

Packaging code —

**Section 6: Protection of metal surfaces
against corrosion during transport and
storage —**

**Subsection 6.1 Cleaning and drying of
metal surfaces**

Committees responsible for this British Standard

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- BCIRA
- British Lubricants Federation Limited
- British Non-ferrous Metals Federation
- British Rubber Manufacturers' Association
- Engineering Equipment and Materials Users' Association
- Institute of Marine Engineers
- Institute of Packaging
- Institute of Petroleum
- Institute of Refrigeration
- Institution of Mechanical Engineers
- Ministry of Defence
- Oil and Colour Chemists' Association
- Timber Packaging and Pallet Confederation

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Foreword

This Subsection of BS 1133 was prepared under the direction of the Packaging and Freight Containers Standards Policy Committee. It constitutes a revision of sections A and B of the 1966 version of BS 1133-6, and brings information on techniques for cleaning and drying of metal surfaces up-to-date. The importance of cleaning and drying to the prevention of corrosion is believed to be of sufficient justification to publish these sections as a separate Subsection of BS 1133.

Information on the selection, application and removal of temporary protectives is published as Subsection 6.2 and constitutes a revision of sections C and D of the 1966 version of BS 1133-6.

It is envisaged that performance standards for temporary protectives contained in section E of the 1966 version of BS 1133-6 will be revised and published as a separate British Standard specification for temporary protectives; with its publication, BS 1133-6:1966 will be superseded and therefore withdrawn.

BS 7195 gives information regarding a source of corrosion not covered by BS 1133-6.

The information given in this Subsection is intended as a general guide and does not cover specific requirements for which specialist advice should be sought.

WARNING. This British Standard calls for the use of substances and procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

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;*
- *Subsection 7.6: Moulded pulp packaging;*
- *Subsection 7.7: Composite containers;*
- *Section 8: Wooden containers;*
- *Section 10: Metal containers;*
- *Section 12: Methods of protection against shock (excluding cushioning devices);*
- *Section 13: Twines and cords for packaging;*
- *Section 14: Adhesive closing and sealing tapes;*

- *Section 15: Tensional strapping;*
- *Section 16: Adhesives for packaging;*
- *Section 18: Glass containers and closures;*
- *Subsection 18.1: Terminology;*
- *Section 19: Use of desiccants in packaging;*
- *Section 21: Regenerated cellulose films, plastics films, aluminium foil and flexible laminates;*
- *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 26, 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 Subsection of BS 1133 gives guidance on methods of cleaning and drying metal surfaces just before employing an appropriate temporary protective treatment (see BS 1133-6.2).

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 General information on cleaning

2.1 The need for cleaning

Freedom from contamination of all kinds is essential in preventing corrosion of metallic surfaces. The best protective against corrosion can be rendered worthless when applied over a contaminated surface.

Contaminants, i.e. unwanted deposits on the surface of an article, are usually present on items, unless preventive precautions are taken during processing. Strict attention should be given to thorough cleaning and also to keeping items as clean as possible during all stages of manufacture.

The cleaning and drying process should be followed as quickly as possible by treatment with an appropriate temporary protective (see BS 1133-6.2).

2.2 Choice and application of cleaner

2.2.1 General

There is no single, universal method of cleaning by which all surfaces can be prepared for the application of protective coatings, and the particular cleaning method for any given type of article should be carefully selected and properly carried out. In this Subsection of BS 1133, information is given about the most common cleaning problems and the most widely used cleaning methods. It is impossible to give complete details of all applications, and complex problems should be referred to specialists in the particular fields. The following factors should be considered:

- a) nature of contaminants to be removed (see 2.2.2);
- b) nature of the materials of which the articles to be cleaned are constructed (see 2.2.3);
- c) complexity of construction (see 2.2.4);
- d) nature of the surface (see 2.2.5);
- e) availability of cleaning materials and equipment (see 2.2.6);
- f) hazards of cleaning materials (see 2.2.7);
- g) stage at which cleaning is carried out (see 2.2.8);
- h) number of articles to be treated (see 2.2.9).

