MANUAL

PRESERVATION OF OLD AND NEW EQUIPMENT AND PIPING STANDING IDLE

DEP 70.10.70.11-Gen.

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the preservation of equipment and piping standing idle, and contains procedures for temporary, short-term and long-term preservation of specific items of plant and component parts.

NOTE: In this DEP, specific Shell and other products are specified or recommended for various preservation applications. It is not intended to preclude the use of equivalent products, provided they are approved by the Principal.

This DEP is a revision of the DEP of the same number dated October 1992. Other than editorial changes, this revision has not been extensive; a summary of the main non-editorial changes is given in (1.5).

The preservation of transmission pipelines is excluded from the scope of this DEP.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in oil refineries, chemical plants, gas plants and, where applicable, exploration and production facilities and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP that is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the objective of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references are made, the number of the section referred to is shown in brackets. All publications referred to in this DEP are listed in (10).

1.5 SUMMARY OF CHANGES SINCE LAST REVISION

Other than editorial changes, the following are the main changes since the last revision:

Section	Change
Throughout	References to MESC numbers removed
Throughout	Ensis and VPI grades updated
3.2.6.1	Vapour Phase Inhibitors listed by grade
6.1	Requirements for austenitic stainless steel extended.
6.2	Requirements for ferritic stainless steel extended.
6.5	Requirements for nickel, nickel alloys and nickel steels extended.

2. GENERAL

2.1 GENERAL PHILOSOPHY

For various reasons it may be decided to shut down a plant or unit for recommissioning at a later date.

The general guidance given in this Manual summarizes the more important procedures used to ensure that the plant is adequately, yet economically, preserved in order to maintain its technical integrity for the period standing idle, and to make resuming production as straightforward as possible.

Preservation procedures recommended for general guidance have been developed for what are considered to be the three principal requirements, which are defined as follows:

Temporary preservation - for plant operating on a cyclic programme, i.e. where the period of idleness between operating periods may be about 2 months (1 year for civil engineering items).

Short-term preservation - for plant which is to be shut down for two months or more, and recommissioned within 1 year (2 years for civil engineering items).

Long-term preservation - for plant which is to be shut down for recommissioning 1 year or more later (2 years or more for civil engineering items).

It is recognized that in some cases there will be justification for adopting a preservation procedure lying between the terms defined above. This will be a matter for local judgement.

NOTE: "Civil engineering items" are those included in (7.5).

2.2 ECONOMICS

The costs of preservation and later recommissioning, together with the costs of providing the on-going services, inspection and safety checks required during the period of idleness, are generally the main factors in assessing the economics of preservation. The possible extension of the period of idleness at some later date should not be overlooked, and provision for such a contingency should appear in the estimates.

The period for which the plant is to be standing idle has a significant influence on the costs of preserving the equipment and rehabilitating it for normal operation. For long periods of idleness, over five years, the overall preservation costs can be high and some careful estimating will be required to support the economic justification.

Recommissioning costs will depend on the location of the plant in relation to other manufacturing facilities. After long-term preservation of comparatively isolated units, these costs can be high. Estimating the rehabilitation should take into account not only the recommendations outlined in (9), but also the replenishment of processing materials and catalysts, the procurement of spares, and the possible requirement for the recruitment and training of personnel or, alternatively, using a contractor. The lead time for replacements should also be taken into account.

2.3 CONDITIONS CAUSING INCIPIENT FAILURE

2.3.1 Influence of climate and cyclic operations

Climatic conditions can be the cause of incipient failure of equipment standing idle. Cyclic operation of plants may also lead to incipient failure of plant equipment.

It is important that these conditions and the effect they can have on various types of equipment are analysed before determining which preservation procedures and methods of protection should be applied.

2.3.2 Rain, moisture and high humidity

The rate of corrosion may increase greatly in areas where the atmosphere has a high humidity and contains corrosive contaminants. In coastal areas, salt deposited by sea spray or rain can have similar adverse effects. High concentrations of these contaminants can collect in crevices and under insulation if the external sheeting is not water-tight.

Severe corrosion can be expected, particularly in plants where the maximum operating temperature of the plant did not permit the application of an effective paint coating. This situation will be aggravated where such plant is in intermittent operation. In such cases additional inspection will be required to determine the degradation rate particularly if the equipment or piping is insulated.

If "cold" insulation (i.e. insulation for cryogenic systems which operate below 0 °C) absorbs moisture during the period standing idle, it can be damaged upon recommissioning when the plant is cooled down.

Similar problems may arise with valves in cryogenic service. Should moisture become trapped in the crevices between the spindle and valve body during the idle period, then the water will freeze when the plant is subsequently cooled down, and the valve may become inoperable.

2.3.3 Temperatures below zero

In climates where sustained and severe freezing can occasionally be expected, the effect of low temperature on materials of construction should be considered.

The effect of ice formation during such periods should also be considered. For example, insulation which is wet could be damaged, and the internals of cooling towers could become overloaded. Snow loading should also be considered, e.g. for floating roof tanks.

2.3.4 Sand and dust

In areas where sand or dust storms may occur, special precautions are needed to prevent fine particles entering the equipment or crevices in the equipment

2.3.5 Idle rotating equipment

Slender horizontal rotor shafts when not rotating could be subjected to a plastic deformation. Such a deformation, even if only very small, will cause damage during subsequent start-up.

Bearings could be damaged by high pressure contact over a long period between two locally contacting surfaces.

2.3.6 Underground drainage piping

These shall be flushed according to DEP 34.14.20.31-Gen., and thereafter kept full of liquid.

2.4 SAFETY AND SECURITY

Once the preservation procedure is completed, the Principal is responsible for ensuring that the plant is completely safe and secure during the idle period. The normal operating work permit system (e.g. for welding and other hot work) should apply to plant standing idle.

Proper financial and physical control shall be followed by the Principal in the event of transfers of equipment to other units.

Unless required to be used for other operating units, control rooms, switch houses and analyser houses should be locked up to ensure that there is no unauthorized use of the building or contents.

Fire-fighting equipment shall be available for plant standing idle. All reasonable precautions shall be taken to ensure that a fire hazard can be contained and that the fire-fighting services are adequate for such purpose.

3. PROTECTIVES AND METHODS OF PROTECTION

3.1 GENERAL

General guidance on methods and protectives for exterior and interior protection is contained in this Section. In practice, it may be preferable, for special reasons, to use a protective of a grade other than that recommended.

In order that a rust preventative may function with maximum effectiveness, it is essential that the surface be thoroughly cleaned prior to its application. Residues of perspiration, soldering fluxes, grinding compounds, atmospheric dust particles, etc., can greatly reduce the effectiveness of a rust preventative.

For enviromental considerations regarding the use and disposal of cleaning and/or preservation agents refer to DEP 70.10.80.11-Gen. and 34.14.20.31-Gen.

A little rust on a highly finished surface is much more critical than on surfaces where wider tolerances are allowed. Particular care is needed in these cases if the ability of the equipment to perform to specification is not to be impaired on recommissioning.

Certain products used in formulating rust preventatives have a low to moderate level of oral toxicity. Applicators should follow the regulations recommended for the safe handling and use of these products.

3.2 RUST PREVENTATIVES

Based on long experience of proven application, the use of Shell products, e.g. Ensis compounds, fluids and oils, vapour-phase corrosion inhibitors and certain grades of greases, is recommended, wherever possible, for the preservation of equipment standing idle.

Ensis protectives are applied as coatings on the surfaces requiring protection. The range consists of products providing oily, soft or hard coatings of various thicknesses. The duration of protection is in general longer as the thickness of the coating increases.
The degree of protection also depends on external circumstances. A given protective will give freedom from corrosion for a much longer time in a dry atmosphere indoors than if stored outside exposed directly to the weather.

3.2.1 **Shell Ensis Oil (grade N)** forms a non-drying oily film and provides protection for parts which are not subject to much handling. It is also suitable for internal protection of equipment, for which it should give up to 12 months' protection for equipment under unsheltered outdoor conditions at temperatures not exceeding 80 °C .

3.2.2 **Shell Ensis Engine Oils** are available in four viscosity grades (10W, 20, 30 and 40) and can be used to protect non-turbocharged internal combustion engines during storage by replacing the normal service lubricant for a short period before shutdown.

3.2.3 **Shell Turbo Oils 'T'** are available in five viscosity grades (32, 46, 68, 78 and 100) and are used for the long-term preservation of steam turbines.

3.2.4 **Shell Ensis Fluids** contain volatile solvents and include products which displace water. After application the solvent evaporates to leave a protective film which, depending on the grade, may be oily, of a grease-like consistency, or hard. The hard films are very resistant to handling but are somewhat less easy to remove than the others.

Ensis Fluid grades S, T and V should provide protection for equipment stored indoors for up to 18 months or under shelter outdoors for up to 12 months at temperatures not exceeding 40 °C. Ensis Fluid grades T and V give a hard thick film and are specially designed for outdoor applications. Ensis Fluid grade C has very strong dewatering properties and is particularly suitable for pretreating prior to application of one of the other grades of Ensis Fluids.

Where fluids are used for internal protection of equipment they should only be applied where they are within reach to facilitate cleaning, e.g. pump internals and casing, etc.

3.2.5 **Shell Ensis Compound CA** is a product of grease-like compounds which give durable protection and can withstand considerable handling. For application it should be rendered

fluid by heating to approximately 75 °C.

The compound should provide protection for up to 12 months outdoors.

3.2.6 Vapour phase corrosion inhibitors

When used in the proper quantities, these vapour-phase corrosion inhibitors can be applied advantageously for the internal protection of turbines, compressors, hydraulic systems, bearings, engines, heat exchangers, pipes, vessels, etc.

Under adverse conditions (e.g. high humidity, widely fluctuating temperatures and corrosive atmospheres) the periods of protection will be reduced and periodic inspection should be performed.

Low temperature will reduce the vapour production rate of VPI and VSI products.

These corrosion inhibitors can be divided into two types:

3.2.6.1 VPIs (Vapour Phase Inhibitors)

VPIs are crystalline powders which slowly vapourise into the enclosed space inside a package.

