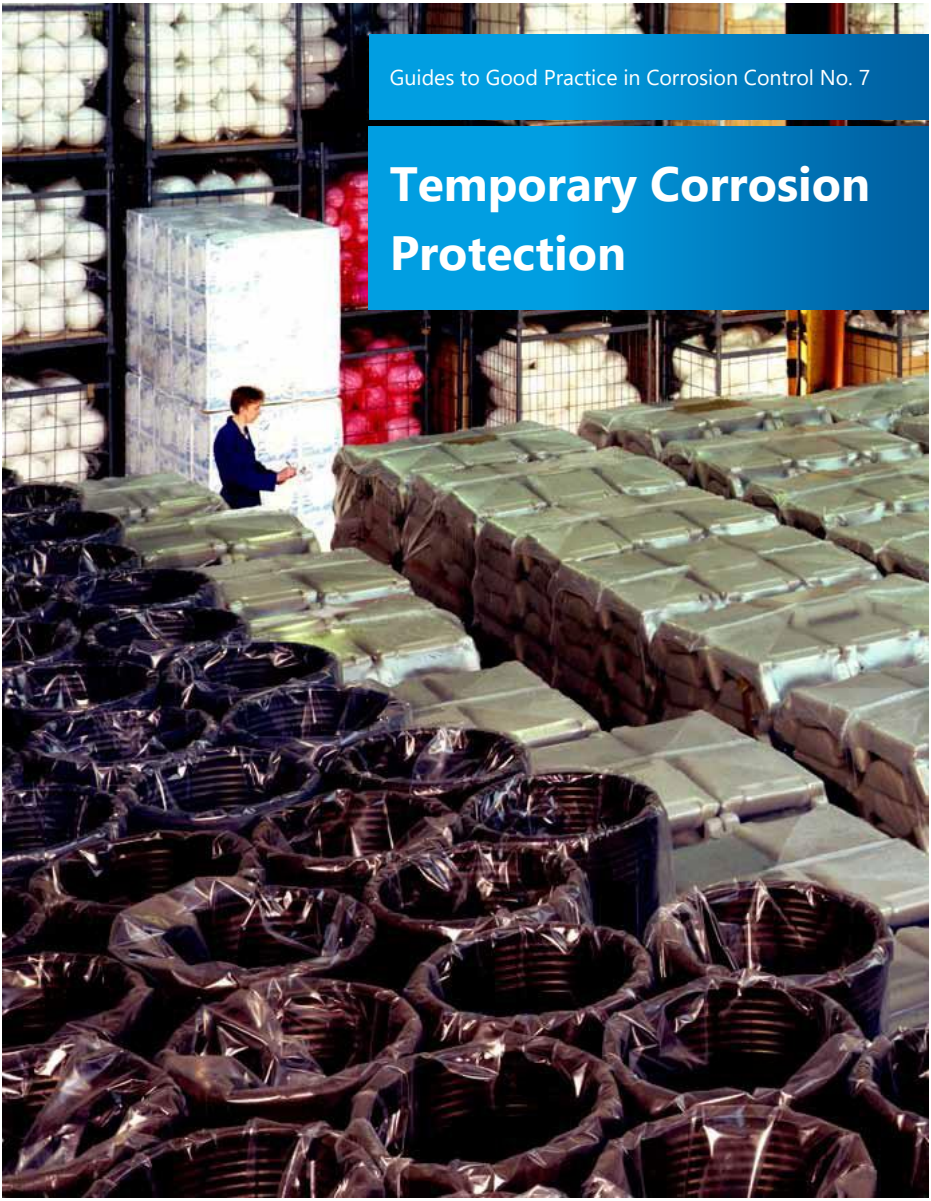
NPL

National Physical Laboratory



Guides to Good Practice in Corrosion Control No. 7

Temporary Corrosion Protection

NPL
National Physical Laboratory

Corrosion Research and Testing

For more information on corrosion research and testing contact Gareth.hinds@npl.co.uk
Or visit our website:
www.npl.co.uk/electrochemistry

National Corrosion Service

The National Corrosion Service (NCS) is operated by NPL on behalf of the National Measurement System to provide a gateway to corrosion and materials expertise for UK users. By acting as a focal point for corrosion enquiries the NCS can make the UK's entire base of experts available to solve problems or can use in-house expertise or teams to carry out consultancy. The NCS also raises awareness of corrosion problems and methods of control.