Information concerning the selection of an appropriate cleaning process is summarized in Table 1. However Table 1 should be used only in conjunction with the detailed information given in the text of this Subsection of BS 1133.

2.2.2 Nature of contaminants to be removed

Residues to be removed are frequently present in association with oil or grease. Cleaning with solvents, such as 1,1,1-trichloroethane, trichloroethylene or a petroleum solvent, can remove grease and dislodge mechanically entrained material, such as metallic or abrasive residues, without affecting saline material adherent to the metal, e.g. perspiration residues. Aqueous alkaline cleaners are usually capable of dealing with all these residues, by a combination of solution, emulsification and mechanical dispersal, but should be followed by careful rinsing and drying. Rust and other corrosion products, and certain other surface deposits, which cannot be dissolved or emulsified by these methods, may require acid treatment or mechanical removal by abrasives.

WARNING. Safety precautions are necessary when using halogenated solvents (see 3.1.2.4, 3.1.3.2 and 3.1.3.3). 1,1,1-trichloroethane is preferable to trichloroethylene in terms of safety with respect to user exposure to the solvent and its vapour.

NOTE The use of chlorofluorohydrocarbons should be strictly controlled as they are suspected of causing serious damage to the upper atmosphere.

2.2.3 Nature of the materials of which the articles to be cleaned are constructed

Two of the basic questions to be considered are whether the cleaning material will attack an article to the article's detriment and whether it will leave residues which will cause corrosion later. These questions apply particularly to certain degreasing methods.

1,1,1-trichloroethane, trichloroethylene or petroleum solvents, when they are properly employed, will not attack metals. This also applies to mild alkaline cleaners, provided the type chosen is appropriate to the particular metal; strong alkalis are commonly used for cleaning steel, but they should not be used where they can cause attack, e.g. on aluminium and magnesium and their alloys; tin; zinc and brass.

All assemblies incorporating non-ferrous parts require careful consideration. It may be preferable to clean unit parts before assembly.

Articles that are porous or have fine capillary spaces should not be cleaned in alkaline solutions, since complete removal of cleaner residue is then very difficult and corrosion may eventually result. Extended lap-joints or riveted areas, spot welded additions and other similar constructions and some cast iron articles are in this class.

For articles which are partially painted or varnished, 1,1,1-trichloroethane, trichloroethylene and alkali solutions are not generally suitable. Certain emulsifiable solvent cleaners or petroleum solvents can be used.

2.2.4 Complexity of construction

Care should be taken when aqueous cleaners are used for parts or assemblies of complex construction owing to the risk of trapping cleaning solution. Aqueous residues can be removed by dipping in water-displacing protectives such as those classified as TP 2b (see BS 1133-6.2).

If such assemblies are to be coated with protective and it is impracticable to clean the parts and apply the protective before assembling, 1,1,1-trichloroethane, trichloroethylene or another solvent cleaner should be used, but it may be necessary to incorporate special devices in the cleaning apparatus to ensure the removal of any trapped solvent.

Complex assemblies, such as generators, motors, starters, gauges, meters and timing devices, made up from dissimilar materials, such as copper, steel, rubber, carbon, plastics, paper, etc., should not be cleaned by immersion methods. The metallic parts of these assemblies should be cleaned before assembling, and the assemblies themselves should be kept clean and free from corrosion by careful handling with gloves and the use of clean covered boxes, protective bags etc. After cleaning it may be necessary to handle and store parts in an air-conditioned room having controlled low humidity.

2.2.5 Nature of the surface

The degree of finish or polish and of dimensional accuracy should be considered. For example, light rust stain from fingerprints might be tolerated on a casting, but would spoil a highly finished surface. Great care should be taken in degreasing highly finished surfaces made to fine dimensional limits, to avoid any deposit or staining. Such deposits can be caused by incorrect operation of the particular cleaning method and are more likely to occur with alkaline cleaners. Rough machined, stamped or drawn articles can be cleaned by any easily applicable method.