Vapour losses of VPI products from non-air-tight enclosures may be unacceptable and thermal decomposition could occur.

NOTES: (1) Whenever VPI powder is placed inside equipment in small bags, a red tag showing the number of bags installed shall be attached at a prominent place outside the equipment.

(2) Direct contact of the VPI powder with non-ferrous metals and painted surfaces should be avoided.

(3) VPI should not be used in combination with a desiccant.

VPIs were previously marketed by Shell but are now marketed by Contract Chemicals Limited. A description of the various grades is as follows:

VPI 260	A general purpose grade of VPI, most commonly used, capable of providing long periods of protection. Common uses are exterior and interior pipe surfaces, heat exchangers and packaging for protection during transits.
VPI 280	Used in the protection of surfaces in acidic environments. Common uses are heat exchangers, steam boilers, diesel engine coolant systems and packaging for protection during transits. NOTE: This grade is also available from Shell Nederland Verkoop B.V.
VPI 260F + VPI 280F	An inert additive renders both VPI 260 and VPI 280 powders free flowing, enabling areas difficult to access to be protected. Common uses are as with VPI 260 and VPI 280, however with several advantages concerning application.
VPI 300	This grade is used to protect metals in water or humid atmospheres. A highly effective compound for a wide range of applications. Common uses are emulsion paint cans, spray cans, pumps and compressors.
VPI 350	For a combined protection scheme, which can be used in water or humid atmospheres. Preferred use is where non air tight containers are employed and longer term protection is required. Common uses are marine engines, heat exchangers and car engines.

3.2.6.2 VSI (Vapour Space Inhibited) **concentrate** is an oily concentrate that can be added to lubricating/seal oil systems when equipment is not going to be completely filled.

A typical grade is VSI concentrate 8325, marketed by Shell Nederland Verkoop B.V.

The protection is obtained by the evaporation of the medium, the vapour being absorbed as an invisible film on the protected surfaces.

Protection should be effective over an oil temperature range of 15 to 70 °C for up to 12 months. For maximum efficiency, given a temperature of 30 °C , oil to surface distances

should not exceed 2 m. The distances should be less for lower temperatures and may be increased for temperatures higher than 30 °C .

Removal of the inhibitor prior to start-up is not necessary.

High temperature may cause oils to dry out and oils/fluids to crack and become more difficult to remove.

3.3 METHODS OF PROTECTION

3.3.1 Exterior protection

Cocooning
Cocooning is the envelopment of equipment in a single plastic coating. The coating is applied by spraying either directly onto the equipment body or onto a special wrapping of paper or wire netting. Before cocooning, the equipment shall be carefully cleaned of grease and dust, and then dried. Cocooning should conform to the equipment Manufacturer's recommendations. Where possible, the envelope should be pressurized by inert gas (small overpressure).

Painting
Routine maintenance painting programmes for external protection should be continued.

Coating
Shell Rhodina Grease No. 2, Shell Ensis Fluids and Shell Ensis Compounds are temporary protectives suitable for the bright-finished moving parts of mechanical equipment. Storage under cover is preferred.
Before application, surfaces shall be thoroughly cleaned and dried.

Wrapping
Wrapping with waterproof paper or VPI paper is a cheap method of protection. However, the equipment protected in this way should be stored under cover.

3.3.2 Interior protection

Oil coating
Internal oil coating of stationary equipment may be carried out by spraying or, if the foundation is strong enough, by filling and subsequent draining. Use can be made of Ensis Oil grade N or of a light oil of medium viscosity (approximately 35 mPa.s at 38 °C) to form a protective film on the surface.

Filling
Often one of the factors limiting the filling of process and storage equipment is the strength of the foundation.
Adequate measures shall be taken to allow for expansion of the filling fluid, which can be a gas oil or inhibited fresh water (or inert gas, see below).

Vapour-phase corrosion inhibitor
VPI can be used advantageously for the internal protection of engines, bearings, turbines, heat exchangers, pipes, drums, small tanks and like equipment.
Care should be taken to ensure that no pockets of water are present and that the piece of equipment to be protected is dry and properly closed off from the atmosphere.

When complete filling of equipment with Ensis Oil grade N is not to be carried out, the remaining surfaces can be protected by periodically splashing the oil, e.g. by means of rotating moving parts or by adding VSI concentrate or by hanging a small bag with VPI powder above the liquid. Refer also to the notes in (3.2.6.1).

Dry inert gas filling
All hermetically closed equipment may be protected by drying the air or displacing it by an inert gas, e.g. nitrogen, and maintaining a slight positive internal pressure. This pressure is not necessary if a desiccant is present or a vapour-phase inhibitor is used.

Desiccants
Drying agents, such as silica gel, can be used inside closed equipment. The desiccant should be placed in a suitable container and periodically renewed. It shall not be used in

combination with VPI.

Electric heating
The following methods of electric heating may be considered:

(a) Fan heaters; for space heating, e.g. sub-stations, control rooms, basements.

(b) Warm air (strip heating, electric trace heating or lamp bulbs); for equipment which is cocooned or otherwise enclosed.

(c) Anti-condensation heaters for electrical equipment (see 7.7).

4. PREPARATORY PHASE

4.1 DECOMMISSIONING

Plant should be shut down as smoothly as possible, in such a manner as to prevent ingress of corrosive vapour or liquids during shutdown. Any corrosive process fluid should be displaced by an inert medium. This also applies to piping systems.

Effective neutralization is essential with certain processes in order to avoid severe corrosion. Proper control of neutralizing procedures requires steady operating conditions, and in large units unsteady conditions can last for some days.

After shutdown, a check shall be made to ensure all preparatory work has been carried out on the plant. This shall include:

- draining of all contents;
- removal of all catalysts, or containment in such a manner as to minimize the effects of weathering, ageing or mechanical abuse;
- isolation at battery limits (beware of electrical cross connections);
- hydrocarbon gas free and avoid entrance of humid air;
- draining of plate interceptors;
- draining of cooling water from equipment and piping which are to be preserved.

When the plant is free of gas and liquid hydrocarbons, it shall be spaded off from the main flare. For both short and long-term preservation, ammonia and caustic injection lines shall be spaded off.

4.2 INSPECTION AND TECHNICAL AUDIT

Information in plant records compiled from inspection reports on the plant during its operating life-span will provide a fair indication of the general state of the equipment and pipelines, normally as at the previous major shutdown.

The extent of the preservation which will be required, particularly for exterior protection, will depend on the actual condition at time of decommissioning.

4.2.1 Inspection

An external visual inspection shall be carried out and shall include the following:

- inspection of "hot" insulation, checking for areas where moisture could penetrate through the insulation and lead to corrosion under the insulation. The condition of the external coating must be assessed to determine its effectiveness against protecting the equipment for the duration intended;
- inspection of "cold" insulation, checking similarly for flaws in the weather protection/ vapour barrier;
- inspection of the fireproofing applied to steel support structures, checking for areas, particularly at joints, where moisture could penetrate and hence corrode the steelwork;
- a general inspection of painted steelwork in order to establish the scope of the painting programme during the period of idleness;
- examination of all wire ropes, slings and chains used on the plant in order to select the items worth preserving and to scrap the remainder;
- furnace refractories, chemical resistant linings and stack linings: check for areas needing repair before preservation, and neutralise any acid deposits. Particular attention must be paid to any tubes buried in refractory as they are subject to severe external corrosion especially if high sulphur containing fuels have been fired. Thorough materialisation must be carried out (refer DEP 70.10.80.11-Gen.) and SIOP report OP-30316 - 22/7/96) or the refractory removed.

4.2.2 Technical audit

A technical audit shall be undertaken jointly by engineering, inspection and operations personnel, supported where necessary by specialists and representatives of the

Manufacturers of critical items of equipment. Broadly, this audit shall extend to:

- all major items of static and rotating equipment;
- selected items of minor equipment;
- selected piping systems, particularly where there is a history of corrosion;
- the safety/relief valve interlock system;
- listing the instruments and other small items which should be removed to warehouse storage;
- determining any changes which may be required to impressed current cathodic protection systems and insulated flange connections at battery limits;
- assessing the condition of platforms, stairways and handrailing;
- assessing the condition of chemical and refractory linings, insulation, fireproofing, coatings etc.

4.3 DECISION ON THE EXTENT OF PRESERVATION

The following factors are to be considered when deciding on the extent of preservation.

It is important that preservation should be adequate for the purpose intended, yet at the same time it is equally necessary to ensure that it is justified economically. Whilst the extent of preservation is primarily a function of the time for which a plant is to be standing idle, there are other factors which have to be considered simultaneously and it is recommended that this is best achieved through interfunctional discussions at local management level.

In most plants there are the less critical areas where the risk may not be sufficient to justify the combined costs of preservation and later recommissioning, always providing the equipment and access to it remains in a safe condition. This should become apparent from the results of the inspection and technical audit.

Preservation will not be required where:

- the item will become obsolete and will be rejected;
- the item has deteriorated beyond economic repair;
- the item will remain in a safe and satisfactory condition in the local environment without internal and external protection;
- the cost of preserving the item exceeds, say, 25% of its estimated replacement value at some forward point in time. This is approximately equivalent to 15 years' maintenance costs.

If an item standing idle and unprotected would become unsafe, and repairs cannot be justified on economic grounds, measures shall be taken to prevent access to the equipment.

Many preservation procedures require some services and/or attention during the period of idleness, and provision needs to be made for these on-going requirements. These may include engineering maintenance and inspection, some operational shift responsibilities, and provision for lighting and minor power requirements, instrument air and some utilities. Refer to (8).

A preservation procedure should be drawn up for each individual item of equipment, or group of similar items, which shall be based on the recommended preservation procedures for special materials in (6), and on the preservation procedures recommended for specific items in (7). It is a matter for local judgement as to how much detail is recorded, bearing in mind the problems of later recommissioning.

Since a wide variety of equipment is involved, some form of tabulation is recommended, listing each individual item, its duty, the identity of the preservation procedure and any on-going requirements linked to it. Such a tabulation is also a useful means of showing the costs involved. A suggested format is given in Appendix 1.

