DEP SPECIFICATION

PRESERVATION OF NEW AND OLD EQUIPMENT STANDING IDLE

DEP 70.10.70.11-Gen.

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DESIGN AND ENGINEERING PRACTICE

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies technical requirements and recommendations for preservation of both new and old equipment. The following equipment categories are covered:

- Static equipment and piping;
- Rotating equipment;
- Mixing and extruding equipment;
- Civil engineering items;
- Instrumentation equipment; and
- Electrical equipment.

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

This is a revision of the DEP of the same number dated July 1999; see (1.6) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could 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 with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that 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 that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. 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.

1.3.2 Specific definitions

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

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term	definition
Temporary preservation	for a 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 a 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 a plant which is to be shut down for recommissioning 1 year or more in the future (2 years or more for civil engineering items).
Active	status of equipment and piping when it is operating on either continuous or intermittent basis and is needed for operations to maintain unit production.
Idled	status of equipment and piping when it is to be isolated and decommissioned from the process for more than six months, but to be preserved for future use.
Retired	status of equipment and piping when it is to be shut down with no plans for future use.
Old	status of equipment and piping that has been and will remain in service**.**

1.4 ABBREVIATIONS

CS	Carbon Steel
MIC	Microbiological Induced Corrosion
MOC	Management of Change
OCTG	Oil Country Tubular Goods
PTA SCC	Polythonic Acid Stress Corrosion Cracking
SS	Stainless Steel
VPI	Vapour Phase Inhibitor
VSI	Vapour Space Inhibitor

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (8).

1.6 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated July 1999. The following are the main, non-editorial changes.

Old section	New section	Change
2.1	1.3.2 +2.1	Section shortened

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2.3.6	4.2.6	Section 2.3.6 implemented in section 4.2.6
2.4	2.2	Add tagging for equipment filled with Nitrogen
4.3	2.3	Section shortened and examples added where the preservation costs typically exceed the replacement value
5.1	5	Numbering of the section changed
	5.1.5	Special requirements for Deepwater Offshore units taken over from DODEP 02.01C.03.02
	5.1.8	Pneumatic equipments and systems taken over from DODEP 02.01C.03.02, section 5
5.2	3	Specific section for preservation of new equipment added
6	6	No changes
6.1	6.1	Remarks regarding avoiding contact of carbon steel and zinc with SS taken over from DODEP 02.01C.03.02 Reference to NACE RP0170 added
6.8	6.8	Reference to ISO 2230 added
7	4	Section specified for preservation of old equipment
7.2.2	4.2.2	Added, air preheater should be drained for short/long term preservation
7.2.3	4.2.3	Old specification for “Wet and dry storage of Boiler” changed to refer to ASME Section VII, subsection C8,
8	7	Only numbering changed
	Appendix 2-7	New appendix taken over from SARAWAK Standard Engineering Specification SES 20.1

1.7 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of “DEPs on the Web”, available through the Global Technical Standards web portal http://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

1.8 DUAL UNITS

In this DEP, the International System of units (SI) shall be understood to prevail over US Customary (USC) units. USC units are provided in brackets following the SI units for information.

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2. GENERAL

2.1 IDLE PERIOD

The length of the idle period affects every aspect of planning and costs because the longer the equipment will be idle, the more protection is required. An inaccurate prediction of idle time will affect the cost of maintaining the equipment and the ability to restart in the future.

As mentioned in section (1.3.2) preservation programs are divided into three categories:

- Temporary preservation
- Short-term preservation
- Long-term preservation

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.

2.2 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.

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

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.

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 0.35 BAR (35 kPa or 5 psi).

IT SHALL NOT BE DISTURBED WITHOUT PRIOR AUTHORITY FROM OPERATIONS.

IT SHALL NOT BE TAKEN INTO SERVICE WITHOUT INSPECTION DEPARTMENT AUTHORITY.

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. See (7)

Also, the condition of the rust preventives shall be checked at specified intervals.

