PRESERVATION, IDENTIFICATION AND PACKAGING OF SERVICE STORES AND EQUIPMENT ("P.I.P.")

by

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The Object of P.I.P.

During the war it was found that important and vital war stores were arriving at their destinations either useless, or in such a badly damaged condition, that repair on the spot was impossible. In addition, quantities of material were constantly being lost in transit due either to their packages disintegrating or to their being insufficiently addressed and identified. It may be of interest to note the following approximate losses which occurred in one area of the Far Eastern Theatre :—

Aircraft instruments	85%
Bren gun breeches	75%
Electrical equipment	50%
Landing craft spares	50%
Radio equipment	40%
Aircraft radiators and oil coolers	40%

As a result of these extremely heavy, expensive, and in many cases dangerous losses, it was decided to investigate the whole field of Preservation, Identification and Packaging, and, consequent on these investigations, all the Services decided to introduce what is known as " Standard Packaging ". This has proved so successful that losses have been cut down to approximately 5% or below.

Briefly then, P.I.P. is the problem of ensuring that all stores will reach the ultimate user in the same condition as when they leave the factory. It is to be regarded therefore as an integral part of the manufacturing process.

Remember : A Poor Package Properly Packed travels better than
A Proper Package Poorly Packed.

The Hazards

The packaging of stores has two main objects (1) the protection from corrosion during storage and transit due to climatic conditions, and (2) protection from mechanical damage due to rough handling during the same period.

(1) *Climatic Conditions.* All Service stores may be transported to, and stored in, almost any part of the world. They must therefore be protected against very high and low temperatures, high humidities, heavy rainfall, dumping in swamps and on flooded beaches, and against attack by insects and fungoid growths. For example, high temperatures may cause materials such as timber, leather, wool and silk to give off moisture which can cause damage to any items around which they may be wrapped. Condensation due to humid

conditions can cause corrosion on metals and machinery, the growth of fungus and mould on textiles, leather, and camera and binocular lenses. Heavy rainfall, resulting in actual wetting, probably causes more damage than any other factor, for materials such as cardboard and paper will be ruined, certain glues will soften and even nails may lose a great deal of their holding power. As for insects, termites attack timber, paper and leather ; ants attack foodstuffs, and cockroaches damage photographic plates, ink and glue.

(2) *Rough Handling.* All packages may suffer from considerable hard treatment during transport, as they may be dropped from lorry tailboards, slings or railway wagons ; they may be dragged over rough ground or rolled end on end ; they may be landed over open beaches and attempts may be made at pilferage. It is interesting to note that the Americans calculated that a package suffered from some 23 such major handlings on its way from the factory to the Pacific front.

The Standard Aimed For

As it is almost impossible to forecast to what part of the world any particular item of equipment may be sent, it is necessary to P.I.P. items so that they will withstand the worst conditions that they are liable to meet. Although this method of packaging everything to one standard may appear at first sight to be wasteful of time and material, it is the only way of ensuring that the user will receive his equipment in a serviceable condition. A single standard of packaging has therefore been adopted by all the Services, and all methods of packaging which conform to this standard will protect the contents of the package during transport to, and for at least twelve months storage in, any part of the world excluding the Arctic. The conditions envisaged may be briefly listed as :—

(*a*) Dry heat up to 140°F.
(*b*) 95% relative humidity at 104° F.
(*c*) Wide fluctuations of temperature and humidity.
(*d*) Exposure to direct sunlight.
(*e*) Attack by fungi, bacteria and insects.
(*f*) Dust storms, excessive rainfall and floods.
(*g*) Bad handling and shipping.

P.I.P. Methods

To meet this standard, three basic methods of packaging have been evolved : these are called methods I, IA and II. They have been adopted as a result of research, test and practical trial and it has been proved that if such methods are properly applied, the item stands almost a 100% chance of reaching the user in an undamaged condition and ready for immediate use.

Before, however, detailing these methods it will be advisable to take a brief look at the two chief methods of corrosion prevention in common use.

Preventing Corrosion. As is well known, corrosion is due to the combined effect of the moisture and the oxygen in the air. Since removal of the oxygen is impracticable, standard methods of corrosion protection have as their basis the exclusion of moisture.

The first method, and the one in most common use to-day, is to coat the metal surface with some form of protective skin so that moisture and water cannot come into direct contact with the bare metal. Under this heading come all such treatments as painting, tinning, chromium plating and other parallel processes. In a large number of cases, however, it is not possible to use these more permanent methods and more easily removable materials or " temporary protectives " are used.