The preservation required for the exterior of equipment will be determined largely by the

information recorded in the inspection post shutdown report, and by the corrosivity of the local environment. Recommendations for the external insulation are given in (7).

Exterior protection over and above that which may already exist, can be expensive and some calculated risks may be justified. On-going inspection and maintenance, where this is feasible, should always be an option.

Provision should be made for tagging all equipment after preservation, and for fixing the tags in a prominent position. For example, where nitrogen pressurization is applied, the tag may read:

CAUTION

THIS VESSEL IS BEING PRESERVED WITH NITROGEN AT A PRESSURE OF 1 BAR (GA).
IT SHALL NOT BE DISTURBED WITHOUT PRIOR AUTHORITY FROM OPERATIONS.
IT SHALL NOT BE TAKEN INTO SERVICE WITHOUT INSPECTION DEPARTMENT AUTHORITY.

NOTE: Always ensure precautions are taken when entering confined spaces. Refer to safety news letter "Guidelines for entry into confined spaces" of April 1991.

A schedule shall be prepared listing the safety and security checks which shall be carried out at intervals throughout the period the plant is standing idle.
Also, the condition of the rust preventives shall be checked at specified intervals.

5. ACTIONS RELATIVE TO PROCESS UNIT GROUPS AND NEW PLANTS

5.1 OPERATING UNITS

For operating units, the procedure for preserving the equipment is related to the process.

Certain processes are similar in this respect and these are identified in the following six major groups.

5.1.1 Units requiring mechanical cleaning

These generally require thorough cleaning, using mechanical means where necessary. Equipment may be preserved with non-drying oily film protectives, or filled with a suitable oil. This group typically includes:

- crude distillers;
- high vacuum units;
- sulpholane, furfural extraction;
- propane de-asphalting unit;
- naphtha crackers (part);
- thermal crackers (part);
- fractionating sections of conversion units;
- amine units (which should be filled with solvent, avoiding entrance of oxygen).

5.1.2 Units affected by hydrogen

Owing to the presence of hydrogen, care is required when decommissioning to ensure no pockets of hydrogen remain entrapped within vessels and interconnecting pipework. After cleaning, equipment shall be dried out thoroughly and preserved with inert gas maintained at a slight positive internal pressure. This pressure is not necessary if desiccants are used. Oily protectives shall not be used. This group typically includes:

- platformers;
- hydrodesulphurization units;
- hydrocrackers;
- hydrotreaters (lubricating oil);
- HF alkylation units;
- catalytic cracking units.

5.1.3 Chemical plants

Depending on the process, extensive cleaning may be required before thoroughly drying out. The preservation procedures for special materials recommended in (6) are particularly applicable to this group and shall be adhered to. Generally, oily protectives shall not be used. This group of plants includes:

- base chemicals;
- polymers;
- industrial chemicals;
- agrochemicals.

5.1.4 Cryogenic plants

Equipment in plant which is operating at or may be exposed to temperatures of 0 °C or lower is essentially clean, needing only to be warmed up and thoroughly dried out before purging and filling with dry air or inert gas maintained under a slight positive internal pressure. This group of plants includes:

- LNG and NGL plants;
- ethylene plants;
- air separation units.

5.1.5 Utilities and services

In most cases these may be preserved with water, either clean water treated to the extent required by the type of unit concerned or boiler feed water (de-aerated) in accordance with the application procedures recommended in (7.2.3). For preservation of special materials refer to (6). For the protection of rubber-lined equipment in tropical areas, see (6.8).

For some units, preserving with inert gas or dry air with desiccants may be preferred for long-term preservation.

Units in this group include:

- water treatment units;
- cooling water systems;
- sea water distillation;
- fire water systems;
- instrument/tool air.

5.1.6 Product storage

Oil tanks, both fixed roof and floating roof, are classed with crude distillers: internally wetting by gas oil is recommended. Chemical product storage tanks are preserved in accordance with the recommendations for the process concerned.

Refrigerated storage tanks and pressurized spheres are classed with cryogenic plant and should be preserved with nitrogen.

5.2 NEW PLANT

5.2.1 New plant (completed)

Newly completed plant which has not been exposed to operations shall be preserved with dry air after ensuring all equipment and piping is thoroughly dry.

Ingress of water into refractory lined equipment, including stacks, shall be prevented.

5.2.2 New plant under construction (partly complete)

It is recommended that all functions concerned with mechanical and rotating equipment give serious consideration to planning and adopting corrosion prevention measures for such equipment. These should include all phases from initial purchase to ultimate part erection and storage on site, and should include the treatment of spares. The responsibilities should be well defined and agreed upon by Manufacturers, Contractors, operators and any other personnel involved.

It is further recommended that the Contractors or Suppliers of equipment be subjected to the provision that all items are prepared and shipped in such a manner as to provide corrosion protection of all functional surfaces, both internal and external, for up to five years unsheltered outdoor storage. If not already painted, non-functional surfaces may be treated by painting or otherwise as specified by the Principal.

Many Manufacturers have developed their own procedures for accomplishing the above. These should be reviewed by the functions concerned, and may be accepted without change, or modified by mutual agreement.

On delivery to site, all items shall be checked for any breakdown of the Manufacturer's corrosion protection. If protection breakdown is observed, deteriorated coatings shall be removed and the unit or surfaces shall be reprotected. If this work is to be delegated to a Contractor, the scope and the responsibility should be clearly defined.

For storage on site, the preservation procedures recommended in (7) can be used as general guidance for preserving new plant, though cleaning to remove operational deposits and encrustation will not be required.

Small items, components, sub-assemblies, instruments and high-value equipment should be stored in a warehouse and special provision may have to be made for this, including air conditioning.

If not installed, large items such as ducting may be stored in the open, on wooden sleepers, providing there is good drainage and the protection will withstand mechanical damage.

Particular attention shall be paid to identification of equipment. Every item should be prominently and effectively tagged, and each tag shall show the order number and cross reference the Suppliers drawings approved for construction. Alternatively, items may be identified by marking with paint.

6. PRESERVATION PROCEDURES FOR SPECIAL MATERIALS

6.1 AUSTENITIC STAINLESS STEEL

Vessels, equipment and piping of austenitic stainless steel shall be thoroughly cleaned and dried internally because deposits, pockets of water or oil can lead to serious corrosion.
Water containing a concentration of chlorides may precipitate stress corrosion cracking or pitting. Due to biological components left in systems or introduced with the testing or flushing water, there is also the possibility of Microbiological Induced Corrosion (MIC).

Equipment normally exposed to aqueous solutions containing chlorides shall be carefully rinsed with demineralised water, boiler feed water or condensate (note 1) and dried (note 2) immediately after shutdown. Fill with a dry inert gas, e.g. nitrogen, after drying to prevent the introduction of oxygen and maintain a slight positive internal pressure.

NOTE:
1. Demineralised water, boiler feed water and condensate shall have a maximun chloride content of 2 mg/kg.
2. Drying with hot air or an inert gas up to a dewpoint of -30 °C.
3. Equipment such as shell-and-tube heat exchangers may have crevices which prevent proper draining and mechanical drying.
4. When flushing with condensate, boiler feed water or demineralized water it is essential that all surfaces are flushed. The quantity and velocity of the flushing water depends on the equipment volume and shall be determined in consultation with the Corrosion Engineer.
5. Removing water or drying by blowing with hot air or gas shall not be performed unless the flushing has been done with condensate or demineralized water.
6. In locations where water of the required quality is not available (initially or permanently), temporary facilities shall be used (e.g. mobile packaged demineralization units) to prepare the flushing water.
7. The risk of pitting corrosion is considerably reduced if the time between shutdown and preservation is short.
8. Consider the use of a biocide to minimise the risk of Microbiological Induced Corrosion.

Any deposits on non-insulated surfaces shall be removed. Further measures are generally not required for non-insulated surfaces.

Insulated stainless steel equipment provided with a correct paint system under the insulation needs no further treatment.

Non-painted, insulated stainless steel equipment should (regardless of temperature of previous operation) be treated as follows:

- Wet insulation or insulation in bad condition shall be removed;
- Dry insulation in good condition provided with zinc-free metal cladding shall have the seams in the sheeting, including rivets and fixing screws, sealed to obtain a moisture-tight and vapour-tight covering. Where galvanized sheet metal has been used for cladding, it shall be removed and replaced either by aluminium cladding or by a wrapped weather-protective covering;
- Dry insulation in good condition, covered with a bituminous or similar type weather protection or with a hard setting composition shall be inspected for the presence of cracks and voids which shall be repaired with metallic jacketing materials according to DEP 30.46.00.31-Gen.

6.2 FERRITIC STAINLESS (CHROMIUM) STEEL

Ferritic stainless (chromium) steel equipment should be cleaned and dried and be closed for preservation.

NOTE: Due to the possibility of pitting corrosion, Section 6.1 shall also apply to ferritic stainless (chromium) steels.

6.3 COPPER AND COPPER ALLOYS

Equipment of copper and copper alloy should be thoroughly cleaned and dried, and closed for preservation. Particular attention should be given to remnants of ammonium salts, possible ingress of ammonia, or remnants of deposits (e.g. organic debris) which could possibly generate ammonia, resulting in stress corrosion cracking.

6.4 ALUMINIUM

Aluminium equipment shall be kept clean and dry.

6.5 NICKEL, NICKEL ALLOY AND NICKEL STEEL

Nickel, nickel alloy and nickel steel equipment shall be cleaned and kept dry.

NOTE: Due to the possibility of pitting corrosion, Section 6.1 shall also apply to nickel, nickel alloy and nickel steels.

6.6 SILVER AND LEAD

Silver and lead parts shall be cleaned by rinsing with fresh clean water, but care shall be taken not to remove the soft protective layer.

Protection against mechanical damage is necessary.

6.7 TITANIUM, ZIRCONIUM AND TANTALUM

Titanium, zirconium and tantalum parts/equipment shall be cleaned and be protected against mechanical damage.