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.

2.3 DECISION ON THE EXTENT OF PRESERVATION

Preservation should be adequate for the purpose intended and at the same time it is equally necessary to ensure that it is justified economically. 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 inter-functional discussions at local management level.

Preservation will not be required where:

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- 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, 25% of its estimated replacement value at some forward point in time. This is approximately equivalent to 15 years' maintenance costs. This applies typically for:
    - Small bore piping that is DN 50 (2 in) and less;
    - Small pumps, blowers and fans than can be replaced readily;
    - Small motors – experience suggested that it is uneconomical to protect motors of less than 10 kW;
    - Small waste treatment tanks which can be replaced quickly and inexpensively;
    - Inexpensive instrumentation such as small pressure gages, level gages, small control valves.

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, operational shift responsibilities, provision for lighting and minor power requirements, instrument air and some utilities. See (7).

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 (3 & 4). It is a matter for local judgement as to how much detail is recorded, bearing in mind the problems of 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 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 an equipment shall be determined largely by the information recorded in the inspection post shutdown report, and by the corrosiveness of the local environment. Recommendations for the external insulation are given in (3 & 4).

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3. PRESERVATION PROCEDURE FOR NEW EQUIPMENT

3.1 GENERAL

The recommendation from this section shall be applied for new equipment which has not been in service and will be stored on site for a certain period before taken in operation.

Since the equipment has not been taken in operation, draining and cleaning to remove operational deposits is normally not 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. Ingress of water into refractory lined equipment, including stacks, shall be prevented.

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, stencilled or stamped.

3.2 NEW STATIC EQUIPMENT AND PIPING

3.2.1 General requirements

Equipment should be stored in a safe place so that it will not be damaged or misused during idle period and if possible, stored in a fenced warehouse area.

Further measures other than the ones described below may be necessary depending on local climate conditions (e.g. in areas with high humidity, in coastal areas containing a lot of salt in the air, desert area, where sand or dust may occur, arctic areas where the equipment might be affected by very low temperatures and snow).

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.

New equipment shall be painted and/or coated according to DEP 30.48.00.31-Gen. or DEP 70.48.11.30-Gen. as applicable. Any coating damages shall be appropriately re-instated.

3.2.2 Pressure vessels

Temporary preservation

If vessels are not shipped with inert gas purge, the vessels should be opened and its internal visually inspected for ingress of water and condition of preservative. Preservative shall be renewed if necessary and flange covers reinstalled. Vessels shall be thoroughly dried, required preservation applied and then sealed using metal flange covers and rubber gaskets on all flanges.

Temporary preservation should be done by using desiccants, VPI powder, or by spraying the internal surface with corrosion preventive fluids, e.g. ENSIS OIL grade N (depending on what is more economical).

NOTE Instead of Shell ENSIS Oil (grade N) also other equal corrosion preventive fluids can be used, e.g. Agma Synergen 718.

Oil, grease and organic materials shall not be used for pressure vessels in gaseous oxygen service.

If vessels are shipped with inert purge, then pressure shall be checked and maintained per preservation procedure.

Visible weep holes in reinforcing pads, corrosion plates, etc., shall be packed with grease.

Machined surfaces, like flange faces other than those furnished with permanent blinds, and other finished or delicate parts shall be well-greased and protected against rusting and

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damage. Oil, grease and organic materials shall be not used for pressure vessels in gaseous oxygen service.

Bolts and nuts shall be coated with a suitable thread lubricant to prevent galling or corrosion. The lubricant shall be removable with mineral spirits or a solvent. Copper or molybdenum disulfide containing thread lubricants shall not be used.

Stainless steel equipment (SS exterior surface) shall be stored separately from CS equipment to prevent getting into contact with CS, CS scales or rust. See (6).

Service gaskets and spare parts shall be packaged separately and stored in warehouse. All packages shall be separately identified by package number with the vessel tag number clearly indicated.