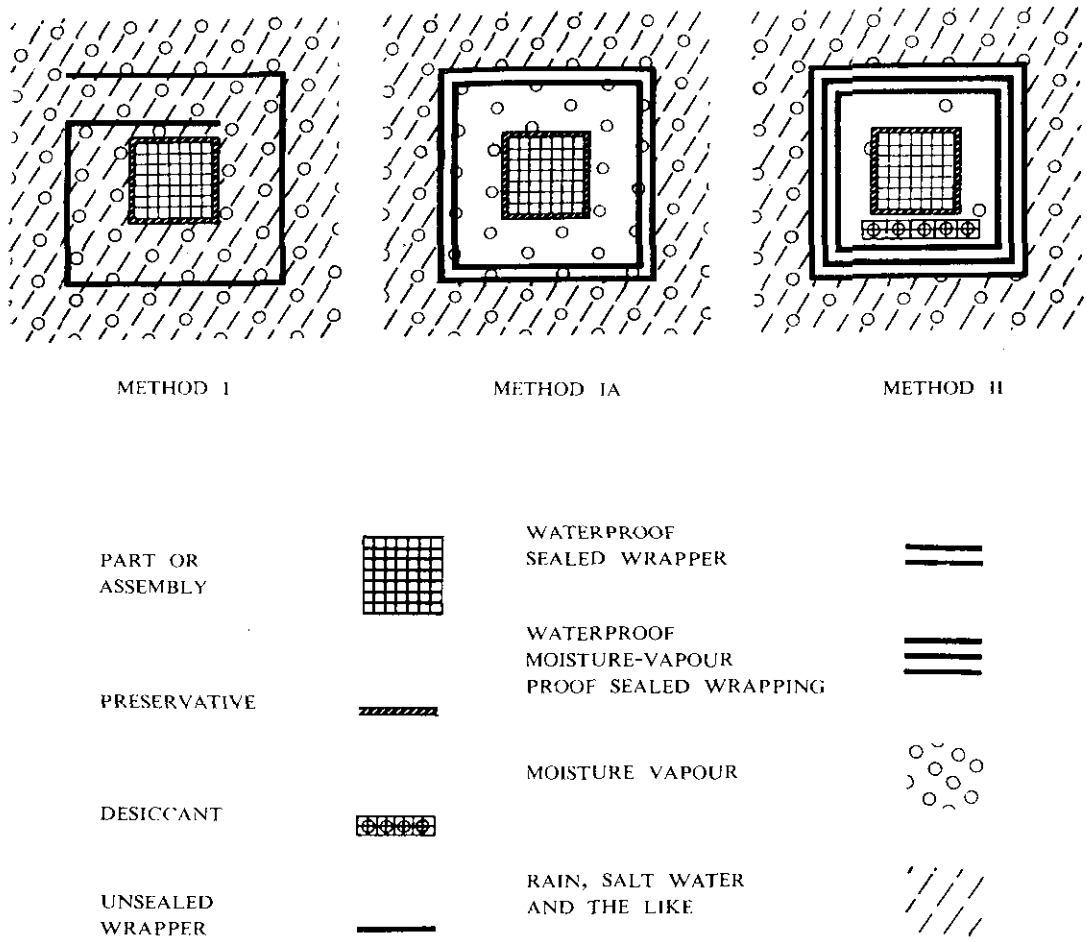


FIG. 1.—DIAGRAMMATIC REPRESENTATION OF PACKAGING METHODS

The second method of prevention is to remove as much moisture from the air in contact with the metal as possible. It has been successfully proved that corrosion does not take place when the Relative Humidity (or R.H.) is below 30% : above this figure corrosion is slow until about an R.H. of 65% or more, when it will be rapid and appreciable. The method II pack is based on this system.

Methods I, IA and II. Briefly, methods I and IA rely on the first way of corrosion prevention and method II on the second. They are diagrammatically represented in fig. 1.

Method I is used when complete protection against corrosion is provided by the preservative. This preservative must be adequate to resist the action of corrosive atmospheres, moisture vapour and liquid water : it must not flow off during hot weather, must not be absorbed by blocking and dunnage, and must not be easily scraped off or squeezed away. The preserved item is subsequently wrapped to prevent contact of the part's surfaces with dunnage and blocking, and to provide protection against damage from impact and abrasion. From a corrosion standpoint, the wrapper itself contributes little or no protection.

