

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

TECHNICAL SPECIFICATION

GUIDE TO WAREHOUSING OF CHEMICALS

PTS 30.06.10.46

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This revision of PTS **30.06.10.46 – Guide to Warehousing of Chemicals (February 2011, Revision 1)** has been updated *either* to incorporate PETRONAS Lessons Learnt, Best Practice *and/or* 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 **30.06.10.46 - Guide to Warehousing of Chemicals (March 1990)** will be removed from PTS binder / e-repository from herein onwards.

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Revision History

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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/Divisions 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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- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) and 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

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Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, PTS shall not, without the prior written consent of PETRONAS, be disclosed by users to any company or person whomsoever and the PTS shall be used exclusively for the purpose they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of PETRONAS.

The copyright of PTS vests in PETRONAS. Users shall arrange for PTS to be held in safe custody and PETRONAS may at any time require information satisfactory to PETRONAS in order to ascertain how users implement this requirement.

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1.0 INTRODUCTION

1.1 SCOPE

This manual to provide a concise and practical guidance on the warehousing of packed chemical products.

Many of the aspects dealt with are covered in greater detail on other publications but are dealt with here only to the extent deemed necessary to demonstrate their relevance to chemicals warehousing.

Although it is important to build or adapt warehouses to high constructional standards or to upgrade equipment, it is also critically important to give detailed attention to routine operating procedures and standards and, most importantly, to contingency planning for emergency situations. The most damaging consequences of many a disaster have often been the result, not of the emergency itself but rather the failure to be prepared for it or to respond to it as planned, thus negating many of the defence mechanism carefully engineered into the building, site or systems at the design and construction stage.

Because of the diversity of warehousing operations, the advice contained in a publication such as this can at best be general. It becomes specific only when the reader questions the adequacy of a given warehousing operation and attempts to measure vulnerability in relation to the various problem areas covered, e.g. the nature and quantity of product in stock and its proximity to residential property, rivers, lakes or the sea.

The conduct of such critical reviews on a regular basis is commended to all having management responsibility for chemicals warehousing operations.

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 the *PETRONAS* Group and to Contractors nominated by them.

This manual is intended for use by all involved in handling and storage of chemicals.

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 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

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 or maintenance 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 its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal. The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 SPECIFIC DEFINITION

External Standards - standards (e.g. ISO, EN, ANSI, ASME, BS, API, etc.) issued under the auspices of a non-PETRONAS body.

OPU - an Operating Unit of PETRONAS may it be wholly or partly owned by PETRONAS.

Standard - a document providing rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

1.4 ABBREVIATIONS

<i>DIN</i>	<i>Deutsches Institut für Normung e. V.</i>
<i>DSEAR</i>	<i>Dangerous Substances and Explosive Atmospheres Regulation</i>
<i>GHSED</i>	<i>Group Health, Safety and Environment Division of PETRONAS</i>
<i>IEC</i>	<i>International Electrotechnical Commission</i>
<i>IP</i>	<i>Institute of Petroleum</i>
<i>LPG</i>	<i>Liquefied Petroleum Gas</i>
<i>PTS</i>	<i>PETRONAS Technical Standards</i>
<i>PVC</i>	<i>Poly Vinyl Chloride</i>

1.5 SUMMARY OF CHANGES

The previous edition of this PTS was dated March 1990. Summary of changes made in February 2011 to the last edition is given below:

Section	Changes
Page 2	Inserted the word "either" and "or" in Para 1 of new PTS edition.
1.2	Replaced the word "ESU" in Para 1 of previous PTS edition with "PETRONAS" in the new PTS edition.
1.3.2	Deleted Para 1 in previous PTS edition.
1.4	Deleted abbreviations of "ESU" and "HSE" in the previous PTS edition.
	Added some abbreviations in the new PTS edition.
1.5	Deleted section "Cross References" of previous PTS edition.
	Replaced with new section of "Summary of Changes" in the new PTS edition.
2.1	Deleted the word of "which are" in Para 1 of previous PTS edition.
	Inserted Para 3 (reference document) in the new PTS edition.
2.1.1	Added reference of Table 1 to the section in the new PTS edition.
2.2	Added "IP Code: Part 3" in Para 2 of previous PTS edition.
	Replaced the word "BS" at Note section of previous PTS edition with "IEC" in the new PTS edition.
2.3	Added Note No. 2 (reference document) in Para 3 in the new PTS edition.
2.4	Replaced the word "are" in Para 1 of previous PTS edition with "is" in the new PTS edition.
2.5	Changed the title "Safe Handling of Chemicals" of previous PTS edition with "Safe Handling, Storage and Waste Disposal of Chemicals" in the new PTS edition.