Short/long term preservation

The same actions as for temporary preservation are also required for short and long term preservation except using descants or oil.

For short and/or long term preservation vessels shall be purged and filled with a dry inert gas such as nitrogen at a pressure of not less than 35kPa (5psi). Pressure gage should be installed at the pressure vessel in order to check the pressure during idle period.

Air reservoirs, pulsation dampeners etc. shall be protected from internal corrosion damage by suspending bags of vapor phase inhibitor (e.g. Shell VPI 260), in the vessel before it is sealed. Warning labels shall be attached externally and the quantity of inhibitor bags noted.

For vessel with an internal corrosion resistant cladding (e.g. SS, Nickel-alloys, plastic and rubber or glass-lined equipment) no further measures are required other than as for temporary preservation.

3.2.3 Furnace and Boilers

Temporary preservation

Tubes and headers shall be purged and filled with dry inert gas such as nitrogen at a pressure of not less than 35kPa (5psi). A pressure gage should be installed in order to check the pressure during idle period. The refractory should be protected against water ingress. In order to avoid condensation at the flue gas side and fire box, the flue gas side should be well ventilated by leaving open access doors and dampers; the stack draft should also be utilized if possible

Short/long term preservation

In additional to temporary preservation the burners should be removed and stored in the warehouse.

External protection
For periods of up to 5 years, external insulation should be left in place and inspected and repaired where necessary to prevent the ingress of water.

Where the lay-up period is for 5 years or more, insulation should be removed and a complete paint system should be applied in accordance with DEP 30.48.00.31-Gen. or DEP 70.48.11.30-Gen. as applicable.

3.2.4 Shell-and-tube heat exchangers and air –cooled heat exchangers

Temporary preservation

If exchangers are not shipped with inert gas purge, the exchangers should be opened and its internal visually inspected for ingress of water and condition of preservative. Preservative shall be renewed if necessary and flange covers reinstalled. Exchangers shall be thoroughly dried, required preservation applied and sealed using metal flange covers and rubber gaskets on all flanges.

Temporary preservation should be done by spraying the internal surface with ENSIS OIL grade N or blowing VPI powder into the tubes and hanging small bags of the powder strategically in the channel (depending on what is more economical). The exchanger shall

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be properly closed at tube and shell side to prevent entry of water and other foreign material. Before spraying and/or flushing with ENSIS Oil grade N all internal parts should be sprayed and /or flushed with de-watering fluid e.g. SHELL ENSIS Fluid grade C.

NOTE Instead of Shell ENSIS Oil (grade N and C) other equal corrosion preventive fluids can be used, e.g. Agma Synergen 718.

One end of the exchanger needs to be tilted up greater than 10 degrees and held to ensure water is completely drained from all the tubes.

Oil, grease and organic materials shall be not used for pressure vessels in gaseous oxygen service.

If exchangers are shipped with inert purge, then pressure shall be checked and maintained per preservation procedure.

Visible weep holes in reinforcing pads, corrosion plates, etc., shall be packed with grease.

Machined surfaces, like flange faces other than those furnished with permanent blinds, and other finished or delicate parts shall be well-greased and protected against rusting and damage

Bolts and nuts shall be coated with a suitable thread lubricant to prevent galling or corrosion. The lubricant shall be removable with mineral spirits or a solvent. Copper or molybdenum disulfide containing thread lubricants shall not be used.

Chloride protection shall be provided for external stainless steel surface.

Service gaskets and spare parts shall be packaged separately and stored in warehouse. All packages shall be separately identified by package number with the vessel tag number clearly indicated.

Short/long term preservation

The same actions as for temporary preservation are also required for short and long term preservation except using desiccants or corrosion preventing oil.

For short and/or long term preservation vessels shall be purged and filled with a dry inert gas such as nitrogen at a pressure of not less than 35kPa (5psi). Pressure gages (shell and tube side) should be installed at the heat exchanger in order to check the pressure during idle period.