6.8 PLASTIC AND RUBBER

Direct sunlight, heat and weathering will cause deterioration of most plastic and rubber-based materials, and shielding is thus required.
Rubber-lined equipment shall also be protected against exposure to direct heat or radiation by the sun, either by shielding or covering (allowing free circulation of air around the equipment) or by keeping it filled with fresh clean water.
Freezing of the water shall be prevented.
Protection against mechanical damage may be required.

6.9 GLASS-LINED EQUIPMENT

Glass-lined vessels should be cleaned and have all openings closed except the bottom drain. Jackets should be cleaned and dried, protected with VPI and closed. Refer also to the notes in (3.2.6.1).
Two out of three of the clamping bolts should be loosened.
Bright stirrer parts should be treated with Shell Ensis Compound CA or Shell Rhodina Grease 2, as should the clamping bolts and flanges.
Protection against mechanical damage is necessary.
Glass-lined diaphragm-type valves should not be dismantled, particularly if they are equipped with a PTFE diaphragm, but be opened fully.
Protection against mechanical damage is necessary.

6.10 CARBON AND GRAPHITE EQUIPMENT

Equipment of these materials should be cleaned, but not disassembled.
Protection against mechanical damage is required.

6.11 BRICK-LINED/REFRACTORY-LINED EQUIPMENT

Pre-stressed brick lining should be kept above 0 °C in order to avoid excessive stresses in the lining.
All stacks and refractory-lined equipment shall be protected against water ingress and, in tropical areas, condensation of water vapour.

7. PRESERVATION PROCEDURES FOR SPECIFIC TYPES OF EQUIPMENT AND THEIR COMPONENT PARTS

7.1 GENERAL

The recommendations in this Section are for general guidance and should be used to develop the preservation procedure required for each item, or group of similar items.

Specialist advice should be sought from the Principal on the preservation of items not specifically covered in this Section.

For static equipment, piping and civil items it is recognized that the requirements for short-term preservation can be, in many cases, the same as would be needed for long-term preservation. Therefore the requirements for short-term and long term are combined under the single heading of `short/long-term preservation'. In the respective sub-sections the purpose of temporary preservation remains as defined in (3.1).

For rotating equipment, plant-mounted instruments and electrical equipment, recommendations are given for temporary, short-term and long-term preservation as defined in (3.1).

Winterization shall be considered whenever equipment and/or piping is preserved by filling with water. For some applications, electrical trace heating may be considered as an alternative.

7.2 STATIC EQUIPMENT AND PIPING

7.2.1 Vessels and columns

Temporary preservation
Drain inventory, then purge with nitrogen and maintain nitrogen pressure. Associated relief valves can be left in place and serviced according to the schedule for normal operations.

Short/long-term preservation
Vessels and columns should be drained, purged and cleaned. They may then be preserved by filling with dry inert gas, by the use of desiccants, with VPI powder, or by spraying the internal surface with Ensis Oil grade N. The vessel or column shall then be properly closed up. Refer also to the notes in (3.2.6.1).

As an alternative to applying Ensis Oil grade N, vessels and columns may be sprayed internally with gas oil, then filled with gas oil to a volume equal to 10% of the capacity, and properly closed up.

See (5) for influence of process on preservation procedures.

Associated relief valves can be left in place or removed for servicing and storage. If left in place, the relief valves shall be spaded off. If removed, the nozzles shall be blanked off.

7.2.2 Furnaces

Temporary preservation
Purge the tubes and headers with nitrogen and maintain under nitrogen pressure or fill with oil if acceptable. Where feasible, manually clean all metal exposed to flue gases, and leave furnace doors partly open and protected from rain. Remove burners for servicing and checking, then replace. Circulating water-air preheaters shall be kept drained.

Short/long-term preservation
Clean the tubes thoroughly internally, then dry out coils, headers and manifolds, and close up. Clean the outside of the tubes and all metal surfaces exposed to the flue gases as for temporary preservation.

Remove burners to store, clean and preserve with Ensis Oil grade N.

Refractory-lined equipment should be protected against frost and water ingress, especially if it can accumulate in the lining. Neutralisation of refractory with NH_3 should be considered, especially if high sulphur fuel oil has been used.

7.2.3 Boilers

Temporary preservation
Keep in operation on warm stand-by. Condensate systems should be kept in operation. Due attention should be given to winterizing in view of the potentially lower system heat loads.

NOTE: Whilst this could be acceptable for short shutdowns the costs may be high. Cleaning and neutralizing the acidic constituents on the flue gas side with ammonia, and laying up the water side under specially prepared wet or dry conditions are the alternatives, see below.

Short/long-term preservation

- Flue gas side cleaning
  If sulphur-containing fuels have been burnt, carry out a thorough neutralization (NH_3 and $NaHCO_3$) cleaning and drying procedure in accordance with DEP 70.10.80.11-Gen.
- Flue gas side preservation
  For storage, the flue gas side should be well ventilated by leaving open access doors and dampers; the stack draught should also be utilized if possible.
- Steam/water side
  For indefinite long-term storage, dry storage is recommended. For periods up to about one year either dry or wet storage may be applied. Wet storage is normally easier to implement but routine water testing is necessary. Heating will also be necessary if freezing conditions are expected.

Wet storage of the steam/water side
Fill the boiler and superheater completely (until vents overflow) with water containing an approved oxygen scavenger, maintaining a pH above 10. Water shall be de-aerated boiler feed water dosed prior to filling; it should be sampled once each week for 4 weeks then once in 2 weeks, or as considered necessary. All boilers have adequate vents and drains to provide representative samples. Overdose if necessary to maintain minimum conditions throughout.

Connect a nitrogen supply to the highest vents and maintain overpressure of 100-500 mm water gauge.

During periods when freezing is expected, apply heat by using steam or electric heaters or by circulating hot de-aerated feed water, maintaining water conditions as close as practicable to the specified requirements for normal operation.

Dry storage of the steam/water side
After the flue gas side cleaning operation, the boiler shall be drained.

If clean sulphur-free fuels, e.g. natural gas, have been fired, blow the boiler empty from a pressure of 3-5 bar (ga) to take advantage of residual heat to assist drying. Ensure that no carry-over to the superheater occurs.

Dry non-drainable pendant superheaters by using steam or electric heaters or by vacuum drying. This may take 2 to 3 days or more.

Thoroughly dry the boiler and superheater by blowing with dry air or nitrogen, or use a de-humidifier until existing air humidity is consistently less than 35%. Flush the air out with nitrogen until the oxygen level is less than 1% by volume. This will require about 5 volumes of nitrogen. Maintain a nitrogen overpressure of 100-500 mm water gauge.

External protection
Precautions defined by local circumstances will be necessary to prevent rain ingress into areas where natural drying is hindered. This, for example, applies to areas beneath leaking cladding around insulated piping and fittings, and to the boiler casing. Severe corrosion has been experienced in these areas.

For periods of up to five years, insulation should be left in place. Inspect and repair the insulation where necessary to prevent the ingress of water.

Where the lay-up period is for 5 years or more, insulation should be removed from piping and a complete paint system applied (see DEP 30.48.00.31-Gen).

7.2.4 Shell-and-tube heat exchangers coolers, condensers

Temporary preservation
Drain inventory, then purge both shell side and tube with nitrogen and maintain under nitrogen pressure. Special attention is needed to remove liquids trapped at the bottom of vertically hanging hairpin bundles as installed in hydrocracker-type units.

Short/long-term preservation
Clean all heat exchangers thoroughly, then dry. Carbon steel heat exchangers may need mechanical and/or chemical cleaning.

Where oil can be tolerated and no moisture is present, spray or flush carbon steel heat exchangers with Ensis Oil grade N.

As an alternative to applying Ensis Oil grade N, heat exchangers may be filled with gas oil.

Where oil cannot be tolerated, carbon steel can be protected with appropriately inhibited water, or with VPI powder blown into the tubes and small bags of the powder hung strategically in the channel ends before closing up. Refer also to the notes in (3.2.6.1).

Preserve heat exchangers made of copper alloy or stainless steel by cleaning, drying thoroughly, then sealing up.

With copper alloy, particular attention should be given to remnants of ammonium salts or deposits that could possibly generate ammonia, like many sorts of organic debris. Connections with ammonia containing systems shall be broken.

With stainless steel, particular attention should be given to remnants of water or deposits, the effect of which can be very detrimental (see Section 6).

During periods of severe freezing, equipment could be exposed to slight vacuum conditions, which may be detrimental to certain types of shell-and-tube heat exchangers. The vacuum can be broken with nitrogen.

External protection
The procedure described in (7.2.3) should be followed.

7.2.5 Air-cooled heat exchangers

Temporary preservation
Drain inventory, then purge with nitrogen and maintain under nitrogen pressure. Check lubrication of transmission and run fans for about one hour every week.

Short/long-term preservation
Clean and flush tubes and headers with Ensis Oil grade N if no moisture is present. Hang small bags of VPI powder in headers, then close up. Refer also to the notes in (3.2.6.1).

If oil cannot be tolerated for process reasons, the equipment shall be dried and preserved with inert gas or dry air at slight overpressure.

Clean fan blades and preserve metal blades with Ensis Fluid grade T, or remove to store and preserve with Ensis Fluid grade S, T or V.

Preserve transmission actuator and drive as recommended in (7.3).

Cover the bundle completely to prevent debris settling within fins and to avoid any circulation of humid air through the bundle which could cause corrosion of the bonds between fins and tubes.

7.2.6 Piping and fittings

Temporary preservation
Normal shutdown procedure. Inspect at regular intervals and apply any particular safety measures considered necessary.

Short/long-term preservation
All piping internals shall be flushed and properly drained. The larger carbon steel lines (over 50 mm nominal bore) should be filled with dry air, then sealed up. For oxygen and chlorine lines, filling with dry inert gas is recommended. Ensure no solid particles or traces of oil can get into the air or inert gas.

Where considered justified, the smaller carbon steel lines may be similarly preserved.

Where water or oil is permissible, coating the inside of the carbon steel pipe with Ensis Oil grade N, or filling with gas oil, or filling with inhibited water may also be considered. Water-filled lines shall be adequately winterized to prevent freezing.