For more information on NCS services and products please contact us at: ncs@npl.co.uk

A free advice service is available to UK Residents and Companies on materials and general corrosion related matters.

You can also contact the NCS by phone on 020 8943 6142.

This is an update of a DTI publication first issued in 2008, which was written by Mr Richard Rogers of Fuchs Lubricants. This revised version has been prepared by Mr Peter Morgan FIIMS, MICorr, MEI of Lithgow Associates, on behalf of NPL for the Department of Business, Energy and Industrial Strategy. Edited by Dr. A. Turnbull and Dr. G. Hinds, NPL.

This page was intentionally left blank

Contents

1. Introduction

Many of the metallic parts, components and finished products produced by manufacturing industries may have bare metal surfaces that require protection until brought into use or receive inter stage protection prior to further assembly or processing. They may be finished metallic parts that need to receive some form of protection from corrosion during shipping or storage, or they may require some form of protection from corrosion whilst in use.

Typical examples are automotive parts which require protection for a few days, weeks or months; fasteners; steel strip; steel sections; drawn sections of steel; aluminium alloys; yellow metals, etc. during a delay in the manufacture and supply schedule.

In some cases the parts may need to be protected after machining. If this has been carried out with a water-miscible coolant then the parts may need to be dewatered or dried as part of the overall protection.

The metal to be protected may be ferrous, aluminium alloy, copper-based alloy, or other non-ferrous material, each of which may require a different specific approach to the formulation of the protective. The metal may be part of an assembly together with other metals with plastics or rubber seals and contact compatibility with other parts of the assembly will require consideration.

In many cases, the overall protection is provided by a combination of individual materials such as a surface coating in combination with outer wrapping, often combined with VCI (vapour-phase corrosion inhibitors). For instance, a machined part may be dewatered, with the same dewatering fluid leaving a protective film which is then augmented by wrapping in VCI-treated paper or stored in VCI poly-film containers. It is therefore important that both corrosion protection and subsequent packaging be considered together, rather than in isolation.

The use of some VCI products on their own allows protection without the inhibitor being in direct contact with the protected surface, enabling use or assembly without the need for removal.

Sometimes the temporary protective may perform other additional functions, such as serving as a lubricant or as a cleaning fluid. For example, in press forming of steel strips the same coating carries out both the corrosion protection and the lubrication of the forming process. As a cleaner it may be used for rinsing or cleaning machined parts and the film left by the cleaner may serve also as the temporary protective.

This guide helps to explain the concept of temporary corrosion protection; it describes the various types of protection available, points to ongoing trends, and gives guidance in their selection and application.

2. Purpose – What Are They For

A Temporary Corrosion Protective is by definition a material that can be easily removed from the metal surface after treatment. It is not designed to be permanent or difficult to remove in the same way as a paint system or plastic coating.

The material may need to provide protection when exposed to a variety of differing corrosive atmospheres: indoors, outdoors either under cover or fully exposed, in a marine environment under effects of direct sunlight, perhaps in a radiation flux, in the presence of specific chemical corrosives in an industrial environment, etc.

During its protective period it needs to give adequate freedom from corrosion of bare metal surfaces for a predetermined length of time in manufacture, assembly, storage or distribution. The term of protection will need to be determined for each application, in line with other requirements and the type of protective selected.

Since temporary protectives are invariably used in inter-stage manufacturing operations, they may need to be compatible or in harmony with later stages in the production operations. In particular, compatibility with any materials such as paints, adhesives, sealants, etc., which may be applied to the metal surface at a later stage, is important even though there may be prior removal/degreasing cleaning operations.