For heat exchangers not made of carbon steel (bundle and internal cladding of shell and channel) no further measures are required other than for temporary preservation.

The bundle of air-coolers shall be completely covered 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.

3.2.5 Piping and fittings

Temporary preservation

Installed piping should be cleaned, dried and sealed.

Fittings and flanges shall be stored in shelter / warehouse so as to minimize ingress of rainwater and other foreign matter.

New piping and fittings (as delivered from vendor) shall be stored appropriately to prevent corrosion.

If these items are in protective coverings (as delivered from vendor) then no further preservation is required.

Short/long term preservation

For installed piping constructed of material other than carbon steel or cladded with corrosion resistant material no further measures are required than for temporary preservation.

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Carbon steel lines larger than DN 50 (2 in) should be filled with dry air, and 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.

Underground lines shall be purged and filled with dry inert gas such as nitrogen at a pressure of not less than 35kPa (5psi) at the shell and tube side. Pressure gages should be installed in order to check the pressure during idle period.

Metallic underground piping shall be protected by cathodic protection.

Fittings and flanges shall be spray coated over the entire body using SHELL Ensis Fluid. Fittings and flanges of less than DN 200 (8 in) shall be stored in shelter / warehouse so as to minimize ingress of rainwater and other foreign matter.

Large fittings may be stored outside for up to 6 months in their delivery crate or a suitable crate supplied at the storage site. The crates shall be lined with bituminous heavy gauge brown paper. The crates shall be clearly marked with their contents and be raised at least 0.5m (19 in) clear of the ground on timber or other suitable material to avoid immersion in mud and water. A sound tarpaulin or similar waterproof covering shall be placed over the crates and be securely fastened down. Some ventilation shall be permitted at the base and between the crates.

The contents of the crates shall be inspected periodically to check the protective coverings and for any ingress of water.

NOTE: Pipes stored outside warehouse or shelter (as delivered from vendor) shall be stored on a slope to promote drainage. Stored pipe and fittings to be aligned so that the prevailing winds will blow through the equipment to dry it; the higher end of the pipe is at the upstream side except if the prevailing wind is from the south. In that case the higher end is to the north.

3.2.6 Other static pressure vessel equipment

Other new static pressure vessel equipment like:

- Valves and attachments;
- Stuffing box packings;
- Relief valves;
- Flare and flare lines.

shall be preserved as specified for old equipment (4.2.7 to 4.2.12) and if possible stored in sheltered locations (indoors) e.g. warehouse.

New gaskets, bolts and nuts shall be stored in sheltered locations e.g. warehouse (indoors) above dew-point temperature. If these items are in proper original wrapped up condition (as delivered from the vendor) no further preservation is required. Only large or special bolts and nuts (which are very expensive or have long delivery time) should be coated with SHELL ENSIS Oil H, SHELL Engine Oil R30 or similar SHELL approved oil.

3.3 NEW ROTATING EQUIPMENT

New rotating equipment shall be preserved as specified for old equipment (see section 4.3); though cleaning to remove operational deposits and encrustation will not be required.

3.4 NEW MIXING AND EXTRUDING EQUIPMENT

New mixing and extruding equipment shall be preserved as specified for old equipment (see section 4.4); though cleaning to remove operational deposits and encrustation will not be required.

3.5 NEW CIVIL ENGINEERING ITEMS

New installed civil engineering items shall be preserved as specified for old civil engineering items (4.5), though cleaning to remove operational deposits and encrustation will not be required.

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General structural steel goods

Steel Plates shall be stacked vertically with plastic or treated wood spacers to avoid damage to protective coatings.

The bottom rows of tubular, I-beams etc. shall be laid on wooden lined steel racks with a minimum ground clearance of 0.5m (19 in) to avoid contact with water, mud, sand, etc. in order to prevent corrosion.