Steam lines should be drained, paying special attention to low points and dead ends in the system, then preserved with dry air. If left filled with water, ensure adequate winterization and thermal relief provisions.

Piping constructed of material other than carbon steel should be cleaned, dried and sealed; see procedures for special materials in (6).

For process piping where the supporting structure is not designed to carry a full liquid load, dry out thoroughly, paying particular attention to low points. For long lines, it may be necessary to install additional drains or manholes at strategic points by "hot-tapping" (which shall comply with DEP 31.38.60.10-Gen.). Preserve by filling with dry air or inert gas, then sealing up.

Pig launchers and receivers shall be treated as the piping system in which they are installed.

7.2.7 Valves and attachments

Temporary preservation

Generally as for piping and fittings. Valve spindles should be protected with Shell Ensis Compound, see (3.2.3).

Short/long-term preservation
Valves and attachments are preserved together with and in the same manner as the system in which they are incorporated, or by the same procedure applying to the process equipment with which they are associated. Valves should be left slightly open to avoid metal to metal contact, wherever possible; diaphragm valves shall be left in the fully open position.

Valve packing is left in place without further attention during the period of idleness.

Valve spindles should be protected with Shell Ensis Compound, see (3.2.3).

7.2.8 Stuffing box packings

Temporary preservation
Leave all packings intact.

Short/long-term preservation
Remove all metal-braided and graphite fibre packings and replace with non-metallic packings. Otherwise, leave intact. Attach a metal tag to the stuffing box to indicate that the packing needs renewal at the time of recommissioning.

7.2.9 Gaskets

Temporary/short-term preservation
Leave all gaskets intact.

Long-term preservation
Leave all gaskets intact. See also (9.2).

7.2.10 Flanges

Temporary preservation
No action required.

Short/long- term preservation
Exposed flanges are vulnerable to corrosion if left unprotected. Clean thoroughly, then wrap moisture-proof tape round the aperture between adjacent faces of the flange joint. Apply Ensis Fluid grade S,T or V to nuts and exposed threads of studs.

All broken flanges shall be fitted with metal covers and preserved with Ensis Fluid grade S, T or V.

7.2.11 Relief valves

Temporary preservation
Normal shutdown procedure.

Short/long-term preservation
Leave them in place or spade off the flanged connections and remove the relief valves for cleaning, servicing and indoor storage.

7.2.12 Flares and flare lines

Temporary/short/long-term preservation
Where all necessary provisions have been made lower the flare and clean and inspect for iron sulphide corrosion. Should this be detected, hydrojet flare and dry out.
Spade off flare and flare gas system and purge with nitrogen.
Check earthing and lightning protection.
Flare tips provided with a refractory should be removed to the warehouse for storage; alternatively, the refractory shall be protected against water ingress.

7.2.13 Cooling water systems

Temporary preservation
Keep in operation. If this is not possible, drain the system and refill with inhibited water.

Short/long-term preservation

In many cases it may be preferable to keep cooling water systems operational. It is largely a local decision which should take into consideration site operating requirements, the materials of construction and the level of the water table, all of which can influence the economics over the longer term.

When shutting down a closed-loop cooling water system, adequate measures shall be taken to maintain the required inhibitor levels. The system shall be winterized and regularly inspected.

It may be advisable first to drain and clean the cooling tower basin, and then refill with inhibited make-up. The fan drive motor should be removed, cleaned, then preserved in accordance with the requirements for rotating equipment (7.3). All unpainted external metal parts should be painted or preserved.

Open cooling water systems using sea or river water may be stopped only when all vital equipment items, such as heat exchangers, have been isolated. These should be cleaned and preserved by dosing the system with an inhibitor.

Underground cement-lined cooling water lines shall be filled with water. Above-ground cement-lined pipes shall be drained.

7.2.14 Fire-fighting systems

Temporary preservation
Keep all systems functional.

Short/long-term preservation
Automatic systems should be kept on 'manual' or 'de-energized'/'blocked-in'. Fixed fire-fighting systems should be kept functional and energized for about 15 minutes every two weeks.

Adequate measures shall be taken to winterize where necessary.

7.3 ROTATING EQUIPMENT

7.3.1 General

As a general rule, all exposed shafts and polished surfaces shall be thoroughly cleaned and coated with Ensis Fluid grade S, T or V (3.2.4).

Manual rotation of shafts at weekly intervals is recommended. Rotation through a minimum of 5 complete turns is good practice. The position of the shaft at rest should be advanced by a $^1/_4$ turn each time.

Equipment with synthetic oil systems require special measures for preservation; specialist advice should be sought from the Principal for these systems.

Oil-mist lubricated bearings should be treated as oil-lubricated bearings, see (7.3.8).

Where the equipment mentioned in (7.3) is coupled with an electric motor or generator and the equipment needs to run for a specific length of time, the requirements of the notes under (7.7.2) and (7.7.3) shall also be met.

7.3.2 Centrifugal pumps

Temporary preservation

- fill bearing housings with service oil/grease as appropriate;
- rotate shafts weekly.

Short-term preservation

- clean and dry pump internally;
- flush pump and drain pump and seal system with Ensis Engine Oil grade 30 or Ensis Oil grade N;
- seal suction and discharge connections carefully and mark covers/blinds;
- fill bearing housings with Ensis Engine Oil grade 30 or Ensis Oil grade N.
  The shaft should be rotated during filling to ensure complete coating of the surfaces in contact;
- where a stuffing box is fitted, replace packing with non-metallic packing;
- fill pump to 10-50% of internal volume with Ensis Oil grade N;
- plug vents on bearing housing;
- rotate shaft regularly (at least every two weeks).

Long-term preservation

- flush pump with Ensis Engine Oil grade 30 or Ensis Oil grade N;
- clean and dry casing inside and pump internals thoroughly, then preserve with Ensis Fluid grade S;
- drain oil-lubricated bearings and refill with Ensis Engine Oil grade 30 or Ensis Oil grade N, then plug the vents on the bearing housing;
- clean out grease-lubricated bearings and repack with new grease;
- where a stuffing box is fitted, remove the old packing, lightly grease the stuffing box then insert two new non-metallic packing rings and the gland, and tighten slightly;
- where possible, mechanical seals should be removed;
- plug all open ports in the gland plate;
- mask the gap between the gland plate and shaft, or shaft sleeve;
- open gear couplings, clean out and refill with new grease; clean outside of couplings and preserve with Ensis Fluid grade S, T or V;
- spade off all pumps in/outlets;
- rotate shaft regularly (at least monthly);
- inspect after 12 months and at yearly intervals thereafter.

7.3.3 Reciprocating pumps

Temporary preservation

As for centrifugal pumps.

Short-term preservation

- drain pump;

- flush pump with Ensis Engine Oil grade 30 or Ensis Oil grade N;
- remove the cylinder and valve covers;
- treat the internal surfaces with Ensis Fluid grade T if no moisture is present;
- replace the covers and rotate the crankshaft through several revolutions by hand;
- remove stuffing box packing, then treat shaft with Ensis Fluid grade T and mask the opening between shaft and gland plate;
- fill all lubricators with Ensis Engine Oil grade 30 and pump through;
- if gearbox is fitted, refer to (7.3.8) for preservation of enclosed gears;
- do not rotate crankshaft during storage;
- fill cranckase with Ensis Engine Oil grade 30;
- run oil pump every month;

Long-term preservation

As for short-term preservation.

7.3.4 Compressors and blowers

Temporary preservation

• Compressors

- isolate compressor from process connections;
- purge gas side with nitrogen and maintain nitrogen blanket;
- operate lubricating oil system once a week for about 30 minutes;
- rotate the shaft once a week simultaneously with the operation of the lubricating/seal oil system;
- maintain nitrogen purge on lubricating/seal oil tanks.

Short-term preservation

• Centrifugal compressors/blowers

- purge the gas side with nitrogen and maintain nitrogen blanket;
- add VSI concentrate to lubricating/seal oil and operate system weekly for about 30 minutes;
- drain cooling system and refill with inhibited water or, if freezing is possible, drain system, dry it then close it up;
- rotate shaft weekly simultaneously with the operation of the lubricating/seal oil system;
- maintain nitrogen purge on lubricating/seal oil tanks.

NOTE: Gas turbines with standby duty requirements and operating in corrosive or humid environments should have the compressor section coated as recommended by the gas turbine Manufacturer.

• Reciprocating compressors

  - add VSI concentrate to the lubricating oil and operate the lubricating oil system for about 30 minutes, simultaneously running the compressor unloaded for the same period;
  - purge the unit with nitrogen and maintain under nitrogen pressure;
  - close suction and discharge lines;
  - maintain a nitrogen purge on distance pieces, or hang small bags of VPI powder inside the distance pieces - see also the notes in (3.2.6.1);
  - operate the lubricating oil system weekly for about 30 minutes, at the same time barring the unit over.

Long-term preservation

• Centrifugal compressors/blowers

  - inject condensers/coolers with Ensis Fluid grade T then close up;
  - drain cooling system and flush until clean, then dry thoroughly with forced hot dry air and close up;
  - add VSI concentrate to oil systems;
  - remove rotors, clean thoroughly. Either apply Ensis Compound CA and store on blocks in a warehouse, or store on blocks in a container under nitrogen pressure;
  - clean and dry internals and bearings, and all internal surfaces, then spray or brush on Ensis Fluid grade H;

- replace top casing and seal both ends, hang small bags of VPI powder inside casing, blank off process piping, seal all vents and ensure all is air-tight; refer also to the notes in (3.2.6.1);
- purge casing with nitrogen;
- open gear couplings, either clean out and refill with new service grease, or preserve with Ensis Oil grade N. Clean the external surfaces of couplings and preserve with Ensis Fluid grade S, T or V.

  Depending on anticipated period of idleness, and the local environment, cocooning the compressor casing and, separately, its rotor may be considered worthwhile as an additional measure.