3. Fields of Application – Where Are They Used

The different uses and applications for temporary protectives include the following:

- Steel and coated steel strip
- Steel profiles, sections and tubes
- Aluminium or other alloy strip and sections
- Machined parts and components either as finished items or for later assembly
- Tools and machine tools in manufacture, storage and supply
- Fasteners such as screws, rivets, bolts, etc.
- Machinery parts, either finished or for later assembly
- Automotive components and sub-components
- Electrical parts and assemblies
- Construction and off-highway equipment
- Metal tanks, valves, and lines
- Agricultural parts and machinery
- Vehicles or machinery protected in shipment
- Assemblies of equipment, moth-balled for long or short periods

4. Generic Types – What Varieties of Protective Are Available

A number of different types of temporary protective are classified in BS 1133:1991, Section 6.2, Protection of Metal against Corrosion during Transport and Shipment, Temporary Protectives and their Application; these designations are also used below. There are however a number of other classifications or specifications for achieving temporary protection from corrosion: for example, the UK Ministry of Defence have their own Corrosion Preventatives specified in Defence Standard 01-05 (issue 13, section 4: PX- Corrosion Preventatives). Some of these have NATO Reference numbers and all have NATO Stock Numbers. The US specifies in a similar way under MIL Specification Numbers.

The classifications and designations in BS1133 are:

A. Solvent-based fluids: Coatings deposited on surfaces by the evaporation of solvents

TP 1a	Deposits a *hard* film, quick drying
TP 1b	Deposits a *hard* film, slow drying
TP 1a	Deposits a *hard* film, slow drying - also displaces moisture from wet surfaces
TP 2a	Deposits a *soft* film following solvent evaporation
TP 2b	Deposits a *soft* film - also displaces moisture from wet surfaces

Solvent-based fluids, which deposit a coating after the carrier solvent has evaporated, have been a traditional form of protection for some years. Usually they have a low viscosity, which together with appropriate additive treatment enables wet surfaces to be dewatered as part of the protective process. The periods of protection may range from a few days indoors to over a year outdoors. Type TP 2b fluids are widely used as automotive 'damp start' sprays, for removing moisture from plug leads, and traditionally as dewatering fluids providing inter-stage protection for components directly after machining with water-miscible cutting fluids.

Solvent-based fluids are usually applied either from a dip tank, by spray system or by brushing.

Special Application Notes – Solvent-Based Coatings

1. **Combustion:** The solvents used are usually light hydrocarbons, kerosene or white spirit fractions. Even lighter and sometimes more combustible solvents tend to be used for those products requiring a faster dry time. Hydrocarbon solvents present risk of combustion. A continuing trend has been to use solvents that possess a higher flash point and therefore a reduced risk of combustion.

2. **Health Hazards:** Use of solvent-based fluids in confined areas and contact with the skin can present health hazards.
3. **Volatile Organic Compounds:** The solvents used in these fluids can be classed as Volatile Organic Compounds and may cause photochemical smog. Legislation is in place to control the use of VOCs, and government is actively promoting elimination or reduction.
4. **Removal Degreasing:** Removal of the softer and lighter films is usually by conventional solvent or water-based degreasing fluids. Hard, particularly heavy, film coatings are usually removed by solvent-based fluids. Sometimes the use of heat and/or forced air circulation may be required to speed up the process.
5. **Dip Tanks – Solvent Evaporation:** If applied by dip tank, users must be aware that the solvent in the tank system will gradually evaporate away leaving a richer more concentrated fluid which will tend to deposit an increasingly heavier coating. Large users should check the additive concentrations regularly, seeking advice from their supplier on any rectification required.
6. **Spray Systems – Seal Compatibility and Nozzle Blockage:** Check that all parts of the spray are compatible; the drying solvent may affect elastomer seals or coatings. With heavier-build coating system, particularly the hard film materials, check that nozzles remain clear. Nozzles on sprayers that are used only intermittently are best cleaned after use with solvent or blown through to clear.

B. Soft Film – Grease-like, non-solvent

The grease-like protectives tend to be specified where consumers are seeking a soft heavy build film. They are particularly used for core protection of wire ropes, cables, and chains where flexing will not result in breakage of the protective film; for these applications the protective also serves as a lubricant.

