

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

MAINTENANCE PAINTING

PTS 70.48.10.10

DECEMBER 2009



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This revision of PTS 70.48.10.10 – MAINTENANCE PAINTING (**December 2009, 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* or **blue** font.

The previous version of this PTS 70.48.10.10 (**December 1995**) 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.

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1. INTRODUCTION

1.1 SCOPE

This is a new PTS which specifies requirements and gives recommendations for maintenance painting of existing equipment and structures. It describes the essential criteria for deciding whether maintenance painting is needed and it assists in the selection of a suitable paint system.

PTS 40.48.00.30 "Paint and Paint Materials" and PTS 30.48.00.10 "Painting and Coating" are now rendered out of date and are withdrawn.

It is stressed that this PTS gives general requirements for maintenance painting only. For specific equipment where conflicting requirements are defined in other PTSs or other applicable publications, the requirements of those documents shall prevail.

This PTS may be used in conjunction with PTS 30.48.00.31-P ("Protective Coatings & Lining") since the generic systems described therein are compatible with the systems used in this PTS.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of or managed by PETRONAS. It may be distributed to Manufacturers/Suppliers nominated by them.

This PTS is intended for use in oil refineries, chemical plants, gas plants, 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, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document 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 with the object of obtaining agreement to follow this document as closely as possible.

1.3 DEFINITIONS

1.3.1 General 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 or maintenance 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.

Painting system is a term intended to include, with equal emphasis, not only the well accepted components of a system such as surface preparation and paint materials but also application, inspection and safety functions.

Coating system is a term which refers to the applied and cured multilayer film or to the components of a system based on non-paint type coating.

Initial painting facilities meaning painting of new construction projects or complete recoating of existing during major maintenance.

Maintenance painting meaning periodic painting after initial painting (repair, touch up of corroded areas or deteriorated paintwork)

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

Add the following:

The word **may** indicates an option.

1.3.2 Specific definitions

Chalking	The appearance of a loosely adherent fine powder on the surface of a paint coating, arising from the degradation of one or more of its constituents.
Cracking	The splitting of a dry paint film, usually as the result of ageing.
DFT	Dry film thickness; the thickness of a dried or cured paint or coating film.
Flaking	The detachment of pieces of the paint film itself either from its substrate or from paint previously applied. Flaking is usually preceded by cracking or blistering.
TDFT	Total dry film thickness; the thickness of the total number of coatings specified.
WFT	Wet film thickness, the thickness of an uncured or wet paint or coating film.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (10).

2. MAINTENANCE PAINTING PHILOSOPHY

Maintenance painting consists of two types of activity:

Large-scale maintenance, necessary because the existing coating has completely deteriorated or failed and the technical integrity or safety of the equipment is impaired. In this case local repairs are not economically justified and the only option is to apply a new paint system in accordance with PTS 30.48.00.31-P

Repair work to rectify damage to a coating caused by corrosion, ageing etc.

Maintenance painting purely for the sake of appearance is not considered an economically justified criterion within the context of this PTS.

To determine how and to what extent any damage to a coating should be repaired, it is necessary to:

- establish the amount of corrosion present,
- establish the type and extent of paint defects present,
- select an appropriate repair procedure, which includes:
 - surface preparation
 - choice and specification of coating system
 - application
 - testing and inspection.

3. ASSESSMENT OF SURFACE CONDITION

In order to establish the correct and successful maintenance painting procedure required, it is critical to assess the condition of the equipment in terms of corrosion and coating condition.

One or more of the following warning signs can indicate if maintenance painting is required:

- general rust formation;
- local rust attack resulting from mechanical damage, typically on edges, in corners, at corrosion traps and on weld seams;
- local rust attack on films that are too thin or caused by porous areas in the coating;
- rust creep from damaged areas;
- flaking of the substrate or between coats;
- blistering;
- cracking of the paint film.

The following sections give guidance with respect to the classification of surface condition.

3.1 CORROSION CRITERIA

To establish the amount of corrosion occurring on carbon and low alloy steels, reference shall be made to the degrees of rusting defined in ISO 4628-3.

NOTE: The approach for stainless steels is given in (3.4).

The estimated amounts of rust break-through on a coating and of the total apparent rust (rust break-through plus under-film rust) shown in this standard are given in Table 1. Comparative American and European standard rust grades are included in the table for reference since these were widely applied in the past, but the ISO standard is now accepted as the norm.

Table 1 Degree of rusting and area rusted

Degree of rusting			Area rusted (%)
ISO rust scale	European rust scale	ASTM D610	
Ri 0	Re 0	10	0
Ri 1	Re 1	9	0.05
Ri 2	Re 2	7	0.5
Ri 3	Re 3	6	1
Ri 4	Re 5	4	8
Ri 5	Re 7	1 to 2	40 to 50

3.2 BLISTERING

The degree of blistering shall be evaluated in accordance with ISO 4628-2. This standard characterises blistering in terms of size and quantity(density) of defects. Table 2 shown the express rating for the quantity(density) and size of the blisters with correlation between ISO 4628-2 & ASTM.

When the blistering frequency observed on a coating becomes "medium", the nature of the blisters shall be studied in order to establish the need for maintenance.

If the area underneath the blisters is dry and the blister itself is raised by gas (e.g. from trapped solvent) there is no urgency for repair. This also applies if the blisters are filled with liquid and if there is little or no corrosion underneath.

Blisters with both liquid and corrosion product underneath indicate that corrosion has been initiated on the substrate and, therefore, repair is necessary. In this case the repair requires complete removal of the blisters since experience has shown that on equipment repaired once (locally) and replaced in service, the blistering is rapidly renewed. Consequently, the only satisfactory procedure is to blast-clean the surface thoroughly, which means a repair comparable with the procedure for a rust scale of Ri 4 as given in Appendix 1.