• Reciprocating compressors

- drain cooling system and flush until clean, then dry thoroughly with forced hot dry air and close up. For a glycol system, maintain the system;
- drain lubricating oil systems and flush until clean, then refill with Ensis Engine Oil of the appropriate viscosity and operate systems for about 30 minutes, simultaneously running compressor unloaded for the same period;
- remove valves and store in gas oil;
- where applicable, remove V-belts and preserve pulleys;
- blank off process piping and ensure all is air-tight;
- purge with nitrogen and maintain under nitrogen pressure. If it is not possible to maintain nitrogen pressure, then:
  - remove pistons and rod and preserve with Ensis Fluid grade V;
  - hang small bags of VPI powder inside valve ports and seal up ports;
  - clean and dry all internal surfaces in contact with the gas, including the cylinder walls, then spray or brush on Ensis Fluid grade S,T or V;
  - hang small bags of VPI powder inside crankcase above oil level, then seal off vents and ensure all is air-tight;
  - clean and dry connecting rods, then spray or brush on Ensis Fluid grade T, hang small bags of VPI powder on connecting rods.

  Refer also to the notes in (3.2.6.1).

7.3.5 Steam turbines

Temporary preservation

- purge with nitrogen or warm dry air and maintain under nitrogen pressure;
- add VSI concentrate to lubricating oil and operate lubricating oil systems weekly for about 30 minutes;
- rotate shaft once a week at the same time.

Short-term preservation

- purge and dry steam side with nitrogen or warm dry air and maintain under nitrogen pressure;
- add VSI concentrate to the lubricating oil and operate lubricating oil system for about 30 minutes;
- drain water-side of condenser and flush until clean, then refill with inhibited water;
- seal off condenser outlet;
- operate the lubricating oil system weekly for about 30 minutes, rotating the rotor at the same time.

Long-term preservations

- purge and dry the steam side with nitrogen or warm dry air;
- drain lubricating oil system and flush until clean, then refill with Turbo Oil 'T' of the appropriate viscosity;
- remove turbine rotor (except for the rotor of small general-purpose turbines, which can be left in place). Either apply Ensis Compound CA and store on blocks in a warehouse, or store on blocks in a container under nitrogen pressure;
- clean and dry internals, internal surfaces and bearings, then apply Ensis Fluid grade S, T or V on areas which are accessible for later manual removal of the fluid;
- relace top casing and seal both ends. Hang small bags of VPI powder inside the casing and blank off piping and seal all vents, ensuring air-tightness. Refer also to the notes in

(3.2.6.1);
- purge casing with nitrogen;
- open couplings, clean out and refill with new service grease; clean outside of couplings and preserve with Ensis Fluid grade K;
- if the rotor is left in the casing, rotate every week while operating the lubricating oil system.

Depending on anticipated period of idleness, and the local environment, cocooning the turbine casing and, separately, its rotor may be considered worthwhile as an additional measure.

7.3.6 Gas turbines

Temporary preservation

Normal shutdown procedure in line with Manufacturer's recommendations or, preferably, as recommended for short-term preservation.

Short-term preservation

- Aircraft derivatives and industrial gas turbines;
  - Thoroughly wash out internal spaces by hosing with a water/detergent mixture, cranking the rotor at the same time. Ensure the combustion chambers, transition sections and turbine blading are also thoroughly washed;
  - Start the turbine and run normally for about 15 minutes to dry out the unit, then allow to cool down;
  - Hang small bags of VPI powder in inlet plenum and close up turbine inlet;
  - Add VSI concentrate to lubricating oil and run system for about 1 hour; this applies where a normal oil is being used. Seek specialist advice for synthetic oil systems;
  - Install electric heaters in exhaust plenum and hang small bags of VPI powder inside. VPI shall not come in contact with or be too close to heaters to avoid decomposition;
  - Install electric heaters within acoustic hood enclosure;
  - Close up unit and ensure electric supply to heaters is maintained. Blank off exhaust system;
  - Rotating the rotor at weekly or other regular intervals of time is optional; refer to Manufacturer's recommendations.

Refer also to the notes in (3.2.6.1).

Long-term preservation

- Aircraft derivatives
  - Thoroughly wash out and dry as for short-term preservation. Remove turbine and store in warehouse in an air-tight box under nitrogen pressure, or return to Manufacturers for preservation at their works;
  - Remove power wheel, clean thoroughly and block for storage. flush with Ensis Compound CA for warehouse storage, or store in an air-tight box under nitrogen pressure;
  - Normal oil systems: drain and flush until clean, then fill with new oil plus VSI concentrate;
  - Synthetic oil systems: seek specialist advice;
  - Clean and dry internals and bearings, and all internal surfaces, then spray or brush on Ensis Fluid grade S, T or V;
  - Replace casing, then seal up and preserve as for steam turbines;
  - Ensure acoustic hood is clean and dry, then hang small bags of VPI powder inside and close up air-tight; similarly for the exhaust arrangement. Refer also to the notes in (3.2.6.1). Cocooning may be considered to be more effective.

- Industrial gas turbines

  As for aircraft derivatives, or:

  - Thoroughly wash out and dry as for short-term preservation;
  - Hang small bags of VPI powder inside inlet and exhaust plenums and close up, all air-tight;
  - Clean and dry all levers, valve stems and other exposed metal parts around the

casing, then apply Ensis Compound CA;
- Acoustic hood and exhaust arrangement - as for aircraft derivatives. Removing the rotor for preservation separately may also be considered.

Refer also to the notes in (3.2.6.1).

7.3.7 Internal combustion (gas and diesel) engines

Temporary preservation

- Run engine weekly for about 30 minutes.

Short-term preservation

- When engine is warm, drain lubricating oil system and fill with Ensis Engine Oil of the appropriate viscosity, then run engine for about 30 minutes;
- Hang small bags of VPI powder in inlet and exhaust manifolds, then close up;
- Drain cooling water system, flush out, then fill with inhibited water, depending on anticipated storage temperature, or drain system, dry it and close up;
- Disconnect battery;
- Do not rotate crankshaft during storage.

Refer also to the notes in (3.2.6.1).

Long-term preservation

- When the engine is warm, drain lubricating oil system and fill with Ensis Engine Oil of the appropriate viscosity;
- Drain cooling water system, flush out, then fill with water to which 10% of Donax C or Dromus B has been added;
- Run engine for about 30 minutes at normal speed, taking it up to top speed a few times before stopping; then drain the water and blow dry the cooling-water jacket with air;
- Drain fuel tanks and fuel filter housings. Fill diesel engine tanks with gas oil, e.g. Fusus Oil A. Fill petrol engine tanks with lead-free petrol. Prime fuel systems;
- Hang small bags of VPI powder in inlet and exhaust manifolds, then close up;
- Seal all vents, generators, starter motors, air filters, dipsticks, etc., with water-proof paper and adhesive tape;
- Disconnect and remove battery;
- Do not rotate crankshaft during storage.

Refer also to the notes in (3.2.6.1).

7.3.8 Bearings/Gears/Couplings

Temporary preservations

Normal shutdown procedure or alternatively:

- Bearings:
  - Fill bearing housing with service oil/grease as appropriate.
- Enclosed gears:
  - Add VSI concentrate to the lubricating oil.
- Open gears:
  - Clean, dry, then spray or brush on Ensis Fluid grade V.

Short-term preservation

- Bearings:
  - Oil-lubricated bearings should be drained and filled with Ensis Oil grade N and run for a short while to ensure complete coverage, then closed up;
  - Grease-lubricated bearings should be cleaned and regreased with the appropriate grease, turned, then closed up thoroughly.
- Enclosed gears:
  - Drain oil from gearbox at operating temperature, then refill with Ensis Oil grade N;

- Operate gear train for about 15 minutes.

  Where the above procedure is not possible:

- Hang small bags of VPI powder inside gearbox and blank off all openings, ensuring the gearbox is sealed air-tight;
- Treat outside of gearbox, including all sealing materials, with Ensis Fluid grade S, T or V.

Refer also to the notes in (3.2.6.1).

- Open gears/Flexible couplings:
  - Clean, dry, then protect by applying two coats of Ensis Fluid grade H, allowing an interval of at least six hours, preferably longer, between applications for solvent evaporation.

Long-term preservation

As for short term:
Warehouse storage is preferred wherever possible and a thorough inspection every 12 months.

7.3.9 Anti-friction bearings

Ball and roller bearings may remain in storage for long periods. They demand a very high standard of protection, and even local light staining may warrant their rejection as unfit for service. To meet these stringent requirements, meticulous attention shall be paid to every aspect of cleaning, protection and packaging. Standard bearings are only acceptable in original undamaged packing.

Very large bearings may be protected with Ensis Compound CA applied under conditions specially controlled as follows to avoid staining of the bearings. Immerse the bearing in the compound at a temperature of 100-120 °C for a sufficiently long period to allow the bearing to attain bath temperature.

7.4 MIXING AND EXTRUDING

7.4.1 Mixers

Temporary preservation
For vessel and stirrer, apply normal shutdown procedure.
Check lubrication of thrust and footstep bearings.
Run motor and stirrer slowly for a minimum of one hour weekly.

NOTE: Although the stirrer needs to run for 5 minutes only, the requirements of the motor (7.7.2) determine the running time of the complete unit.

Short-term preservation
Drain contents of vessel, clean, then purge with dry air.
Disconnect drive to stirrer shaft, then raise and chock stirrer shaft just sufficiently to free the load from the thrust and footstep bearings.
Wrap annular gap with stout plastic film and tape. Fill vessel with nitrogen and maintain under slight positive pressure; or, seal up and hang small bags of VPI powder inside.

Refer also to the notes in (3.2.6.1).

Long-term preservation
As for short term with the addition of a thorough inspection of the internals and protectives every 12 months; or, preferably, remove stirrer shaft, transmission and motor for separate preservation and warehouse storage.

7.4.2 Side-entry mixers

Temporary preservation
Normal shutdown procedure for stirrer relative to tank contents.
Check lubrication of stirrer shaft bearings and pivots.
If the tank contents are sufficient, run motor and stirrer weekly for a minimum of one hour (7.4.1). Refer to DEP 31.51.10.31-Gen. for limiting swept arc clearances.

