

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

RUBBER-LINED PROCESS EQUIPMENT

PTS 30.48.60.10

JANUARY 2009



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This revision of PTS **30.48.60.10** – RUBBER-LINED PROCESS EQUIPMENT (**January 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* font.

The previous version of this PTS **30.48.60.10 (December 1997)** 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' OPUs 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 PTS specifies requirements and gives recommendations for the application, design, qualification testing, fabrication, production testing, inspection, transportation and installation of rubber-lined process equipment.

This PTS is applicable to vulcanised and non-vulcanised rubber lined process equipment, both shop fabricated and field fabricated.

This PTS is a revision of the PTS of the same number dated December 1997; a summary of the main changes is given in (1.5).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this document is restricted to companies forming part of or managed by the PETRONAS Group and, where necessary, to Contractors and Manufacturers nominated by them.

This PTS is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and distribution storage depots and installations.

When PTSs 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 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 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 PTS as closely as possible.

1.3 DEFINITIONS

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 **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 sometimes 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 word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. References used in this PTS are listed in (11).

1.5 SUMMARY OF CHANGES SINCE PREVIOUS EDITION

The previous edition of this PTS was dated December 1997; a summary of the main changes since the last edition is given below.

Section	Change
General	Increased alignment with ISO Standards and PTSs. Title and scope changed to restrict application to equipment excluding piping. Standard drawings for piping deleted.
2.2	Classification and nomenclature in compliance with ISO 1629. Added more trade names and manufacturer for CSM and FKM rubber.
2.3	Properties of rubbers better aligned with PTS 30.10.02.13 and Manufacturers' recent data. Also include referenced to ISO/TR 7620.
3.4	Added requirement for adhesive system.
4.2.2	Added requirements on exposure duration after blasting.
4.3.2	Updated requirements for surface conditions during application.
5.2.3	Added requirement for minimum adhesion strength.

2. APPLICATION

2.1 GENERAL

Rubber linings are mainly used for protection against corrosion and/or erosion damage. In brick-lined equipment rubber is used as a membrane between the brick lining and the load-bearing structure (see PTS 30.48.60.12 and PTS 30.48.60.13).

A wide range of rubbers and elastomers are available for lining process vessels and tanks. Rubbers can also be made with anti-static properties to give a low surface electrical resistance.

Hard rubbers, i.e. hardness greater than Shore D 60, can only be applied by autoclave vulcanisation, and therefore hard rubber lining is restricted to small equipment or components. Only soft rubbers can be applied on site.

Hard rubber linings can only be applied to rigid structures and they are also sensitive to large temperature fluctuations. Soft rubber linings remain elastic over a large temperature range, and consequently they can accommodate major deformation, vibrations and significant temperature changes.

With respect to safety aspects, pressure rating, etc. the regulations which apply to equipment and structures are also valid for rubber-lined systems.

2.2 MATERIAL SELECTION

Material selection is determined by:

- service conditions (pressure, temperature, medium, etc.)
- design
- manufacturing method

The following rubber types are used for lining purposes (classification according to ISO 1629):

Type	Symbol	Service Temperature Range (°C)	
		Minimum	Maximum
Natural rubber	NR	-30	80
Isoprene rubber, synthetic	IR	-30	80
Styrene-butadiene rubber	SBR	-50	100
Chloroprene rubber (Noprene)	CR	-40	100
Butyl rubber	IIR	-40	130
Broombutyl rubber	BIIR	-40	130
Chlorobutyl rubber	CIIR	-40	130
Nitrile rubber	NBR	-35	100
Ethylene propylene rubber	EP, EPDM	-50	150
Urethane rubber	AU, EU	-30	70
Chlorosulphonyl polyethylene	CSM ¹	-35	120
Fluoro rubber	FKM ²	-20	200

¹ Commercially available under trade name "Hypalon" (DuPont) and "TOSO-CSM" (Tosoh).
² Commercially available under trade name "Viton" (DuPont), "Technoflon" (Ausimont), "Fluorel" (3M) and "Dai-EI" (Daikin).

Depending on the degree of vulcanisation, rubbers can be classified as 'soft' or as 'hard'. The hardness of soft rubbers is expressed in Shore A, and the hardness of hard rubbers is expressed in Shore D (ASTM D 2240).

Hard rubbers (or Ebonites), i.e. with a hardness higher than Shore D 60, can be produced from NR or blends, e.g. NR/IR, NR/SBR and NR/IR/SBR.

2.3 PROPERTIES OF RUBBER

Each rubber material has a specific limit in terms of allowable service temperature and chemical resistance. Chemical resistance and temperature limits of several rubber types are given in PTS 30.10.02.13. *Additional information might be obtained from ISO/TR 7620.*

2.3.1 Natural rubber (NR)

Soft and hard natural rubber linings are suitable for handling most inorganic chemicals, with the exception of strong oxidising agents such as chromic and nitric acids. Natural rubber linings are also suitable for handling hydrochloric acid. Natural rubber is also resistant to most organic fluids, including alcohols and most esters. They should not be used in the presence of aliphatic or aromatic hydrocarbons, halogenated hydrocarbons, mineral oils and certain vegetable oils. The typical service temperature range is $-30\text{ }^{\circ}\text{C}$ to $+80\text{ }^{\circ}\text{C}$. The bond strength of NR linings on steel is excellent. The hardness is typically Shore A 70 for soft rubber and Shore D 75 for hard natural rubber.

2.3.2 Isoprene rubber (IR)

Isoprene rubber is a synthetic alternative form of NR, and has similar properties.

2.3.3 Styrene-butadiene rubber (SBR)

Styrene-butadiene rubber can be used for the containment of automotive brake fluids, alcohols and mixtures of alcohol and water. The typical service temperature range is $-50\text{ }^{\circ}\text{C}$ to $+100\text{ }^{\circ}\text{C}$. The hardness is in the same range as that of soft natural rubber (NR).

2.3.4 Chloroprene rubber (CR)

Chloroprene rubber (Neoprene), is resistant to ozone and sunlight, and reasonably resistant to oils and chlorine. The typical service temperature range is $-40\text{ }^{\circ}\text{C}$ to $+100\text{ }^{\circ}\text{C}$. The hardness is typically Shore A 70.

2.3.5 Butyl rubbers (IIR, BIIR, CIIR)

Butyl rubbers have excellent tolerance to hydrochloric acid. Butyl rubber is resistant to ozone and sunlight, non-flammable hydraulic fluids, animal and vegetable oils, water, alcohols, ketones and acids. Butyl rubber should not be used in the presence of free halogens, petroleum oils or halogenated or aromatic hydrocarbons. The typical service temperature range is $-40\text{ }^{\circ}\text{C}$ to $+130\text{ }^{\circ}\text{C}$. The hardness is typically Shore A 60.

2.3.6 Nitrile rubber (NBR)

Nitrile butadiene rubber (also known as BuNa-N) is a copolymer of butadiene and acrylonitrile. The acrylonitrile content must be at least 35% by mole to obtain good chemical resistance. Nitrile rubber is resistant to petroleum-based hydraulic and lubricating oils, animal and vegetable oils, acetylene, alcohols, water, alkalis and fuel oils. Nitrile rubber should not be used for phenols, ketones, acetic acids, most aromatic hydrocarbons and nitrogen derivatives. The typical service temperature is $-35\text{ }^{\circ}\text{C}$ to $+100\text{ }^{\circ}\text{C}$. The hardness is typically Shore A 70.