Method IA is used when the preservative gives protection against moisture vapour but not against liquid water. The entry of water from rain, wave slushing or possible immersion is resisted by the waterproof sealed wrapping. To resist corrosion by any transmitted moisture vapour and by any moisture from included air volumes is the function of the preservative. If parts are made of corrosion resisting alloys, etc., the preservative may be light or even left out. In any case the combined wrap and seal must present a continuous waterproof surface, as small breaks, cuts, or holes will greatly reduce the effective life of a package.

In Method II, protection against corrosion is obtained by maintaining the moisture content within the package at as low a level as possible. This is achieved by using a dehydrating agent, or desiccant, to absorb the moisture within the package, and a wrapping of a moisture-vapour proof material, which will be waterproof as well. Any small holes or cracks in this barrier will soon permit moisture to enter and quickly saturate the desiccant, and once this occurs the packaging is useless. Under normal circumstances the desiccant will in time become ineffective and for this reason method II packs will be marked with the date of packaging and the renewal date of the desi cant. Normally this method of preservation will be used on occasions when ordinary preservatives cannot be applied to the items, e.g., radio and electrical equipment.

Identification

So far we have only considered the question of preservation, but correct identification is just as important as proper packaging, for, unless a pack is correctly labelled at every stage of its build up, it will almost certainly be necessary for someone, at some stage in its journey to the user, to open it up to see what is inside. If this happens before the item is actually required for use, the time and materials expended in preservation and packaging will be wasted and the item will in due course reach the user in a rusty or damaged condition. This means that although the details of identification may vary slightly between packages, the principle of re-identification every time the previous identification labels are covered or hidden remains the same throughout. In many cases this will mean seven or even more identification stages, and although this may appear to be excessive, the importance of adequate labelling cannot be over-emphasized.

Items themselves, or wrapped items, are usually identified by a tie-on tag label bearing the necessary particulars. Cartons are identified by two gummed labels, one at one end near the top and the other on the top near the same end. On both occasions labels are protected either by coating with a nitro-cellulose varnish, or by completely covering them with strips of self-adhesive transparent tape. In the case of wax-dipped cartons, gummed labels will not stick to the wax and so such labels are retained in place by a strip of self-adhesive transparent tape long enough to pass completely round the carton. Outer packing cases are normally identified by stencilling.

P.I.P. OPERATIONS

Having now given a general introduction to P.I.P. we will next examine how P.I.P. is carried out in practice.

The layout of packaging plants is normally arranged so that articles move from one operation to another in a continuous flow on mass production lines. After a decision has been reached on the method to be used in packaging the various items, they are passed through some or all of the following stages :—

(1) Cleaning.
(2) Drying.
(3) Preservation.
(4) Primary wrapping.
(5) Cartoning.
(6) Wax dipping (where called for).
(7) Packing in outer container.

The process of identification is carried out at every stage of the operation at which previous identification markings have been covered up.

Cleaning

The importance of proper cleaning cannot be over-emphasized, as, whatever method of packaging is employed, and whether or not a preservative is used, it is essential that all metal surfaces are absolutely clean. All subsequent operations are of no value unless this first operation is efficiently carried out. In addition to the more obvious contaminants (e.g., rust, dust, dirty grease, etc.), others such as soldering and welding fluxes, heat treatment salts, chemical deposits and perspiration marks may also be present and must be removed. Some of these residues may be invisible, and because a surface appears clean it must not be assumed that it is so.

The various contaminants met with may be divided into the following two broad groups :—

(1) *Workshop Contamination* (greases, fluxes, etc.). There are various methods of removing these of which the following two are the most usual :—

(*a*) White Spirit Cleaning. Here the item is immersed in a bath of white spirit and if necessary scrubbed with a brush : the white spirit dissolves any grease and oil and any residual materials are removed by the scrubbing process.

(*b*) Trichlorethylene Vapour Cleaning. Trichlorethylene is heated in a special bath and the item is suspended over it, and in the vapour which is produced. The vapour condenses on the initially cold metal and the solvent so formed runs off the item dissolving any grease and oil, and washing off any solids. After draining off and back into the bath the solvent is reheated and the whole cycle is thus repeated continuously.

(2) *Rust.* This is removed by immersing the part in some rust removing solution and by then brushing or scraping the surface to remove the rust deposit which has been loosened by the solution. Immediately after the treatment all traces of the solution must be thoroughly washed off.

General. After the cleaning operations the parts must not be handled with the bare hands until the protectives have been applied : clean rubber gloves must, therefore, be worn between the cleaning operations and preservation.