Short/Long-term preservation
Remove motor/stirrer assembly for separate preservation and warehouse storage.

7.4.3 Rotating disc contactors

Temporary preservation
For vessel and stirrer, apply normal shutdown procedure.
Check lubrication of thrust and footstep bearings.

Short-term preservation
As for mixers, see (7.4.1).

Long-term preservation
As for short term with the addition of a thorough inspection of the internals and protectives every 12 months. Leave shaft in position. It may be necessary to provide some additional exterior protection against accidental mechanical damage.

7.4.4 Extruders

Temporary preservation
Apply normal shutdown procedure for barrel and screw.
Inject Ensis Oil grade N into barrel whilst rotating screw slowly to ensure all surfaces are given a continuous oily film.
Run motor, transmission and screw slowly at weekly intervals for a minimum of one hour (7.4.1) to maintain the oil film throughout.

Short/Long-term preservation
Remove screw from barrel for preservation and warehouse storage. Preserve the barrel inside with Ensis Fluid grade T. Dismantle the nozzle assembly and preserve immersed in Ensis Oil grade N in a sealed container. Clean all components downstream of the nozzles and preserve with Ensis Fluid grade T.

7.5 CIVIL ENGINEERING ITEMS

It should be noted that for civil engineering items the terms "temporary preservation" and "short/long-term preservation" are defined in (2.1) and are different than for other equipment.

7.5.1 Storage tanks and spheres

Temporary preservation
Keep all tanks and spheres operational. Should this be impractical, short/long term preservation should be adopted.

Short/Long-term preservation
All products shall be removed from cryogenic storage, tanks before preservation and this should also be done for other tanks.

Remove all sludge from bottom of oil storage tanks, then flush clean. Other product storage tanks should be cleaned, then dried out thoroughly.

Ensure tank or sphere is gas-free, then disconnect all line work to prevent electric current flow to other equipment. Blank off all open connections. Check lightning protection.

Prevent rain water ingress under tank bottom by ensuring that sealing between foundation and tank bottom is in good condition.

Floating roofs should be supported on the high position supporting legs. Ensure that rainwater drainage is fully effective by opening the drains and the emergency drain in the roof. Any rainwater that may be collected on the tank bottom via the emergency opening in the roof shall be removed periodically. The drainage of floating roofs needs special attention after long frost periods because frozen rainwater may plug the drain system; the roof should be brought to the lowest level to rest on legs, and the drain cleaned out.

In order to ensure a tank may breathe whilst standing idle, leave a number of manholes or other suitable openings near the bottom partly open, say 25 mm, and provide some protection from rain and flying debris without obstructing air flow through the opening. All pressure/vacuum valves shall be serviced.

Check emergency drain systems and inspect at three-month intervals.

Spheres should be purged with nitrogen, then maintained under nitrogen pressure.

Check cathodic protection systems and keep in operation.

If products cannot be removed from tanks or spheres, adequate measures shall be taken to ensure the safety of the installation, particularly where the formation of explosive mixtures may occur during the period of idleness.
Proper measures shall be taken to prevent corrosion due to condensation and arising from contact of the product with the surrounding atmosphere.

7.5.2 Stacks

Remove access doors and replace by loose laid refractory bricks to allow natural draught circulation.
Check lightning protection.

Refer also to DEP 34.24.27.31-Gen.

7.5.3 Structural steelwork

Temporary preservation
Normal scheduled maintenance.

Short/Long-term preservation
Routine maintenance painting programme for external protection should be continued throughout the period of idleness.

7.5.4 Steel wire ropes

Temporary preservation
Normal scheduled maintenance.

Short/Long-term preservation
If re-use is justified, clean and protect with Ensis Fluid grade S, T or V.

7.5.5 External insulation

Depending on the results of the post shutdown inspection (4.2.1), the following measures are advised to prevent external corrosion.

Temporary preservation
Leave insulation on equipment.
Inspect at regular intervals and repair to prevent the ingress of water.

Short/Long-term preservation
On plants which are painted underneath the insulation, the insulation may be left intact for long-term periods providing it is reasonably sound and in good condition, and ends are sealed. Insulation which is unsound, or considered susceptible, should be removed and made good.

One metre of cold insulation on vertical piping, which is not provided with vapour stops, should be removed at the low points in order to drain condensed water out of the insulation.

On plants which are not painted underneath the insulation and where a comparatively larger proportion of the insulation may not be in good condition, consideration should be given to removing all unsound insulation and painting the metal surfaces thus exposed in accordance with DEP 30.48.00.31-Gen.

Generally, insulated columns, vessels and exchangers are more susceptible to exterior corrosion through deterioration of the insulation than is insulated piping on plant standing idle for 5 years or longer.

7.5.6 Fireproofing

Temporary preservation
Normal scheduled maintenance.

Short/Long-term preservation
Inspect at regular intervals and maintain in good condition, paying particular attention to places where rainwater can penetrate.

7.5.7 Drainage system

Reference is made to DEP 34.14.20.31-Gen.

7.6 INSTRUMENTATION EQUIPMENT

7.6.1 General

Instrumentation equipment includes instrument units and components, instrument systems, control valves, computer equipment and peripherals, plant communication equipment and systems.

A differentiation is made between instrumentation locally installed in the plant (including local cabinets), further referred to as 'plant instrumentation', and instrumentation installed in control rooms, basements, auxiliary rooms and analyser houses, further referred to as 'indoor instrumentation'.

7.6.2 Plant instrumentation

Temporary preservation
The instrument power supply (air or electric) shall stay on.
Continue with routine maintenance and checking.

Short/Long-term preservation
Subject to the economic evaluation the instrument power supply should stay on. The block valves to the impulse lines shall be closed and the impulse lines shall be drained, including the pressure chamber of the instruments, and the drain plugs shall be left out.
If the instrument supply is switched off, the flow transmitters shall be removed and safely stored in an air-conditioned and locked room. The body and plug of each control valve shall be treated in accordance with (7.2.7). The valve stem shall be cleaned and protected with Shell Ensis Compound.
Long-term preservation
Subject to the economic evaluation the instrument air supply should stay on. The block valves to the impulse lines shall be closed and the impulse lines shall be drained, including the pressure chamber of the instruments, and the drain plug shall be left out.

Pneumatic instruments which are self-purging can remain untouched.
If applicable, small bags of VPI powder shall be hung in the enclosures of the electronic instruments. The enclosures shall be sealed with good quality self-adhesive tape. Refer also to the notes in (3.2.6.1).

The body and plug of each control valve shall be treated in accordance with (7.2.7). The valve positioner shall be treated as an instrument. The valve stem shall be cleaned and protected with Shell Ensis Compound.

7.6.3 Indoor instrumentation

Temporary preservation
As for plant instrumentation (7.6.2) and, if applicable, the air conditioning/purification system shall stay on.

Short-term preservation
As for the plant instrumentation (7.6.2), the instrument power supply should stay on. Computer equipment and peripherals, however, should be switched off. The batteries of the switched off Suppliers shall be removed from the system.

Long-term preservation
The electric instrument power supply shall be switched off and the batteries shall be removed from the system.
The air-conditioning/purification system shall stay on but the capacity can be trimmed to suit the loading after other equipment is removed/preserved.

7.7 ELECTRICAL EQUIPMENT

7.7.1 General

For temporary preservation of electrical equipment no special actions are required, unless otherwise required by the equipment Manufacturer. Normal maintenance and checking shall be applied.

Doors, cable entries and other openings of switchgear and compartments shall be kept closed.

When coolers are provided for electric motors or generators, they should be treated in accordance with (7.2.4) and (7.2.5).

7.7.2 Electric motors

Temporary preservation
When anti-condensation heaters are fitted, they should be switched on.

Short- term preservation
When anti-condensation heaters are fitted, they should be switched on.
When sleeve-type bearings are fitted, the rotors shall be jacked up with wooden blocks, and VSI concentrate added to the lubrication system.

When anti-friction bearings are fitted, they shall be regreased in order to prevent moisture accumulation.

Brushes, if installed, shall be lifted off the slip rings and commutators.

Long-term preservation
Where electric motors are not installed inside a building, they shall be protected against the weather. Where this is not possible, they shall be removed to warehouse storage.

Where anti-condensation heaters are fitted, they should be switched on.

Where sleeve-type bearings are fitted, the lubrication system shall be drained, flushed and filled with service oil plus VSI concentrate.

Anti-friction bearings shall be regreased in order to prevent moisture accumulation.

Brushes, if installed, shall be lifted off the slip rings and commutators.

Where a motor is required to be run periodically for the preservation of the driven equipment, this shall be done for a minimum of one hour.

7.7.3 Generators

For batteries and chargers, reference is made to (7.7.6) and (7.7.7).

Temporary preservation
Where anti-condensation heaters are fitted, they should be switched on.

Short-term preservation
Where anti-condensation heaters are fitted, they should be switched on. All other auxiliary supplies shall be switched off.

Where sleeve-type bearings are fitted, VSI concentrate shall be added to the lubrication system. When anti-friction bearings are fitted, they shall be regreased.

Brushes, if installed, shall be lifted off the slip rings and commutators.

Long-term preservation
Generators installed outdoors shall be protected against the weather or removed to warehouse storage.

Where anti-condensation heaters are fitted, they should be switched on. All other auxiliary supplies shall be switched off.

Slip rings shall be protected against the weather by covering them with a suitable waterproofing material such as 'cling-film' plastic wrapping.

For sleeve-type bearings the rotor shall be jacked up with wooden blocks.

The lubrication system shall be drained, flushed and filled with Ensis Oil grade N or with service oil plus VSI concentrate.

Anti-friction bearings shall be regreased.

Brushes, if installed, shall be lifted off the slip rings and commutators.

NOTE: Where it is required that a generator is run for the preservation of the driver, this shall be done for one hour minimum.
The unit should be loaded as close as possible to full current.

7.7.4 Transformers

Temporary preservation
Transformers to be considered as in normal service and shall remain energized.

Short/Long-term preservation
Transformers to be de-energized and isolated.