2.2.6 Availability of cleaning materials and equipment

The availability of cleaning materials and equipment should be a determining factor in the selection of a cleaning method only after the nature of the contaminant, degree of cleanness required, composition of the part, etc. as detailed in 2.2.2 to 2.2.5, have been given full consideration. Corrosion can actually be caused by the application of inappropriate methods of cleaning. Table 1 and Table 2 indicate the materials, equipment and services required for each method of cleaning.

2.2.7 Hazards of cleaning materials

All the cleaning materials present some hazards. Halogenated hydrocarbons, such as trichloroethylene and trichloroethane, can burn in certain circumstances and are a health hazard if the vapour is inhaled. Other solvents, such as petroleum-based liquids, present greater fire hazards. All organic solvents can degrease the skin and make it liable to infection; alkalis, dry or in solution, have a similar effect and can cause burns, damage to eyes, etc. Hot aqueous solutions and hot solvent baths can also cause burns. It is essential that the appropriate precautions are taken to avoid risk to health. The Control of Substances Hazardous to Health Regulations 1988, SI No 1657, and the HSE Code of Practice 29 "Control of Substances Hazardous to Health — Control of Carcinogenic Substances" 1989, require employers to assess the risks which may arise from hazardous substances at work and then to determine the measures needed to prevent or control adequately exposure to them. It may be possible to eliminate the hazardous substance by changing the process or substituting a safe, or safer, substance. Where this is not practicable, exposure should be controlled e.g. by enclosure, the use of ventilation equipment, general ventilation, safe systems of work and handling procedures, to levels below the limits listed in HSE Environmental Hygiene 40 "Occupational Exposure Limits" 1990. Personal protective equipment should only be used where other measures cannot adequately control exposure.

2.2.8 Stage at which cleaning is carried out

Although the application of cleaning at the proper point in the processing line may be difficult, every effort should be made to clean articles and apply a temporary protective wherever necessary to prevent deterioration. The articles should be cleaned in as simple a unit state as possible and the cleaning should be carried out after the final operation, e.g. machining, forming, gauging or testing. Up to this stage, articles should be carefully handled to keep them as free as possible from contamination. If testing of a complex assembly results in contamination the assembly should be cleaned as thoroughly as possible after the test.

2.2.9 Number of articles to be treated

Most of the recommendations in this Subsection of BS 1133 relate to the treatment of relatively large numbers of parts. Where there are only small numbers of articles, as in small repair and maintenance workshops, elaborate plant may not be justified; petroleum solvent cleaning or emulsifiable solvent cleaning may then be found most convenient and economical as these methods require only the simplest equipment.

2.3 Special methods of application

2.3.1 General

Many of the cleaning processes described in clauses 3 to 5 are generally applied by immersing the article in a tank of cleaning medium. It is nearly always necessary to aid the physical or chemical action of the cleaner by mechanical means, e.g. movement of the article itself or agitation of the cleaner by boiling, introduction of air, or pump circulation. The following two methods of assisting the cleaning action are also applicable in some cases and reference is made to them in the appropriate clauses.

2.3.2 Electrolytic cleaning

This is applicable to inorganic solutions such as alkaline cleaners and acid pickles. The articles to be cleaned are attached to suitable fixtures and immersed in a solution kept at room temperature. A low voltage current is then passed through the articles and solution, liberating gas bubbles at the surfaces being cleaned. The formation and escape of these bubbles to the surface of the solution exerts a scrubbing action which aids cleaning.

2.3.3 Ultrasonic cleaning

This makes use of vibrations in the cleaning liquid, usually at frequencies between 18 kHz and 1 MHz, produced by exciting a magnetostrictive or ceramic transducer at its resonant frequency by means of a current produced in a mechanical generator or, more usually, an electronic oscillator. The exact choice of frequency should be made in consultation with the equipment manufacturer and will depend on the nature of the cleaning problem. The vibrations in the liquid produce cavitation, i.e. the successive formation and rapid collapse of many minute bubbles which exert a scrubbing action on the articles and are particularly effective in detaching insoluble fine solid matter from crevices; a subsequent rinse in the cleaning medium may be necessary to effect the final removal of the solid matter. The vibration generates heat in the cleaning liquid which may need to be cooled to keep it below the maximum safe temperature if ceramic transducers are used. Because of the increased fire risk, the use of ultrasonic techniques with flammable solvents should be avoided. This method can be used to assist grease removal by solvents (see item d) of 3.1.2.1) or aqueous detergents (see item c) of 3.4.2.1) or rust and scale removal by acids (see 4.2.2.2).

