

A single drop of liquid paraffin B.P.

(approximately 0.1 mL) is placed on a white tile or plate of glass. A $100 \text{ mm} \times 100 \text{ mm}$ sample of film is then placed over and in contact with the drop and held down by a 60 mm to 65 mm diameter brass ring, weighing approximately 30 g. A small amount (approximately 0.1 g) of an oil-soluble dye powder (e.g. Sudan Red IV) is placed on the surface of the film, above the area of contact with the drop of oil, and at daily intervals is moved along the film with a smooth, clean, dry spatula. The dye should not leave a coloured streak, as distinct from a slight general coloration, on the surface of the film in fewer than 7 days.

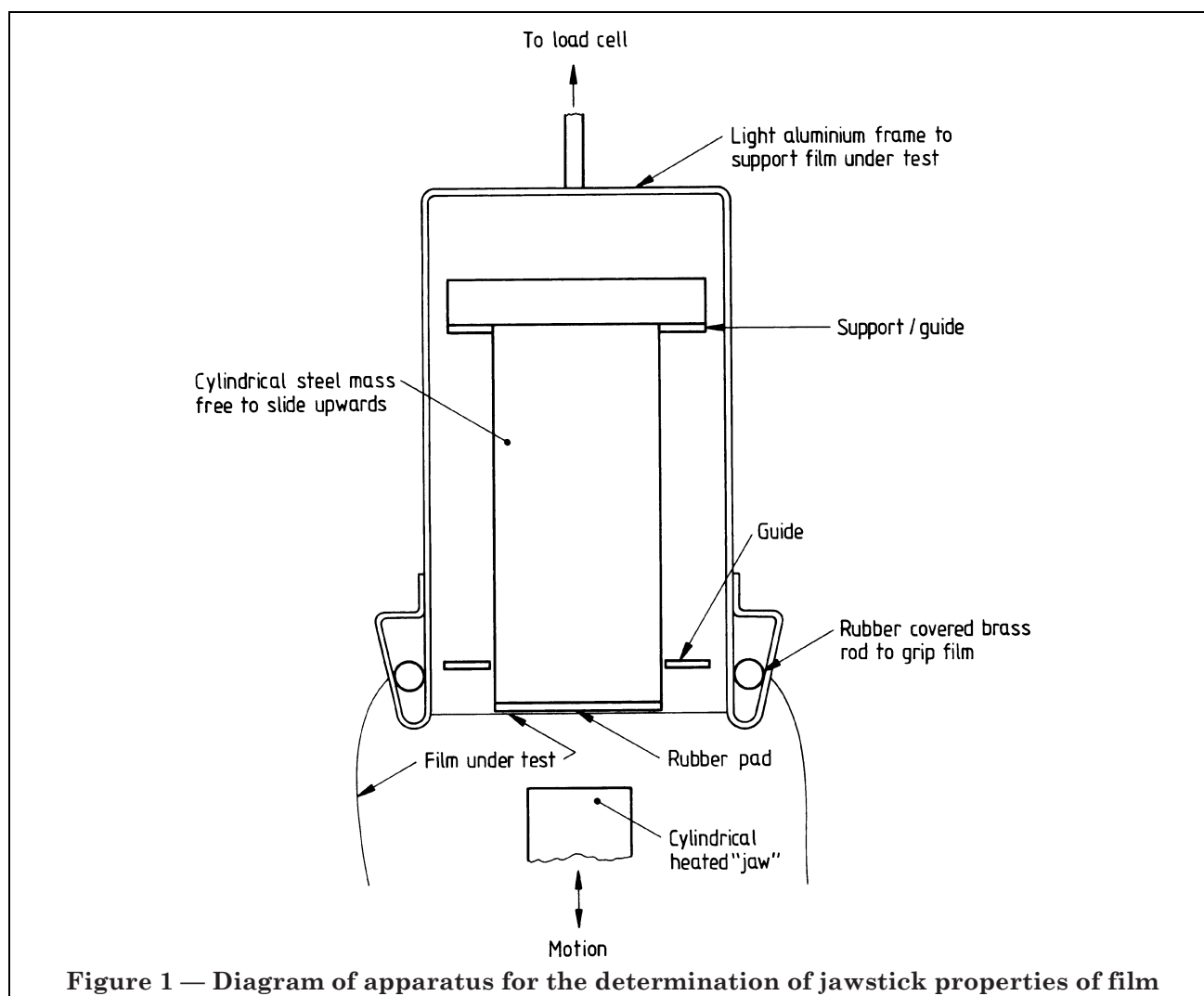


Figure 1 — Diagram of apparatus for the determination of jawstick properties of film