TP 3	Petroleum jelly, Vaseline™ or petrolatum-based materials frequently applied by hot-dip or by smearing or trowelling onto surfaces
TP 4a	Mineral oil-based greases usually smeared or trowelled onto surfaces to give a thick film
TP 4b	Synthetic or vegetable oil-based greases, non-mineral oil, applied by smearing or trowelling and applied in those applications where special compatibility with sealants or adhesives is necessary
TP 5	Semi-fluid compounds based on highly viscous oils, usually thixotropic, to control flow and applied by smearing or by hot-dip

Application is by smearing or trowelling, although since they generally have fixed melting points, hot-dip application can be used to apply a lighter and more controlled coating weight.

At temperatures above their melting point they can also be pumped and sprayed with appropriate equipment to fill more inaccessible voids.

C. Protective oils – Soft film type, non-solvent

TP 6a	Protective, non-solvent oils, leaving a soft oily film. Applied by spray, dipping, etc. May be thixotropic.
TP 6b	Oils for filling sumps of equipment, engines, gearboxes, compressors, etc., for protection whilst in storage or shipping

Protective oils are available in a wide variety of viscosity ranges but all are designed to leave an oily soft film on surfaces without the use of a solvent, so avoiding some of the disadvantages of solvent-based materials. They range from very low viscosity (approx. 4 mm^2/s at 40 °C) to highly viscous fluids.

The protective coating oils are applied by dip, spray brush or circulation. For larger applications, such as for instance application of protective oils to metal strip at steel mills, these fluids are applied by electrostatic spray, and are therefore designed to achieve the correct electrical characteristics.

Special Application Notes – Protective Oils

1. **Thixotropic oils:** Some oils behave in a thixotropic manner, i.e. whilst pumped, sprayed or agitated, they behave as a normal liquid; but while at rest (for instance after spray droplets alight on a vertical surface) they behave almost as a solid, inhibiting flow and drain from the surface. For this reason thixotropic oils can offer advantages above and beyond those of conventional oil, helping to maintain film thickness even on vertical surfaces and therefore maintaining anti-corrosion design characteristics as well as reducing spillage onto surrounding floor areas.
2. **Protective oils for sumps:** Many oils are designed to be multifunctional and to serve as a lubricant. For instance, Type 6b fluids are available as storage oils for the sumps and lubrication systems of compressors, gearboxes, engines, etc. and many such products are designed to be compatible with the usual lubricant used in the equipment at a later stage. In some cases they may also be suitable for lubrication of the equipment in the longer term.
3. **Prelubes:** A special type of multifunctional oil, prelubes are a type of corrosion-preventive oil designed for electrostatic application to steel strip at the mill. That same coating is designed to provide the lubricant capabilities in the press for forming steel strip into car and truck body panels under body parts, etc. The protective coating is also designed to be fully compatible in the later auto assembly process so that the material may be compatible with process cleaners, paint coating processes as well as adhesives and sealants used in assembly.

4. **Wash fluids:** Some of the low viscosity protective oils are also designed as wash fluids for parts during manufacture to remove metalworking fluids and to provide a light protective film in storage.

D. Strippable coatings

These coatings are resin or plastic in consistency, usually of a heavy build and removable by mechanical stripping, normally by hand. They are commonly used for protection of hand tools during storage.

TP 7	Hot dip, strippable coatings, generally based on hot-melt resins and plastics. The part is dipped into the hot melt.
TP 8	Strippable coatings deposited from a solution of resins in rapidly drying solvents, applied by spray, brush or dip.

Special Application Notes – Strippable Coatings

1. **Physical protection:** This type of heavier build coating has attractions in also protecting parts against physical damage.
2. **Solvents:** Type 8 may give the same combustion and safety hazards outlined for solvent-based materials, see above.
3. **Costs:** In view of the heavy coating weight, higher costs are frequently encountered, although coating finally stripped off can often be re-used.
4. **Hot dip baths:** Suppliers of strippable coatings are also able to provide guidance on suitable thermostatically controlled baths for applying Type 7 products.