2.4 Handling

The handling of parts or assemblies, after cleaning, should be kept to a minimum and the cleaning and drying process should be followed as quickly as possible by treatment with an appropriate temporary protective (see BS 1133-6.2). When handling is necessary, clean gloves or similar protection should be used. Canvas, PVC or leather are suitable materials for gloves.

3 Removal of oil, grease, dirt and swarf

3.1 Trichloroethylene cleaning

WARNING. 1,1,1-trichloroethane is preferable to trichloroethylene in terms of safety with respect to user exposure to the solvent and its vapour.

3.1.1 General information on trichloroethylene cleaning

Subclause 3.1 gives information on the complete removal of oil, grease, dirt and swarf from unit parts or simple assemblies, with the solvent trichloroethylene. Several methods of processing are available; the appropriate process depends upon the type and degree of contamination.

Trichloroethylene degreasing should not be used on assemblies containing fabric, rubber or other non-metallic materials unless it is known that no damage will result. Assemblies containing such materials can often be cleaned without damage using 1,1,2-trichloro-1,2,2-trifluoroethane (this is generally known by its trade name followed by the figures 113) by similar processes and in similar equipment to those used with trichloroethylene.

3.1.2 Procedure for trichloroethylene cleaning

3.1.2.1 Processes

The four main processes are described below. The precise details of the equipment and method of operation for each process depend on the quantity and characteristics of the parts or assemblies to be cleaned. The plant manufacturer's recommendations should be followed.

a) *Trichloroethylene vapour process*

To remove simple films of oil and grease, articles can be subjected to the vapour process, in which the parts are suspended in a bath of solvent vapour; the vapour condenses on the cold surfaces of the articles and the condensate dissolves the oil and grease, taking it away to the base of the tank. To ensure maximum condensation, the temperature of articles should be less than or close to room temperature at the time of immersion; they should be passed through or suspended in the solvent vapour until condensation ceases to occur, after which no further degreasing will take place.

Light metal articles that reach the vapour temperature rapidly and articles with a very heavy film of grease may need a second immersion after cooling. Alternatively, before removal from the vapour, a stream of liquid solvent may be applied over the surfaces, and this also removes loose dirt deposits.

b) *Trichloroethylene liquid process*

Loosely bound contamination that is too great for vapour treatment, e.g. swarf, road dirt, can be removed by immersing the parts in vigorously boiling trichloroethylene.

The articles should be passed through or suspended in the boiling solvent until all oil and dirt have been removed. Heavily oiled articles should be immersed in two or even three separate compartments containing progressively cleaner solvent. Immersion in one bath of boiling trichloroethylene may be followed, after cooling, by immersion in solvent vapour until condensation ceases to occur (see item a) of 3.1.2.1).

c) *Trichloroethylene jetting process*

Articles with dirt deposits that cannot be removed with boiling trichloroethylene may require jetting at high pressure with the hot solvent. The jetting should be carried out only in apparatus especially designed for the purpose.

d) *Trichloroethylene ultrasonic cleaning process*

An alternative method of removing fine solid particles as well as grease is to introduce ultrasonic agitation into a compartment of cool solvent; this, unlike high pressure jetting, is practicable in open plants and is particularly useful for small intricate parts on which there is polishing or lapping compound. After treatment in the ultrasonic compartment the work should pass through a vapour zone so that it dries as it leaves the plant.

3.1.2.2 Drying

After trichloroethylene degreasing the articles are hot and normally dry. Articles of a complex construction with crevices, capillaries, etc. may require further drying at 100 °C to 120 °C.