Drying

The items, after cleaning, must be thoroughly dried and this is normally done by a jet of warm, dry air, or by placing them in a warm oven. Items fresh from cleaning should be preserved at once, as it has been shown that corrosion may be much more rapid on items which have been left temporarily unprotected.

Preservation

It must be realized at once that there is no universal protective which can be used for all items, and many factors have to be considered in choosing any particular preservative. Amongst these are the following :—

(*a*) The composition of the item to be preserved.
(*b*) The nature of surfaces concerned.
(*c*) The complexity of the item.
(*d*) The nature of the subsequent packaging.
(*e*) Whether the preservative will have to be removed before the item is used.

In most cases the choice of preservative is a matter of convenience and depends on the size of the item, as is the choice of the method of application. Whenever possible items are dipped, but spray or brush methods are also used where dipping is not possible.

The " Temporary Protectives " normally used can be divided into four groups as follows :—

Group I. Hard Film Protectives. These are solvent deposited, thin, tough film preservatives capable of being handled and resistant to abrasion. They will withstand and will provide protection against water and moisture vapour for long periods. They must be cleaned off before use and so are unsuitable for assemblies embodying moving parts. Wrapping is not necessary other than for protection against rough handling in transport : they may be removed by gasoline or kerosene.

Examples : (*a*) CS.1033D, Composition, Rust Preventive (Naval Stores Patt. 1178/E9).
(*b*) DTD.279, Lanolin, Pigmented (Patt. No. 1180/E9).

Group II. Soft-Solid-Film Types. This group will also provide protection against moisture vapour and water. They are similar to stiff greases and give a thick soft film, which is more liable to be displaced than Group I preservatives. The coating is best cleaned off before use but since meticulous cleaning is not necessary as any residual material will disperse harmlessly in lubricating oil they are widely used for intricate assemblies.

Examples : (*a*) CS.1317, Mineral Jelly (Patt. No. 890/E8).
(*b*) CS.881, Grease G.S. (Patt. No. 861/E8).

Group III. Thin Film Solvent Deposited. These are solvent deposited thin, soft films of lanolin, hardening slightly on ageing. Protection is not as good as Groups I and II, and as they will not stand abrasion, wrapping is necessary. They are best cleaned off before use, but this is not strictly necessary as the material will dissolve in lubricating oil. Usually used for interior surfaces where Groups I and II cannot be applied.

Examples : (*a*) CS.1746 Lanolin Solution (Patt. No. 1177/E7).
(*b*) DTD.121 Temporary Rust Preventive.

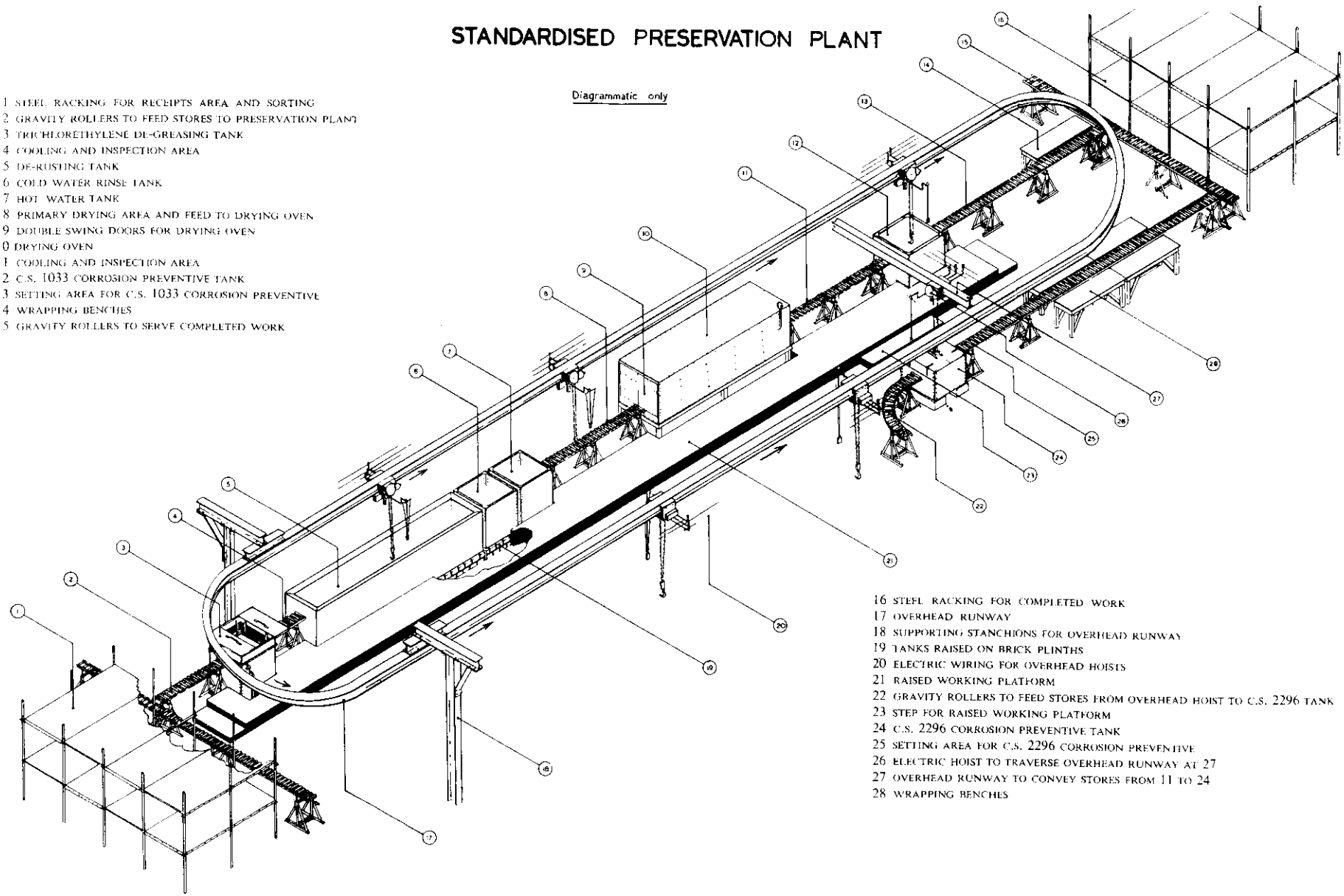
Group IV. Oil Film Type. Non-drying thin-film protectives intended mainly for internal surfaces or delicate mechanisms. Removal is not necessary.