E. Volatile Corrosion Inhibitors

Usually abbreviated to VCI (Volatile Corrosion Inhibitor) or VPI (Vapour Phase Inhibitor), this type of protection showed considerable increase in use during the 1990's. Whilst originally mainly used for protecting steel surfaces, products are now available for protecting other metals and for multi-metal situations. VCI products work by continuously releasing a vapour with powerful anti-corrosion properties; on contact with metal the vapour is adsorbed onto the surface creating a film that will protect the metal from corrosion. The film is rehealing and self-replenishing through further vapour release.

Formulations are available that can function in the presence of trace acid residues but their efficiency can be impaired, for instance, by acids exuding from wooden packaging. Enclosed systems are recommended for maximum performance of this type of product, but dosage rates usually allow for some leakage. The most important criteria are that the vapour has access to all surfaces to be protected and that ingress of water is prevented. When selecting a VCI care should be taken to establish compatibility with paints, plastics and all metals to be protected. Some inhibitors may attack paints and plastics and actively corrode some non-

ferrous metals (see notes below). Although these products are volatile it is recommended that they should be placed within 30 cm of the surface to be protected for best results. Methods for application are described below.

TP 9	Paper	Supplied as rolls or sheets. Impregnated into various types, weights and grades of paper. The paper may emit VCI from either one or from both faces.
	Polymer Film	Supplied as rolls, sheets or usually bags tailored to the correct size for later heat sealing. Suited not only for protection of small parts but also for protection of individual large machine tools, vehicles, complex machinery, etc.
	Powders	VCI Powders are used to protect pipe work and tank systems, box sections, etc. by blowing through the system using low pressure compressed air and then sealing the system. Powders may also be applied from a solvent such as alcohol.
	Powder Sachets	Powder contained in perforated sachets, used in conjunction with other sealed packaging.
	Tablets	Small tablets, incorporated into other forms of sealed packaging.
	VCI Oils	Oil-soluble VCI products are blended with mineral oils to produce oils that can be used in mothballing of power generators and hydraulic systems, and can also be used for protecting sealed spaces or box sections.
	Water Soluble VCI Products	Normally based on water-soluble VCI powders and other water-soluble inhibitors, these products are mainly used as hydro-test additives and for enclosed cooling systems.

Special Application Notes – Volatile Corrosion Inhibitors

1. **Physical VCI chemicals:** can be used to enhance the performance of the other types of temporary protective coatings that have been described earlier, and are frequently used in conjunction with other types of protection.
2. **Protection period:** Provided that the component to be protected is in a sealed environment, and the correct weight of VCI is introduced, the protection period can be almost indefinite. Conversely, when the seal is breached the volatile inhibitor will be lost to atmosphere, leaving the surfaces potentially open to corrosion.
3. **Metals:** The VCI products used can be specific for the various metal types. A VCI recommended for ferrous materials may not provide protection for other metals, and parts constructed of a combination of metals will need to be protected by VCI products designed to protect all the metals used.

4. **Controlled emission:** In addition to supply of the chemical as sachets or tablets, special "emitters" are available which allow controlled emission of the VCI chemical into the atmosphere. This may be used for large sealed areas, such as machine rooms that may not require access by personnel over long periods, or the mothballing of electrical and other equipment in sealed rooms. These emitters may be sponge impregnated with a VCI Powder or plastic containers holding powder that have a breathable surface allowing the VCI to function.

F. Contact Inhibitors

TP 10 Contact inhibitors – consisting of chemicals to inhibit corrosion when in direct contact with metal surfaces.

Papers may be impregnated with solutions of conventional non-volatile inhibitors. Parts that are wrapped in papers with contact inhibitors are activated when condensed or contaminating moisture leaches out the inhibitor.

Special Application Notes – Volatile Corrosion Inhibitors

1. **Physical Inhibitors Metal-Specific:** As with VCIs, the inhibitors are usually selective to only one metal type.
2. **No Sealing:** The system does not require to be sealed.
3. **Water Leaching:** Repeated or prolonged wetting of the paper will leach out all inhibitor, reducing efficiency.
4. Trends have been away from use of conventional contact inhibitors and towards use of VCI-impregnated papers, etc.