NOTE: Dry-type transformers require heating when switched off. Deterioration of the core and insulation may otherwise occur due to the effects of humidity.

The supply to tap changer control panels shall be switched off.
For protection of panels, reference is made to (3.3.2).

7.7.5 HV and LV switchgear

Temporary preservation
Switchgear is to be considered as in normal use and shall remain energized.

Short/Long-term preservation
Where possible, panel heaters shall be switched on. Switchgear shall be de-energized when a supply is not required.

NOTE:
- Supplies to equipment which is not in use during the preservation period, shall be isolated and/or padlocked in the 'off' position.
- For safety reasons live switchgear shall not be covered with plastic sheets.

7.7.6 Rectifiers and inverters

Temporary preservation
The equipment is to be considered as in normal use and shall remain energized.

Short-term preservation
Inverters in general and chargers for nickel-cadmium batteries shall be de-energized where possible.
Chargers for lead-acid batteries shall remain energized for 'float charging' the associated batteries.
When anti-condensation heaters are fitted, they should be switched on.

Long-term preservation
The equipment shall be de-energized where possible. Chargers for lead-acid batteries may have to remain in service to float charge the batteries. Anti-condensation heaters shall be switched on, if fitted.

7.7.7 Batteries

Temporary preservation
Batteries are to be considered as if in normal use and shall be kept on float charge.

Short-term preservation
Nickel-cadmium batteries shall be fully charged and then be disconnected where possible. Lead-acid batteries shall remain on float charge.

Long-term preservation
Nickel-cadmium type batteries shall be disconnected and taken out of service. They shall be

discharged to a cell voltage of 0.6-0.8 V and then drained.

Lead-acid batteries of the vented and valve-regulated types should remain on float charge. Alternatively vented-type lead-acid batteries should first be fully charged, then drained and flushed with distilled water.

Vent holes shall be sealed and the electrolyte stored for future use in suitable containers. Reference should also be made to Manufacturer's instructions.

8. MONITORING OF PLANT STANDING IDLE

8.1 GENERAL

Throughout the period in which plant or equipment is standing idle, regular visual inspection and some operational activity as outlined below is required at regular intervals.

8.2 SAFETY AND SECURITY

Safety checks shall be carried out at specified intervals. Occasional spot checks should also be considered.

Control rooms, switch houses, analyser houses and other buildings which have been locked up (2.5) shall be checked and any signs of unauthorized use shall be investigated and corrective action taken.

It shall be ensured that the electrical supply for lighting and minor power requirements (and any other services which may be required for safety and preservation) continue to function satisfactorily.

Evaporation of water from idle drainage systems can result in the fire seals being broken, with consequent hazards.

8.3 STATIONARY EQUIPMENT AND PIPING

Desiccants, and continued effectiveness of air/gas tightness, shall be checked.
Inhibitor levels and, wherever water is being used for preservation, the concentration of anti-freeze shall be checked.
It shall be ensured that furnace refractories and stack linings are dry and not freezing.
Preservation of all exposed metal surfaces should be checked by visual inspection.
All items removed to warehouse storage should be accounted for and their preservation should be checked.

8.4 ROTATING EQUIPMENT

It shall be checked that shafts are rotated at specified intervals.
Lubrication and, where specified, oil circulation through lubrication systems should be checked at regular intervals.
Inhibitor levels and, wherever water is being used for preservation, the concentration of anti-freeze shall be checked.
Desiccants, and continued effectiveness of air/gas tightness, should be checked, as should the preservation of all exposed metal surfaces. It shall be verified that electric heaters and trace heating continue to function satisfactorily.
Acoustic and thermal insulation shall be visually inspected.
All items removed to warehouse storage should be accounted for and their preservation checked.

8.5 CIVIL ENGINEERING ITEMS

Bottom drainage of storage tanks, floating roof drains and seal gaps shall be checked.
The preservation of all wire ropes and slings taken into store shall be verified. External insulation and fireproofing of steel support structures shall be inspected.
The painting and preservation of all exposed steelwork and metal surfaces shall be checked.

8.6 INSTRUMENTATION EQUIPMENT

8.6.1 Plant instrumentation

Desiccants shall be checked regularly and be replaced as required.
The wrapping and sealing of instruments shall be checked regularly and be repaired/replaced as required.

Stored instruments shall be checked to ensure that they are being kept in good order and are not being misused for alternative applications.

8.6.2 Indoor instrumentation

The air humidity and temperature shall be checked to ensure that it is being kept at the required level, if applicable, and that the environment is being kept clean and dust-free. Batteries shall be maintained as required.

8.7 ELECTRICAL EQUIPMENT

When motors are running periodically, normal maintenance procedures shall be applied to regreasing anti-friction bearings.

Oil levels in sumps of sleeve bearings shall be checked and topped up when required.

Anti-condensation heaters shall be checked for proper functioning.

Desiccants, including those of transformer breathers, shall be checked every two months and replaced when required.

Weather protection shall be checked for integrity, and repaired when required.

For non-hermetically sealed transformers, oil samples shall be taken once every 4 years. The oil shall be filtered prior to re-energising a transformer.

The preservation of exposed metal surfaces shall be checked, and improved where necessary.

The electrolyte level of batteries which are under charge shall be checked once every six months.

Impressed-current cathodic protection systems shall be checked monthly.

9. RECOMMISSIONING

9.1 GENERAL

Recommissioning of plant which has been standing idle shall be undertaken safely and in accordance with good engineering practice. Before start-up the line-up of the unit has to be in accordance with the latest revision of the Process Flow Schemes (PFSs) and Process Engineering Flow Schemes (PEFSs).

The preservation procedures used for the equipment and piping should be reviewed to ensure proper cleaning and preparation for start-up.

The removal of petroleum-based protectives by means of hydrocarbon solvents with low flash point has to be handled carefully to prevent fires.
VPI powders are flammable and careful and thorough removal either by air blasting or water washing is necessary as a safety precaution before starting up fired equipment. This applies equally where welding on plant may be required before recommissioning.

9.2 STATIC EQUIPMENT AND PIPING

All equipment should be opened up for internal inspection. Areas of earlier corrosion attack should be logged and the wall thicknesses measured.

There should be random checking for external corrosion under insulation.
Valve packings should not need repacking but there may be certain exceptions, for example where repacking after start-up would be inconvenient.

Stuffing box packings will need replacing only where metal-braided packing is specified (7.2.8).

Gaskets should not be replaced except if they have failed on pressure test.

All piping and equipment shall be system-pressure-tested to the maximum operating pressure.
Under very special circumstances, pneumatic testing may be required. When this is the only possible method, full safety precautions shall be taken. Refer to DEP 61.10.08.11-Gen. for details.

All relief valves shall be stripped, cleaned and shop-tested, and care taken to ensure each relief valve is correctly located on plant before start-up.

All pre-recommissioning modifications to piping and equipment shall be pressure-tested to code requirements before start-up.

9.3 ROTATING EQUIPMENT

It is always advisable to recall the Manufacturers' representatives to assist with the reassembly and test running of major items, particularly if they have been involved in the original preservation of the equipment and its components.

As a general rule, Ensis Oil grade N should be replaced by the service oil before equipment goes into service. However, where lubricating/seal oil systems have been charged with clean service oil plus an inhibitor, or with Shell Turbo Oil 'T', there should be no need to change the oil again before start-up.

Before test running steam turbines, precautions shall be taken to ensure the steam supply is clean and free of trace particles that could damage turbine blades.

9.4 CIVIL ENGINEERING ITEMS

Storage tanks should be opened up for internal inspection, including a thorough examination of tank bottoms and pads. When considered necessary, tank pads shall be redressed to ensure that water does not accumulate near the tank shell.

Insulated tanks should be checked at random points for external corrosion.

The Principal's specialists shall be consulted in regard to requirements prior to the recommissioning of low-temperature storage tanks and piping.
Spheres should not need an internal inspection if the preservation procedures have been followed.

All wire ropes, slings and shackles shall be examined and proof-load-tested after preservation, and before being taken on plant for general or specific usage. Ensis Fluids need not be removed before installation, and once operational, the normal greases may be applied to the wire ropes without danger of contamination.

9.5 INSTRUMENTATION EQUIPMENT

After a period during which temporary preservation was applied, no specific actions are required.

After short-term preservation, complete loop testing shall be carried out, including the functional testing of alarm, binary logic, safeguarding and control systems. Control valves shall be cleaned and stroked.

After long-term preservation, computer equipment and telecommunication equipment shall be fully tested. All flow transmitters shall be recalibrated. The plant `in-line' instruments shall be removed, checked and cleaned as required.
Depending on the cleaning method for the piping, the 'in-line' equipment shall be temporarily replaced by spool pieces.

After long-term preservation all plant instrumentation (including the instruments from store) shall be removed, cleaned, checked and recalibrated as required.

9.6 ELECTRICAL EQUIPMENT

For recommissioning of electrical equipment after short and long-term preservation periods, the `Maintenance Inspection' requirements of DEP 63.10.08.11-Gen. shall apply. The relevant inspection and test forms shall be filled out.

10. REFERENCES

In this DEP reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Thermal insulation for hot services	DEP 30.46.00.31-Gen.
Painting and coating of new equipment	DEP 30.48.00.31-Gen.
Hot-tapping on pipelines, piping and equipment	DEP 31.38.60.10-Gen.
Side-entry mixers for storage tanks	DEP 31.51.10.31-Gen.
Drainage and primary treatment systems	DEP 34.14.20.31-Gen.
Reinforced concrete stacks	DEP 34.24.27.31-Gen.
Field inspection prior to commissioning of mechanical equipment	DEP 61.10.08.11-Gen.
Field inspection of electrical installations and equipment	DEP 63.10.08.11-Gen.
Cleaning of equipment	DEP 70.10.80.11-Gen.

APPENDIX 1 TABULATION FOR PRESERVATION PROCEDURES

Equipment No.	Service	Fluid handled	Preservation procedure		Estimated cost	Preparation for service	Estimated cost	Routine maintenance and inspection during period of idleness	Frequency and done by
			Internal	External					