Examples : (*a*) CS.1663 Composition, Preservative, Spraying (Patt. 1168/E7).
(*b*) DTD.561 Oil, Instrument, Corrosion Inhibiting (Patt. 1181/E9).

STANDARDISED PRESERVATION PLANT

Diagrammatic only

1 STEEL RACKING FOR RECEIPTS AREA AND SORTING
2 GRAVITY ROLLERS TO FEED STORES TO PRESERVATION PLANT
3 TRICHLORETHYLENE DE-GREASING TANK
4 COOLING AND INSPECTION AREA
5 DE-RUSTING TANK
6 COLD WATER RINSE TANK
7 HOT WATER TANK
8 PRIMARY DRYING AREA AND FEED TO DRYING OVEN
9 DOUBLE SWING DOORS FOR DRYING OVEN
10 DRYING OVEN
11 COOLING AND INSPECTION AREA
12 C.S. 1033 CORROSION PREVENTIVE TANK
13 SETTING AREA FOR C.S. 1033 CORROSION PREVENTIVE
14 WRAPPING BENCHES
15 GRAVITY ROLLERS TO SERVE COMPLETED WORK



16 STEEL RACKING FOR COMPLETED WORK
17 OVERHEAD RUNWAY
18 SUPPORTING STANCHIONS FOR OVERHEAD RUNWAY
19 TANKS RAISED ON BRICK PLINTHS
20 ELECTRIC WIRING FOR OVERHEAD HOISTS
21 RAISED WORKING PLATFORM
22 GRAVITY ROLLERS TO FEED STORES FROM OVERHEAD HOIST TO C.S. 2296 TANK
23 STEP FOR RAISED WORKING PLATFORM
24 C.S. 2296 CORROSION PREVENTIVE TANK
25 SETTING AREA FOR C.S. 2296 CORROSION PREVENTIVE
26 ELECTRIC HOIST TO TRAVERSE OVERHEAD RUNWAY AT 27
27 OVERHEAD RUNWAY TO CONVEY STORES FROM 11 TO 24
28 WRAPPING BENCHES

PACKAGING

The method of wrapping depends on the method of packaging (I, IA or II) to be used, and it is therefore advantageous to describe the three methods separately from this stage on.

Method I. Method I is used when the preservatives are of Groups I or II, as such preservatives provide complete protection against corrosion. Items are generally wrapped to protect the preservative from damage from abrasion and from contact with any blocking or dunnage used in the cases. The items are wrapped immediately after preservation in a " primary wrap ", the material of which depends on the type of preservative used. For Group I materials a waxed wrap is used and for Group II materials a grease-resisting paper is employed, the latter being applied in two separate layers. Small items are then placed in a carton with cushioning where necessary, and large items are usually placed direct into a wooden case or box.