G. Water-Based and Emusifiable Protectives

Usually mixed with water prior to use; applied by dip, spray or brush. These deposit an oily or waxy film after drying.

TP 11a Depositing oily film; TP 11-b Depositing wax film.

Temporary protectives that are mixed with water prior to use have been preferred in some areas over solvent-based fluids, particularly to eliminate the safety related problems of use. They are successful in some but not all areas of use.

Special Application Notes – Water-Miscible Protectives

1. **Concentration:** Usual concentrations vary from 5 – 25 % by volume of the protective in water, users are advised to check recommended ratio and to control carefully and regularly.
2. **Concentration Measurement:** can frequently be carried out at the tank side by use of refractometer. Seek advice from supplier.

3. **Temperature:** Some water-based fluids are designed for use at ambient temperatures, some at elevated temperatures; typically 60 °C – 70 °C. Use by dip at higher temperatures helps water to dry out more rapidly after coating: correct corrosion protection can only be achieved after allowing parts to be fully dried.
4. **Water loss from diluted fluid:** Use, particularly at higher temperatures, causes water loss from the system. A mix that starts at 10 % may quickly over- concentrate to 25 % and this over-concentration may affect film formation.
5. **Hard water:** High water hardness may affect mix stability, leading to separation and scumming; seek advice from supplier.
6. **Microbial degradation:** As with water-miscible cutting fluids, such water mixes may suffer from growth of micro-organisms. Note that until the diluting water has been driven off from the coating the correct level of corrosion protection will not be achieved.

H. Desiccators and Dehumidifiers

Corrosion of ferrous materials usually only takes place in the presence of water and susceptible parts should always be protected from aqueous contamination. Storage indoors under cover or in areas where condensation cannot occur is therefore recommended.

One way to remove moisture from a sealed environment, bag, box, container, etc. is to incorporate sufficient solid desiccant such as silica gel within the container or to use a dehumidifier.

Special Application Notes – Desiccants and Dehumidifiers

1. **Removes moisture only:** Note that desiccants/ dehumidifiers do not themselves control corrosion, only removing one of the potential corrosive elements.
2. **Volume of solid desiccant required:** Consult suppliers and other guides for details of quantity of desiccant required for particular volumes and conditions. Failure to use correct threshold levels will result in corrosion.
3. **Timber:** Note that packing materials such as timber palettes, bearers, dunnage, etc. can hold considerable quantities of water and may be a significant potential cause of corrosion.
4. **Condensation:** During shipping a container may be subjected to travel through a number of climate changes. This can result in formation of condensation on the metal surfaces. A number of specialist manufacturers produce suitably packaged desiccants to maintain humidity levels at about 30% RH to prevent spoilage of the cargoes carried in these containers.

I. Inert Atmosphere

Oxygen from the atmosphere is invariably required for corrosion to occur. Replacement of air by a dry inert gas such as nitrogen or carbon dioxide either in a sealed environment or one where a small positive pressure can be maintained may be suitable for temporary corrosion control of some components or equipment. Note that nitrogen may be preferred, since some alloys show potential for corrosion under carbon dioxide.

J. Barrier Foil

The performance of temporary corrosion inhibitors can be enhanced or replaced by the use of a barrier foil. These are usually laminates consisting of three layers. An aluminum layer that has very low moisture transmission rate is sandwiched between a polyester layer that gives the foil strength and a polyethylene layer that facilitates a good seal. This foil will have moisture transmission rates in the region of 0.05 g/m^2 per day of moisture vapour compared to up to 4 g/m^2 per day for polyethylene under the same conditions. Using barrier foil and either a VCI or a desiccant can provide a very effective anti-corrosion package for long-term store.

5. Multifunctional Corrosion Protectives

Mention has already been made (see above) of temporary corrosion protectives that also provide other functions. There has been a trend towards multifunctional fluids that has been quite marked in recent years.