	<i>Replaced the PTS reference "PTS 60.023" of previous PTS edition with "PTS 60.1502, 60.2112 and 60.3005" in the new PTS edition.</i>
4.0	<i>Changed the title "Construction" of previous PTS edition with "Design and Construction" in the new PTS edition.</i>
4.5	<i>Deleted the statement of previous PTS edition with the new statement in the new PTS edition.</i>
4.12	<i>Added the word "see Section" at Para 2 in the new PTS edition.</i>
4.15	<i>Deleted Column 3 of previous PTS edition.</i>
	<i>Replaced "BS 5345" of previous PTS edition and replaced with "IEC 60079-14-2003" and put it at Column 2 of new PTS edition.</i>
	<i>Deleted "Note" section of previous PTS edition.</i>
4.19	<i>Inserted new section "Construction Quality" in the new PTS edition.</i>
5.5.3	<i>Inserted Para 3 in the new PTS edition.</i>
5.6	<i>Added the word "with video camera" at Para 2 (a) in the new PTS edition.</i>
6.3	<i>Replaced at Note section the word "HSE department of ESU" of previous PTS edition with "GHSED of PETRONAS".</i>
	<i>Changed the title "Product Separation On" of previous PTS edition to "Product Separation" in the new PTS edition.</i>
	<i>Added the word " and labeling" at Para 3 in the new PTS edition.</i>
6.13	<i>Added the word "Section" at Para 2 (g) of previous PTS edition.</i>
7.0	<i>Inserted Para 2 (reference documents) in the new PTS edition.</i>
7.2.4.2	<i>Added the word "see Section" at Para 1 of previous PTS edition.</i>
7.5.1	<i>Replaced the word "HSE department of ESU" in Para 1 (f) of previous PTS edition with "GHSED of PETRONAS".</i>
7.5.2	<i>Replaced the word "HSE department of ESU" in Para 5 and Para 9 of previous PTS edition with "GHSED of PETRONAS".</i>
8.0	<i>Updated all standard references.</i>
	<i>Relocated and reword the Notes statements or disclaimer.</i>

2.0 PRODUCT HAZARDS

In order to plan a safe warehousing operation it is essential that all personnel concerned have an appreciation of product hazard. It is strongly recommended that a formal order approval procedure be established for all products acquired for the first time and that this should include checks to ensure that handling safety and hazard information have been obtained and circulated to all stock points prior to product arrival. The presence in or arrival at stockpoints of products in respect of which no such data has been provided should be regarded as grounds for serious complaint at senior management level.

2.1 HAZARD TYPES

The main problems likely to be encountered are from products which are flammable, combustible, toxic, corrosive or oxidising agents.

Consideration should also be given to hazardous reaction products from combustion, contact with water or interaction of chemicals, etc.

Refer PTS 60.2112 for details on hazard types.

2.1.1 FLAMMABLES

These are substances which can produce flammable vapour/air mixtures and which are therefore potential sources of explosions and fires. Classification is determined by flash point, this being the lowest temperature at which the substance will form a flammable vapour/air mixture (*Refer Table 1 in Section 2.2*).

2.1.2 COMBUSTIBLES

These are substances which are not flammable in the sense that they emit flammable vapours but which will nevertheless burn. In addition to packaged substances, other items which are often stored in warehouses such as empty or lay-flat cartons can also be placed in this category.

2.1.3 TOXICS

These are substances which may be harmful to man, animals and aquatic life by way of:

- a) ingestion, i.e. by swallowing
- b) inhalation, i.e. by breathing in the vapours
- c) absorption, through the skin

Such products can also cause considerable damage to the environment in the form of spillage or contaminated fire fighting water.

2.1.4 CORROSIVES

These are substances which will attack skin or materials such as wood or metal. Therefore leakage can corrode other packages and structures.

2.1.5 OXIDISING AGENTS

These are substances which can evolve oxygen (usually on heating) and which therefore can increase the fire hazard (Oxygen supports combustion.) They can also react violently with other materials.

2.2 IDENTIFICATION OF FLAMMIBILITY HAZARD

In a chemicals warehousing operation it is necessary to define those products which may produce flammable atmospheres during handling or storage.

To do this it is necessary to consult the Institute of Petroleum classification of flammable products - *IP Code: Part 3* (Table 1).

Table 1: Classification of chemical and petroleum products by flammability

Class	Sub-class	Flash-point (closed cup)
0		Liquefied Petroleum Gas
I		Below 21°C
II		Between 21°C and 55°C inclusive.
		These are sub-classified as follows:
	(1)	Substances stored or handled at temperatures below their flash point
	(2)	Substances stored or handled at temperatures above their flash point
III		Above 55°C and up to and including 100°C. These are sub-classified as follows:
	(1)	Substances stored or handled at temperatures below their flash point
	(2)	Substances stored or handled at temperatures above their flash point
Unclassified		Above 100°C

Thus products which may cause a flammable atmosphere during warehouse handling or storage are:

- a) Class 0 : e.g. aerosols based on LPG
- b) Class I : all products with a flash point lower than 21°C
- c) Class II (2) : products with a flash point between 21°C and 55°C inclusive, when stored or handled at temperatures above their flash point

Note: In various sections of this guide, reference is made to certain standards like *IEC*, *DIN*, etc. It is to be understood that there exist other national and international standards which may be equivalent or more stringent and may be mandatory in the region concerned.