Method IA. This method is normally used where the preservative employed affords full protection against moisture but not against liquid water. The wrapping is therefore designed to do this, and the following are the more usual ways of achieving it :—

(1) *Conforming Wrap Method.* After the preserved item has been wrapped in grease-proof paper as in Method I above, it is wrapped again in " Carton Wrap G.S. 2566," which is a scrim backed paper wax impregnated. This material will remain in any shape in which it may be moulded and will also adhere to itself. The wrapping is moulded to the item so as to exclude as much air as possible, and then the ends of the wrap are sealed by a lock joint seam. The entire package is then dipped complete in a special sealing compound, and in order to prevent adjacent packages sticking together, the whole is overwrapped with " Glassine " or brown paper.

(2) *Carton, Overwrap and Wax Dip Method.* In this method the item or items after being wrapped in their primary wrap are placed direct into a carton. The carton is then sealed with tape, wrapped in mouldable wrap and wax dipped as before, the whole being overwrapped, to prevent sticking, with " Glassine " or brown paper.

(3) *Carton in Waterproof Bag.* Here, instead of wrapping and wax dipping the carton as in (2) above, the carton is placed in a waterproof bag which is sealed by the appropriate method.

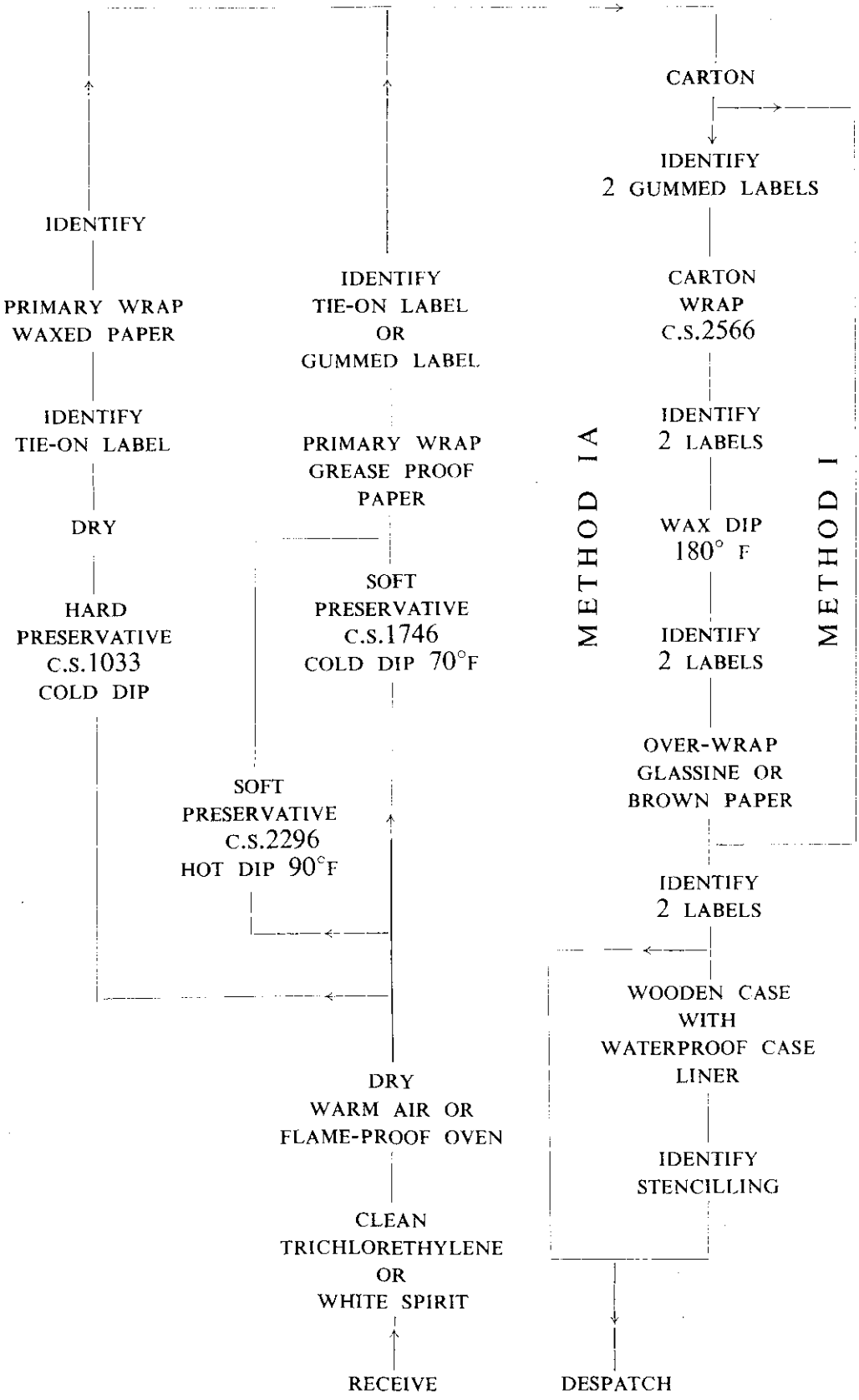
After Methods I and IA have been carried out, further packing is required if any bulk consignment is to be made up. Large items with a Group I preservative are frequently placed direct into an outer wooden case with suitable case furniture to prevent movement, and some form of wrapping to prevent removal of the protective. Cartoned items are usually packed in a wooden case fitted with a sealable bag liner, this liner being made of bitumen impregnated paper laminate, which, being waterproof, serves further to protect the cartons.