Prime examples are:

1. **Mill oils and prelubes:** Protectives for sheet steel and aluminums, or mill oils, which are required particularly when the steel strip is intended for the automotive industry, need to serve not only as corrosion protective but also as presswork lubricant. Such oils are applied at the mill at low coating weight; they provide protection during storage at the mill, shipping to the press shop, and storage both before and after pressing into body panels. Specifications raised by the motor industry now refer to these as "prelubes", requiring a high level of press performance and subsequent compatibility during the assembly operation. The same prelubes also need to provide protection from corrosion and staining of cold rolled and hot rolled steel, galvanised/galvannealed strip, strip that has been electro-coated with zinc, zinc-nickel alloys and aluminium.
2. **Metalworking and corrosion protectives for machined parts:** It has been accepted for many years that cross-contamination exists from one chemical to another during machining operations. Light oils that are formulated to contain additives both for metalworking and for corrosion protection are now specified for certain machining operations and the same fluid may also provide the final protection during storage

and shipment. In some cases, the same fluid may also be used for lubrication of various parts of the machine tools themselves.

3. **Wash fluids:** Wash fluids used following metalworking operations may cause cross-contamination of subsequent corrosion protectives. In new trends, light corrosion preventive oils are often also used as wash fluids, thereby reducing problems of cross-contamination with one multifunctional fluid.

6. Environmental Considerations

The area or environment in which a temporary corrosion protective is used may dictate or require special considerations in terms of toxicity, emissions to atmosphere, potential for pollution of earth or water or for contact with food. Examples are:

1. **Incidental Food Contact:** Special products are available which comply with requirements for incidental food contact. In most parts of the world including the UK, products that are listed by the US NSF (National Sanitary Foundation) are accepted where incidental food contact may occur. This registration was previously carried out by the US Department of Agriculture.
2. **Rapidly Biodegradable Protectives:** Where products are used in sensitive applications and where potential contamination of earth or watercourses may occur, products that exhibit rapid biodegradability are available. Whilst these products give satisfactory performance in protection of metal surfaces, they are based on renewable resources and designed to degrade rapidly when accidentally spilled onto land triggered by exposure to high levels of micro-organisms.

Suppliers will be able to advise on selection of the most appropriate product for special applications.

7. Pre-cleaning and Removal

It is generally accepted that the performance of a coating system is improved by good surface preparation before application. This is particularly true with permanent coatings and BS 7773: 1995, Code of Practice for Cleaning and Preparation of Metal Surfaces covers this in some detail. For temporary protectives the requirements are less onerous and will depend on the component being protected and its surface condition. In general, surfaces must be free from contaminants that are corrosive or may impair adhesion or continuity of coating or restrict access of inhibiting vapours.

The contaminant will normally dictate the choice of preparation. Solvent degreasing, an alkali wash or steam cleaning removes oil or grease, and mechanical acid and electrolytic techniques may be employed to remove scale or rust. In some cases a simple water wash may be sufficient but others may require a combination of more than one treatment.

Removal of temporary protectives is normally achieved using the same techniques employed for pre-cleaning although the standard of cleanliness required will be dictated by any further process the part may undergo. In many cases the protective system may be left in place. Manufacturers will give their recommended method of removal on the technical data sheet for each product.

8. How to Select

Answers to a number of questions can help in selection of the correct temporary protective system and for most appropriate selection the user is advised to consult suppliers for specific recommendations. The supplier should give answers to the following questions:

- What metal or metals, and how complex?
- How contaminated the surface is?
- What preparation can be carried out?
- If it is water-wet?
- What length of protection is required?
- What methods are available for application?
- If necessary, how will it be removed?
- What is the atmosphere and does the atmosphere vary; is it in a marine or industrial area?
- What temperatures and temperature changes are involved over the lifetime of the protection?

The conditions and period of exposure, the shape of the component or assembly, quantity of items to be treated and the method of application govern the final choice.

Generally speaking there are four environments:

1. **Controlled atmospheres:** In principle, no protective is needed inside an oxygen-free or desiccated package but a light oil or grease is often applied as a fail-safe before and after packing and in the event of a temporary control failure.
2. **Dry indoor storage or sealed packages:** Components stored in heated indoor rooms or sealed packages should be coated with oil or grease or, if preferred, packed with a volatile corrosion inhibitor.
3. **Covered out door storage:** The period of storage will dictate the choice of product. For protection periods of one to two years, soft hot dip or solvent-deposited types are typical. In some cases over-wrapping may be necessary.
4. **Unsheltered outdoor storage:** When cover against the elements cannot be provided soft hot dip or solvent-deposited films with increased thickness or hard films are recommended. Secondary wrapping may be recommended.