2.3 AREA CLASSIFICATION FOR FLAMMABLE PRODUCTS

Area classification is the division of a facility into hazardous and non-hazardous areas and the subdivision of hazardous areas into zones. It is necessary for any facility where flammable products are produced, processed or stored.

The objective of area classification is to reduce, to an acceptable level the probability of the coincidence of a flammable atmosphere and any source of ignition. In particular it provides a basis for the correct selection and location of electrical equipment.

Hazardous areas are sub-divided into three zones:

- a) Zone 0: in which a flammable atmosphere is continuously present or is present for long periods
- b) Zone 1: in which a flammable atmosphere is likely to occur during normal operations
- c) Zone 2: in which a flammable atmosphere is not likely to occur during normal operations and, if it does occur, will only exist for a short period

Note: 1. Any area not classified as Zone 0, 1 or 2 may be regarded as a Safe Area.
2. Refer IEC 60079-10 and DSEAR 2002 for zones classification.

2.4 GUIDANCE ON ZONE CLASSIFICATION

The foregoing provides the basic rules for flammability hazard identification and zone classification. However specific zone classification and the associated rules for determining the extent of a given zone within an enclosed area is complex.

They depend on:

- a) the frequency and duration of the actual or potential source of release of flammable vapours
- b) the rate and type of release
- c) the characteristics of the flammable substance
- d) the design of the building
- e) the degree and adequacy of the ventilation available

There is therefore a need for some general practical guidance and it is recommended that:

- a) well ventilated buildings used for the storage of packed flammable substances, i.e. Class 0, I or II (2) should be classified as **Zone 2**
- b) poorly ventilated buildings used for the storage of packed flammable substances, i.e. Class 0, I, or II (2) should be classified as **Zone 1**
- c) all buildings used for the storage of packed flammable substances, i.e. Class II (1), III or Unclassified may be classified as a **Safe Area**.

Note: Where a warehousing operation is integrated with plant formulation facilities it may need to be classified as a Zone 1 area.

2.5 SAFE HANDLING, STORAGE AND WASTE DISPOSAL OF CHEMICALS

Please refer PTS 60.1502 and PTS 60.2112 for guidelines on safe handling, storage and waste disposal of chemicals.

Refer PTS 60.3005 for waste management of chemicals.

3.0 LOCATION

When planning a new warehouse the following factors should be considered:

- a) stock levels and degree of product hazard
- b) proximity to houses, offices, factories, schools, hospitals etc
- c) proximity to combustible vegetation
- d) prevailing winds
- e) proximity to water courses, e.g. rivers, lakes, wells or the sea particularly where the water course is used as a potable water source close to or downstream of the warehouse for fishing as a food source, regardless of scale for recreational purposes
- f) liability of the site to flooding

It is difficult to quantify these points. However a site that is expected to carry large stocks of hazardous products, which is close to houses, water courses and vegetation, and is prone to flooding and where the prevailing winds are such that in the event of fire they increase the danger to local inhabitants, would obviously be extremely unfavourable.

THE SUITABILITY OF THE LOCATION OF EXISTING WAREHOUSES SHOULD BE RE-CONSIDERED IN THE LIGHT OF THESE POINTS.

4.0 DESIGN AND CONSTRUCTION

4.1 GENERAL

Warehouses should be substantially closed in and be capable of being locked.

4.2 FRAME

The frame of the building should be of concrete or steel. A steel frame should preferably be fire proofed.