For convenience a diagrammatic sketch has been produced showing the various operations involved in producing a Method I and IA package in their proper sequence. Particular note should be made of the large number of Identification stages (page 28).

Method II. Method II packaging is used when it is not possible to preserve the item at all or when it is possible to preserve only part of it. As has been said already, preservation is here achieved by removing as much moisture from the air as possible and for this we require (1) a good desiccant and (2) a

DIAGRAMMATIC SEQUENCE OF OPERATIONS

METHODS I AND IA



good moisture-vapour proof (MVP) barrier. With regard to (2) the two materials in chief use are

(*a*) a metal foil laminate, and

(*b*) Carton Wrap C.S.9566, followed by wax dipping as in method IA. The ideal M.V.P. barrier is, of course, a sealed metal can or drum, and these are used on a large number of occasions.

The following are the more usual methods of making method II packs :—

(1) *For Small Items.* The item is wrapped in a primary wrap and cushioning material is placed over any sharp edges and corners to protect the M.V.P. barrier from damage. The article, complete with the correct quantity of desiccant, is then placed in a metal foil laminate bag, the open end being heat sealed, the whole then being placed in a carton.

(2) *Box, Bag, Box Process.* Here the item, after primary wrapping, together with the desiccant is placed inside a carton. The carton is then placed inside a sealable metal foil laminate bag, which in turn is put in an outer carton.

(3) *Use of Mouldable Wrap.* This is exactly the same as method IA, carton, overwrap and wax dip, except that no preservative is used and the desiccant is placed with the article inside the carton.

(4) *Floating Bag Method.* This is the method in common use for larger items of equipment. The essential difference between this and any other type of method II packaging is that the part or assembly is rigidly mounted on a base or cradle which forms part of the outer container. The enclosing barrier has holes through it to permit passage of the mounting bolts, these holes having suitable gaskets so that the M.V.P. barrier remains sealed. The desiccant is distributed as widely as possible in bags secured at convenient points, and as much air as possible is extracted before the bag is finally sealed. With this type of package the M.V.P. barrier has hardly any stress to resist and it is this important factor which makes this method preferable to any other whenever possible.

Note on Desiccants

Desiccants are materials which, when exposed to a moist atmosphere, will absorb moisture from the air until they become saturated. In general they will absorb up to 40% of their own weight before this occurs.

There are several types of desiccant in use but the two most common are (*a*) Silica Gel and (*b*) Activated Alumina.

The weight of desiccant which should be used is given by the following formulae which were developed by the Ministry of Supply :—

$$W = \frac{ARM}{60} + \frac{D}{2} \text{ lb for Silica Gel } (a), \text{ and}$$

$$W = \frac{ARM}{40} + \frac{3D}{4} \text{ lb for Activated Alumina } (b)$$

where A = Area in sq. ft. of M.V.P. Barrier

R = Moisture-Vapour transmission rate of Barrier material in grams/sq. metre/24 hours

M = Required life of package in months

D = Weight of hydroscopic material within the barrier envelope.

