

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

TECHNICAL SPECIFICATION

THE PRESERVATION OF OLD AND NEW EQUIPMENT AND PIPING STANDING IDLE

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This revision of PTS **70.10.70.11** - THE PRESERVATION OF OLD AND NEW EQUIPMENT AND PIPING STANDING IDLE (**December 2010, Revision 1**) has been updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font.

The previous version of this PTS **70.10.70.11 (July 1999)** will be removed from PTS binder / e-repository from herein onwards.

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PREFACE

PETRONAS Technical Standards (PTS) publications reflect the views, at the time of publication, of PETRONAS OPU/Divisions.

They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. 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 technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

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

When Contractors or Manufacturers/Suppliers use PTS they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, it is expected of them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the PTS. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the owner.

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1. INTRODUCTION

1.1 SCOPE

This PTS 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 PTS, specific Petronas 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 PTS is a revision of the PTS 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 PTS.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this document is confined to companies forming part of PETRONAS Group and to Contractors nominated by them.

This PTS 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 PTS 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 PTS 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 PTS 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** indicate a requirement.

The word **should** indicate 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 PTS 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
<i>Throughout</i>	<i>Shell Ensio Engine Oils change to Petronas MOTOLUB CS3 CF</i>
<i>Throughout</i>	<i>Shell Ensio Engine Oils 10W change to Petronas MOTOLUB CS3 CF 100W</i>
<i>Throughout</i>	<i>Shell Ensio Engine Oils 20 change to Petronas MOTOLUB CS3 CF 20</i>
<i>Throughout</i>	<i>Shell Ensio Engine Oils 30 change to Petronas MOTOLUB CS3 CF 30</i>
<i>Throughout</i>	<i>Shell Ensio Engine Oils 40 change to Petronas MOTOLUB CS3 CF 40</i>
<i>Throughout</i>	<i>Shell Turbo T change to Petronas Jenteram HC</i>
<i>Throughout</i>	<i>Shell Turbo T 32 change to Petronas Jenteram HC 32</i>
<i>Throughout</i>	<i>Shell Turbo T 46 change to Petronas Jenteram HC 46</i>
<i>Throughout</i>	<i>Shell Turbo T 68 change to Petronas Jenteram HC 68</i>
<i>Throughout</i>	<i>Shell Turbo T 78 change to Petronas Jenteram HC 78</i>
<i>Throughout</i>	<i>Shell Turbo T 100 change to Petronas Jenteram HC 100</i>
APPENDIX 2	Add lubricant equivalent chart

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 PTS 34.14.20.31, 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 environmental considerations regarding the use and disposal of cleaning and/or preservation agents refer to PTS 70.10.80.11 and PTS 34.14.20.31.

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 *Petronas* and *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 Petronas MOTOLUB CS3 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 Petronas Jenteram HC Oils are available in five viscosity grades (32, 46, 68, 78 and 100) and are used for the long-term preservation of steam turbines.

Petronas MOTOLUB CS3 Oils and Petronas Jenteram HC Oils are Petronas lubricant product marketed by Petronas Lubricant International Sdn. Bhd..

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 vaporise 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 PTSEnd 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 PTS 70.10.80.11) 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.