Table 2: Correlation between ISO 4628-2 & ASTM D714 rating system

Quantity(density)		Size	
ASTM	ISO	ASTM	ISO
none	0		
-	1	-	1
few	2	8	2
medium	3	4	4
medium-dense	4	4	4
dense	5	2	5

3.3 CRACKING, FLAKING AND CHALKING

The degree of cracking, flaking and chalking in a coating shall be evaluated in accordance with ISO 4628-4, ISO 4628-5 and ISO 4628-6, respectively.

These phenomena alone shall not be used as a criterion for urgent maintenance painting provided that they are not accompanied by significant corrosion, i.e. provided that $Ri \leq 3$ as indicated in (3.1)

3.4. STAINLESS STEEL SUBSTRATES

The necessity to carry out maintenance painting on stainless steel surfaces shall be governed by a visual judgement of the existing coating (including the condition of any insulation) since "degree of rusting" is not a relevant criterion for these substrates.

4. TYPES OF MAINTENANCE

Depending on the condition of the coating, one or more of the following four types of maintenance should be applied:

4.1 PREVENTIVE CLEANING

Periodic removal of all contaminants, e.g. salts, dirt, grease, oil, etc., by hosing with fresh water is sufficient if the coating is contaminated but no breakdown or corrosion is observed (i.e. Ri 0). If needed, a concentrated detergent may be used. If conducted regularly this will reduce the impact from the environment and result in longer maintenance intervals.

4.2 SPOT REPAIR

If the paint film, apart from local rust areas, is sound and adequate (Ri 3), the areas that are corroded shall be spot cleaned and touched up to full film thickness. All corrosion products shall be removed and the interface between the sound coat and cleaned areas shall be properly prepared.

4.3 RENOVATION

For renovation ($R_i = 4$), spot repairs shall be carried out to the existing coating in accordance with (4.2), and a full topcoat shall be applied. The existing coating system shall be sound and adequate and the new topcoat shall enhance the corrosion inhibition. In some cases a complete renovation may be needed for reasons of a change of colour or to prevent increased dirt retention.

4.4 REFURBISHMENT

This requires total removal of the existing coating system ($R_i \geq 5$). Surface preparation and application of a new coating system shall be carried out in accordance with PTS 30.48.00.31-P.

Table 3 contains recommendations for the selection of the appropriate type of maintenance for coated surfaces based on their current condition. Maintenance painting should not be necessary for coated surfaces where less than 1% of the surface area is corroded ($R_i \leq 3$).

Table 3: Typical maintenance practices

Paint surface condition	Rust scale (ISO 4628-3)	Maintenance	Minimum recommended surface pretreatment (ISO 8501)
Contaminated No corrosion	$R_i 0$	Preventive cleaning (4.1)	-
1% of surface area corroded	$R_i 3$	Spot repair (4.2)	St 2
<10% of surface area corroded	$R_i 4$	Renovation (4.3)	St 3/Sa2
>10% of surface area corroded	$R_i 5$	Refurbishment (4.4)	Sa 2 1/2

5. PAINTING SYSTEM SELECTION

Based on the maintenance practices given in Table 3, painting schedules are given in (Appendix 1) for carbon steel and low-alloy steels where rust scales $R_i 3$ or $R_i 4$ have been detected.

The procedures for spot repair or renovation can then be derived from (Appendix 2), where the appropriate paint systems are listed.

The following factors should be taken into account in selecting the most appropriate, economic painting system:

- compatibility with existing coating systems;
- operating temperature;
- adhesion to the existing substrate;

- required lifetime before next maintenance;
- remaining life of the equipment or structure.

5.1 DESIGN TEMPERATURE

The Operating Temperature of the equipment shall be used in selecting a paint system in (Appendix 1).

5.2 COMPATIBILITY WITH EXISTING COATING SYSTEMS

For spot repair and renovation the selected paint systems shall be the same as or compatible with existing coating systems.

Epoxies and polyurethanes may only be applied on top of alkyd paints in exceptional cases and only after a thorough investigation has been conducted into the softening and adhesion of the proposed coating system. In such cases the paint Manufacturer shall be consulted.

Silicate-based paints shall not be applied on top of organic coatings or organic shop-primers as there is insufficient intercoat adhesion.

6. SURFACE PREPARATION

For the optimum performance of paint systems the surface preparation shall, wherever possible, be carried out by dry blast-cleaning. If dry blast-cleaning is not strictly necessary

(e.g. rust scale Ri 3) or not feasible (e.g. due to limited access, risk of damage to equipment, light gauge steel, the proximity of electrical components or instrumentation) then power tool cleaning shall be applied.

6.1 SURFACE PREPARATION BY BLAST CLEANING

Before blast cleaning, any oil, grease and dirt shall be removed either by means of a suitable solvent, by steam cleaning (with an alkaline cleaning agent if necessary) or by water jetting. Excessive layers of rust shall be removed by chipping. Weld spatter and sharp edges shall be removed.

If the surface being prepared lies adjacent to a coated surface which is not to be refurbished, the blast cleaning shall overlap the coated surface by at least 25 mm. The remainder of the existing coated surface shall be properly protected with shields or screens to prevent any possible damage to the coating.

The following four preparation grades (in accordance with ISO 8501-1) are recognised:

- Sa 1 : Light blast-cleaning
- Sa 2 : Thorough blast-cleaning
- Sa 2½ : Very thorough blast-cleaning
- Sa 3 : Blast-cleaning to visually clean steel

6.2 BLAST-CLEANING TECHNIQUES

6.2.1 Abrasives

Abrasives for use in blast-cleaning carbon steels and low alloy steels are specified in ISO 8504-2.

Suitable abrasives are:

- Chilled iron grit or shot.