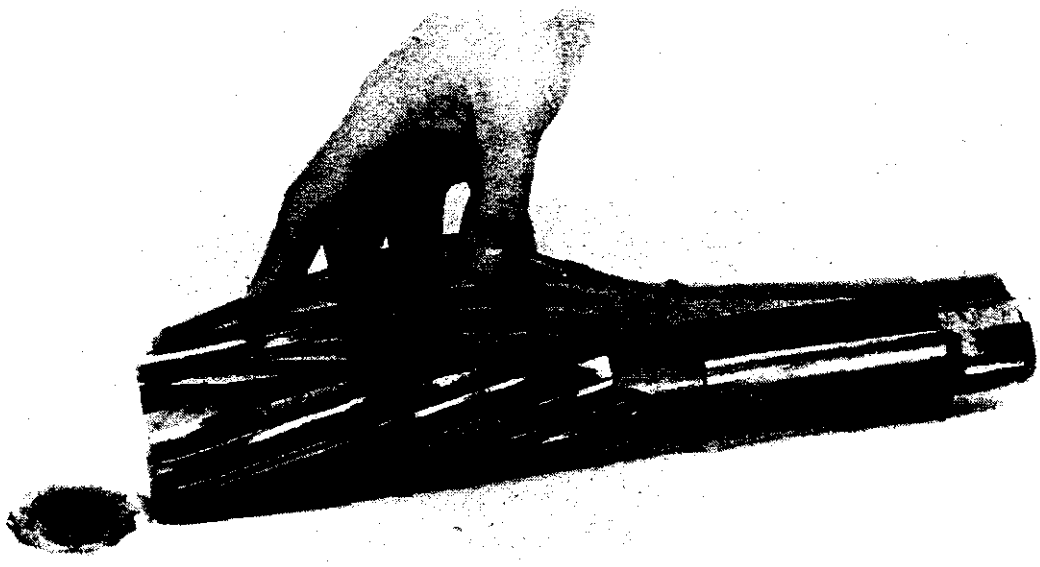


FIG. 2.—HOT DIP STRIPPABLE COATING

Where the life of the package is taken as being 12 months, and type I British Metal Foil Laminate (Patt. No. 4640/E12) or a wax dipped Mouldable Wrap is used with Silica Gel (Patt. No. 182/E6), formula (*a*) is reduced to

$$W = 1/5A + 1/2D \text{ lb}$$

In all cases it is most important to attach a label to a method II pack giving the date at which the dessicant should be renewed.

Other P.I.P. Developments

There are two further preservation methods worthy of note, the first being already in use, and the second being still in the experimental stage.

(1) *Hot Dip Strippable Coatings.* This is a thick plastic film which provides a tough, transparent skin which gives good protection against mechanical damage to cutting edges and critical surfaces. It is based on a mixture of ethyl cellulose and mineral oil mixes and has the advantage that it exudes oil on to the metal surfaces underneath the coating. Items to be preserved are cleaned and then dipped in a molten solution of the compound at a temperature of 180°—200° C for about 5 seconds. Preserved items require no wrapping and can be packed loose. To remove the coating it is only necessary to slit it down with some sharp instrument and peel it off, when it will be found that the item is coated with a thin film of oil.

After use the material can be melted down and used again.

(2) *Vapour Phase Inhibitors.* These are slightly volatile materials, the vapour of which condenses on adjacent metal surfaces forming a thin film capable of inhibiting corrosion even in the presence of moisture.

So far as is known at present they are only fully effective in the protection of iron and steel. The oustanding advantage with V.P.I. is that it need not be applied directly to the surface requiring preservation, but need only be deposited in the neighbourhood of such surfaces, a preliminary figure for its range of action being one foot. V.P.I. can also be used for impregnating paper, which in its turn can be utilized for wrapping steel articles and thus preserving them. At the present moment no firm figures are available as to its application, but a number of trials are in progress with the object of obtaining information as to its potentialities.

Further Reading

(1) *The British Standard Packaging Code*, B.S. 1133 *and supplement.*

(2) *Journal of Naval Engineering*, Vol. 2, No. 4, pages 331-341, of January, 1949.

(3) A.F.O. 5761/44—*Packing and Preservation of Gun-mounting, Director, Fire Control Gear, including Spares for Shipment abroad.*

(4) A.F.O's. 3107/45 and 1081/46—*Naval Stores for Tropical Packaging.*

(5) A.F.O. 3641/45—*P.I.P. of Naval Electrical Equipment, including Base and Depot Ship Spares, for Shipment and Storage Overseas.*

(6) A.F.O. 2851/47—*I.C.E.s and Spares—P.I.P. prior to Shipment and after Immersion in Salt Water.*

(7) A.F.O. 4041/47—*Ball and Roller Bearings—P.I.P. and Cleaning prior to use.*