3.1.2.3 Handling precautions

During processing the articles should be placed on hooks or racks or in suitable containers. They should be arranged so that the solvent is able to drain from holes, crevices and other irregularities. Parts or assemblies that would trap solvent should be rotated or tilted during the degreasing process so that trichloroethylene drains out freely. Any assemblies that would trap solvent even though rotated or tilted should either be dismantled before cleaning or be so handled that cleaning is not necessary after final assembly. Handling can be reduced by using mechanical and conveyor type degreasing plants which automatically rotate or tilt the articles. After cleaning, articles should not be handled with bare hands; clean gloves or similar protection should be used and handling should be kept to a minimum.

NOTE If no further processing, such as de-rusting, is required, the appropriate protective should be applied without delay, otherwise corrosion may occur very quickly. It is usually desirable to allow the article to cool to 5 °C above room temperature before applying the protective. Cooling to room temperature may cause microscopic condensation on bare metal surfaces (see BS 1133-6.2).

3.1.2.4 *Safety precautions*

Since trichloroethylene is narcotic, adequate ventilation should be provided and care taken to avoid breathing the vapour. Smoking should not be allowed near degreasing equipment. Contact of the trichloroethylene liquid or vapour with the hands should be avoided as the solvent will remove the natural grease from the skin. Protective gloves, clothing and goggles should be worn. Appropriate safety precautions are given in HSE Guidance Note Environmental Hygiene 5 "Trichloroethylene: Health and Safety Precautions", 1985.

No person should enter a pit or vessel which contains trichloroethylene or in which the solvent vapour may be present, unless suitable precautions are taken. Detailed advice on the necessary precautions is given in HSE Guidance Note General Series 5 "Entry into Confined Spaces", 1977.

Trichloroethylene is non-flammable, but naked flames can cause decomposition of the solvent vapour with the production of harmful acidic gases and should not be allowed near degreasing equipment.

3.1.3 *Materials and equipment for trichloroethylene cleaning*

3.1.3.1 *Material*

The trichloroethylene used should be stabilized against decomposition by the action of heat, light or hydrolysis, and should comply with BS 580, Type 1 or Type 2. Type 2 should be used for cleaning light alloys, when free fatty acids are present or when ultrasonics are employed.

3.1.3.2 *Equipment*

In order to comply with the above safety precautions, only correctly designed degreasing plants should be used. These consist of one or more vessels or compartments having means of heating the liquid trichloroethylene contained in the lower part and a condensing zone near the top, provided by water-cooled coils, to control the vapour level. Pure solvent condensate from the coils is collected by a trough from which it can be led outside the plant for recovery purposes, or to a stock tank for use with an auxiliary spray pump, or back to the plant to provide a replenishment of clean solvent in liquid compartments. One compartment of the plant may include one or more transducers, so that ultrasonic agitation can be applied to the solvent as one stage in the cleaning process. It is usually necessary to limit the temperature of the solvent in such a compartment in order to avoid damage to the transducers; the parts to be cleaned pass in succession through boiling solvent, ultrasonically agitated cool solvent and vapour. Equipment may be manually operated or of the continuous or automatic type.

Heating may be by steam, gas, high pressure hot water, electricity or oil. Automatic safety devices are necessary for all forms of heating to prevent trichloroethylene vapour rising above the condensing coils if the water supply fails or becomes insufficient. Overheating of the liquid solvent is prevented by the use of automatic sump controls in the case of gas, electricity or oil, and by restricting the pressure of steam or high pressure hot water. With gas or oil heating, the flue gases should be discharged to the outside atmosphere as they may be corrosive and affect the degreased parts.

The required heat input to the plant will vary with the amount of material being degreased. It should be sufficient to maintain a vapour level on the condensing coils. There should be an adequate flow of cold water through the coils.

Open top degreasing plants should be fitted with rim ventilation ducting along one or more sides, through which a gentle current of air can be drawn by an extraction fan to the atmosphere. Suitable extraction arrangements are normally incorporated in the upper part of all types of mechanized plants.

3.1.3.3 *Maintenance*

In addition to the correct operation during processing, satisfactory trichloroethylene cleaning is also dependent upon the maintenance described in 3.1.3.3.1 to 3.1.3.3.7.