Separate each item and each row by using preservative treated rope/treated wood spacers to prevent metal-to-metal contact, the build up of water/debris and also to allow a passage of air for circulation.

Where possible, materials shall be stored under shelter.

Goods shall be arranged and stored according to their size, grade, type with the preservation date and heat number clearly stencilled in a visible location.

Rotation of stock materials shall follow a "First-in First-out" system.

3.6 NEW INSTRUMENTATION EQUIPMENT

New instrumentation equipment shall be preserved as specified for old equipment (see section 4.6); though cleaning to remove operational deposits and encrustation will not be required.

3.7 NEW ELECTRICAL EQUIPMENT

New electrical equipment shall be preserved as specified for old equipment (see section 4.7); though cleaning to remove operational deposits and encrustation will not be required.

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4 PRESERVATION PROCEDURES FOR OLD EQUIPMENT

4.1 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 shall 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 (1.3.2).

For rotating equipment, plant-mounted instruments and electrical equipment, recommendations are given for temporary, short-term and long-term preservation as defined in (1.3.2).

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

All idle and retired pressure vessel equipment including piping and tanks, spheres and boilers shall be isolated / separated from remaining active process. If the equipment remains in the process unit it should <u>not</u> be connected to any piping or valves that would allow it to be accidentally placed back in service, without following the appropriate MOC procedures or re-inspection.

4.2 STATIC EQUIPMENT AND PIPING

4.2.1 Vessels and columns

<u>Temporary preservation</u>

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.

For stainless steel vessels (solid or internal SS cladding) the recommendation provided in (6.1) shall be considered.

<u>Short/long-term preservation</u>

Vessels and columns should be drained, purged and cleaned. They may then be preserved by filling with dry inert gas, 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.

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.

<u>External protection</u>
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 and a complete paint system shall be applied in accordance with DEP 30.48.00.31-Gen. or DEP 70.48.11.30-Gen. as applicable.

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4.2.2 Furnaces

Temporary preservation

The tube shall be drained and cleaned internally (e.g. decoked or pigged). For stainless steel tubes, recommendations provided in (6.1) shall be considered.

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.

Air preheaters using hot water or steam as heat transfer medium shall be completely drained in order to prevent plugging due to freezing during winter time.

4.2.3 Boilers

For Boilers for Deepwater Offshore units see (5.1.5)

Temporary preservation

For short shutdowns if the cost is not prohibitive, the unit should be kept in operation on warm stand-by to minimise possibility of corrosion. Condensate systems should be kept in operation. 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, a thorough neutralization (NH_3 and $NaHCO_3$) cleaning and drying procedure in accordance with DEP 70.10.80.11-Gen. shall be carry out.
- Flue gas side preservation
  For storage, the flue gas side should be well ventilated by leaving access doors and dampers open. The stack draught should also be utilized if possible.
- Steam/water side
  To minimise the possibility of corrosion, boilers not in service shall be preserved for the idle period and monitored. The type of preservation method either Dry Storage or Wet Storage should be chosen with the following in mind:
  - For Dry storage, a drying period of a few days is necessary at the end of the idle period before it is allowed for return to service;
  - For Wet Storage, the equipment may return to service on a short notice;
  - In locations where freezing temperatures are expected during standby, Dry storage is preferred. Wet storage requires necessary heating to prevent freezing;
  - Availability of good water quality (same grade as boiler feed water) and chemical dosing facility for Wet Storage;

For long term storage, Dry storage is recommended. Wet storage is not the preferred method for idle time of more than 2 to 3 months.

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For wet and dry storage of the steam/water side and fire side the recommendations according to ASME Section VII, subsection C8, Paragraphs C8.310 :water side and C8.320: Fire side shall be followed.

The unit in idle period should be inspected periodically to monitor possible corrosion damage. For Wet storage, analysis of boiler water shall be carried out periodically and sufficient chemicals added as necessary.

External protection

Precautions defined by local circumstances should be taken 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 in accordance with DEP 30.48.00.31-Gen. or DEP 70.48.11.30-Gen. as applicable.