The following table additionally suggests a number of possible protection routes, and is based on advice previously given in BS 1133, Section 6.2.

Item to be Protected	Type of Protective
Water-wet parts immediately after machining or aqueous wash	Water-displacing solvent deposited or water-based emulsifiable protectives, TP 1c, 2b, 11a, and 11b.
Small articles such as fasteners, etc., not water-wet, to be packed in quantity (where individual wrapping is impractical)	Oil film, TP 6a, supplemented by outer wrappings, preferably with use of VCI materials, TP 9.
Parts of simple geometric shape	Most types of protective suited.
More complex articles such as gears, crankshafts, hand tools	Most types of protective suited, supplemented by VCI for longer-term protection.
Metal parts and assemblies with rubber attached	Vegetable-based grease-type protectives, TP 4b, or TP 9 VCI powders/papers/film. In particular, do not use solvent-based materials.
Assemblies of less complex articles with large proportion of simple surfaces	Grease, TP 4a, on working surfaces and in crevices, then whole article coated with light oil or solvent deposited materials. Preferably supplemented by VCI.
Assemblies of articles with internal surfaces difficult to access, e.g. lubricating oil systems, engines, gearboxes	Use oil film type, TP 6a or TP 9.
Assemblies with delicate mechanisms	Oil film type, TP 6a, supplemented by water and water vapour impervious wrapping which may be VCI-impregnated. Or water-impervious packing without inhibitor, but using VCI and/or desiccant.
Parts and assemblies where no oil or grease film is permitted	Use TP 9 VCI-impregnated sealable film, or water vapour resistant packaging with desiccant.
Especially valuable parts or assemblies, particularly with precision externals	Strippable coating, TP 7, or VCI combinations with VCI-impregnated sealable outer.
Mal strip and profiles later to be subject to a forming process, i.e. for vehicle body parts	Oil film type, TP 6a, preferably a thixotropic prelube with enhanced forming ability.

9. Summary

Temporary Corrosion Protectives are an essential tool in the battle against corrosion and provide the engineer with the opportunity to protect metal components and assemblies with a range of products that are easily removed if required, provide a choice of finishes and methods of application, and a chosen time period for protection.

Frequently the choice of protective is best made holistically, with selection taking into consideration any previous or later processing requirements, and in the light of all circumstances in the use or processing of the item rather than in isolation. Selection of the optimum product or system is often complicated and it is recommended that expert advice be sought before the final choice is made. Users are recommended to discuss potential applications fully with their suppliers.

10. Further Sources of Information, Reference and Guidance

British Standard, BS 1133:1991, Section 6.2, Protection of Metal against Corrosion during Transport and Storage, Temporary Protectives and their Application.

British Standard, BS 7773:1995, Code of Practice for Cleaning and Preparation of Metal Surfaces.

Defence Standard DEF STAN 01-05, Issue 13, Section 4.

L.L. Shreir, R.A. Jarman and G.T. Burstein, Corrosion, Butterworth, 1994.

This page was intentionally left blank

Contact NPL

The National Physical Laboratory

The National Physical Laboratory (NPL) is the UK's National Measurement Institute. The heart of our mission is to deliver science with impact by disseminating research and measurement best practice for economic and social benefit.

National Physical Laboratory
Hampton Road
Teddington
Middlesex
TW11 0LW

Switchboard **020 8977 3222**
www.npl.co.uk/contact

Keep in touch with us

Follow NPL on Twitter:
www.twitter.com/npl

Become a Facebook fan:
www.facebook.com/npldigital

Subscribe on YouTube:
www.youtube.com/npldigital

Follow NPL on LinkedIn:
www.linkedin.com/company/national-physical-laboratory

NPL
National Physical Laboratory