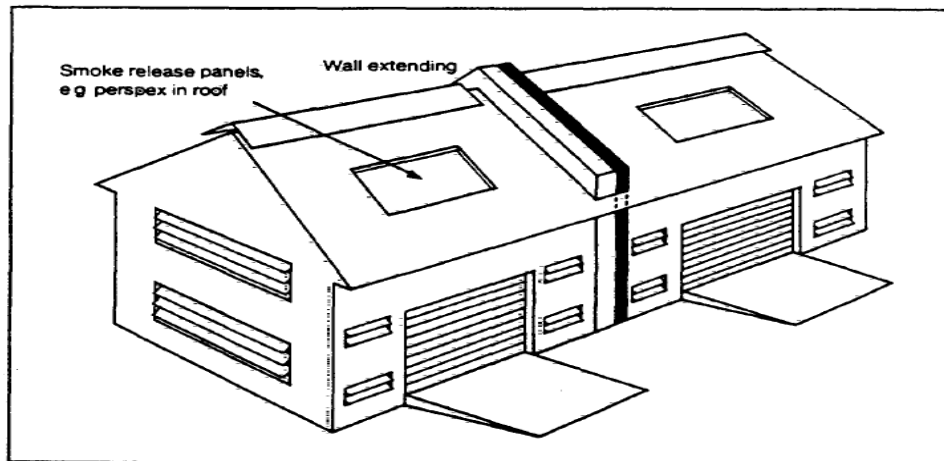
4.3 EXTERNAL WALLS

External walls should be non-combustible. Where adjacent premises or facilities must be protected from the transmission of fire, external walls must be constructed of solid brick (minimum 230 mm thick) or concrete blocks (minimum 150 mm thick). Where there is no such requirement external walls may be clad with steel or similar sheeting (but not aluminium).

4.4 FIRE SEPARATION WALLS

Fire separation walls between various warehouse sections should be constructed in accordance with DIN 4102, Class F 90, i.e. they should have a minimum fire resistance of 90 minutes. Moreover in order to prevent the spread of fire to other sections via the roof sheeting, such separation walls should extend beyond the roof sheeting to a minimum height of 50 cm (Figure 1).

Figure 1: Fire separation wall extending through roof



4.5 FLOORS

The floors shall be of reinforced concrete with sufficient load bearing capacity to withstand the weight of the stock, racking and any mechanical handling equipment to be used. Surface of floors shall be finished with approved floor hardener and chemical resistance lining, and shall be impervious to liquids in both directions (ie from top to bottom and vice versa). Floors shall be constructed free of cracks and with appropriate gradient to facilitate cleaning. Possible ingress of underground water shall be eliminated by providing adequate measures to control buoyancy due to high level of underground water. Floor areas shall also be free of open drains to outside surface water drainage or sewerage systems.

4.6 ROOF

The roof should be of pitched design. It should be designed to allow for the release of smoke and heat in case of fire. Hence construction materials need have no special fire resistance but highly combustible materials (such as wood) which might increase the risk of fire spread should be avoided. Indeed a roof constructed of concrete or other fire resistant material presents a danger of heavy smoke build-up in the event of fire and in such cases smoke relief panels should be inserted in the roof.

4.7 EMERGENCY EXITS

Emergency exits other than those afforded by the main doors should be provided. In planning these, considerable thought should be given to all conceivable emergencies, the prime requirement being that nobody should be trapped in the warehouse.

Emergency exits should be clearly marked and of such a design that, consistent with security, they provide easy exit in case of emergency.

They should be easy to open in the dark or in dense smoke and preferably be provided with panic bars.

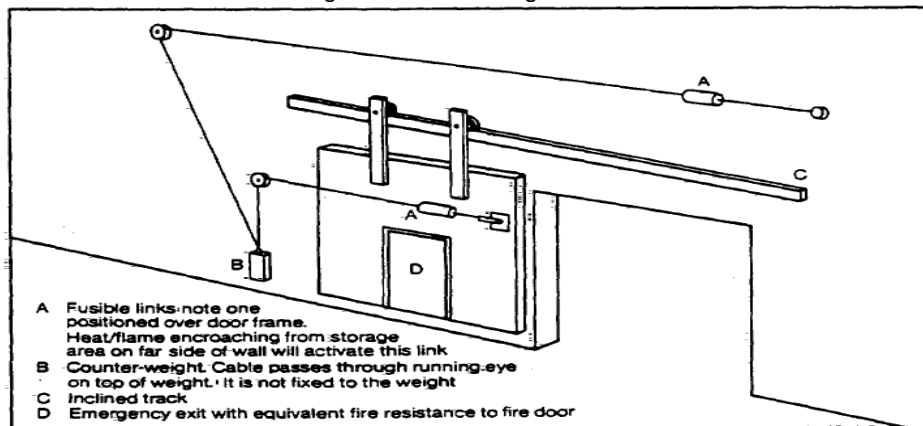
Escape should be possible from any enclosed area in at least two directions.

4.8 FIRE DOORS

All openings in fire separation walls should be fitted with self closing fire doors constructed in accordance with DIN 4102 Class T 90, i.e. with a minimum fire resistance of 90 minutes.

Doors in fire separation walls provided for fork lift truck access should be fitted with a fusible link or a link activated by the automatic fire detection system to ensure automatic closure in the event of a fire. The space required for closure should be kept free from obstruction (Figure 2).

Figure 2: Self-closing fire door



4.9 OTHER ACCOMODATION

As far as is practicable there should be no offices, mess rooms or changing rooms built as an integral part of the warehouse. Where there are such facilities within a warehouse holding flammable chemicals they should be separated from the warehouse by fire walls and self closing fire doors both with a minimum fire resistance of 90 minutes (i.e. to DIN 4102 Class F 90 and Class T 90 respectively).