4.2.4 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, and then dry. Carbon steel heat exchangers may need mechanical and/or chemical cleaning.

Where oil may 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.

Before spraying and/or flushing with ENSIS Oil grade N all internal parts should be sprayed and /or flushed with de-watering fluid e.g. SHELL ENSIS Fluid grade C.

Where oil cannot be tolerated, carbon steel shall be protected with appropriate 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

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

With copper alloy, particular attention should be given to remnants of ammonium salts or deposits that could possibly generate ammonia, e.g. 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 (6.1).

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

External protection
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 and a complete paint system applied in accordance with DEP 30.48.00.31-Gen. or DEP 70.48.11.30-Gen. as applicable.

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4.2.5 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

If no moisture is present, tubes and headers shall be clean and flush with Ensis Oil grade N. Hang small bags of VPI powder in headers, and then close up.

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 (4.3).

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.

NOTE: Instead of Ensis Oil grade N or Ensis fluid grade S, T or V also other equal corrosion preventing fluids can be used.

4.2.6 Piping and fittings

Temporary preservation
For temporary idle periods (up to 2 months) lines should be taken out of service according to “routine” site specific shutdown procedure.

Care should be taken, that:

- Liquid filled lines and fittings cannot be over pressurized by thermal expansion of the blocked in liquid;
- Lines and fittings filled with high viscose liquids (which can only be pumped at elevated temperature) are drained, when the lines are taken out of operation.

As long as lines are filled with process fluid they should be handled still as active (in service) lines.

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, and 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 of the carbon steel pipe internal with Ensis Oil grade N, or filling with gas oil, or filling with inhibited water be considered.

Water-filled lines shall be adequately winterized to prevent freezing.

Steam lines should be drained and preserved with dry air. Special attention should be made to low points and dead ends in the system.

If filled with water, ensure adequate winterization and thermal relief provisions be made.

Piping constructed with 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, shall be drained out thoroughly Particular attention should be made 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.

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The cathodic protection system for underground piping shall be kept in operation and shall be regularly checked.

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

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

4.2.7 Valves and attachments

Temporary preservation

Valve spindles should be protected with Shell Ensis Compound.

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. Only non-acid and non-moisture containing lubricants shall be used for the prevention of fretting corrosion.

VpCI powder should be blown into both the pressure and exhaust side of pneumatic diaphragm or piston valve actuators. Openings and main connections of flange shall be sealed vapour tight.

4.2.8 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.

4.2.9 Gaskets

Temporary/short-term preservation
Leave all gaskets intact.

Long-term preservation
Leave all gaskets intact.

4.2.10 Flanges

Temporary preservation
No action required.

Short/long- term preservation
Exposed flanges are vulnerable to corrosion if left unprotected. Clean thoroughly, and 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.

4.2.11 Relief valves

Temporary preservation

Normal shutdown procedure.

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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.

4.2.12 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.

4.2.13 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, and then preserved in accordance with the requirements for rotating equipment (4.3). 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.

4.2.14 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.

4.3 ROTATING EQUIPMENT

4.3.1 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.

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.

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Equipment with synthetic oil systems requires 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 (4.3.8).

Where the equipment mentioned in (4.3) is coupled with an electric motor or generator and the equipment is required to be run for a specific length of time, the requirements in (4.7.2) and (4.7.3) shall be met.

4.3.2 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.

4.3.3 Reciprocating pumps

Temporary preservation

Same 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;

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- 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 (4.3.8) for preservation of enclosed gears;
- do not rotate crankshaft during storage;
- fill crankcase with Ensis Engine Oil grade 30;
- run oil pump every month;

Long-term preservation

As for short-term preservation.

4.3.4 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;
  - 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;

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- 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 Shell Ensis Compounds 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;
- 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.

4.3.5 Steam turbines

<u>Temporary preservation</u>

- 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.

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