

# PETRONAS TECHNICAL STANDARDS

## DESIGN AND ENGINEERING PRACTICE

### MANUAL

## MECHANICAL MAINTENANCE EQUIPMENT, TOOLS AND BOLT TENSIONING

PTS 70.08.10.11

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|------------|-------------------------------------------------------------|
| PTS No:    | 70.08.10.11                                                 |
| PTS Title: | Mechanical Maintenance Equipment, Tools and Bolt Tensioning |

This revision of PTS **70.08.10.11 – Mechanical Maintenance Equipment, Tools and Bolt Tensioning** 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 **70.08.10.11 (December 1998)** will be removed from PTS binder / e-repository from herein onwards.

**Document Approval**

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**Revision History**

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## 1. INTRODUCTION

### 1.1 GENERAL

This PTS specifies requirements and gives recommendations for the selection of equipment and tools to cover a normal range of mechanical maintenance work on new and existing oil refineries, chemical plants and gas plants.

This PTS is a revision of the PTS of the same number dated December 1998; 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 PTS is confined to PETRONAS companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This PTS is intended for use in oil refineries, chemical plants and gas plants.

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. Based on the potential impact on design, construction and maintenance costs, the Principal may decide to consult with the Authorities concerned with the object of obtaining agreement to follow this PTS as closely as possible.

### 1.3 DEFINITIONS

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction and 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 that manufactures or supplies equipment and services to perform the duties specified by the Purchaser.

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 the Principal.

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. Other documents referenced by this PTS are listed in (7).

### 1.5 SUMMARY OF MAIN CHANGES

The following are the main changes since the last revision:

| Section    | Change                                                                                                                                                                                     |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Front Page | The title changed from "Equipment and Tools For Maintenance: Mechanical Maintenance Equipment, Tools and Bolt Tensioning" to "Mechanical Maintenance Equipment, Tools and Bolt Tensioning" |

|            |                                           |
|------------|-------------------------------------------|
| 6.2.12     | Vacuum truck use and hose selection added |
| Appendix 3 | Automotive service equipment added        |

## 2. GENERAL

This PTS is intended to assist in deciding on the optimum arrangement and layout of a workshop complex to suit its particular needs, and in furnishing the mechanical maintenance team with the necessary tools and equipment, both in the workshops and in the field.

This PTS is intended to cover the requirements for any size of refinery, plant or installation. The final arrangement of the workshops and the selection of equipment will depend on many factors, including the location and industrial environment around the site.

In selecting the numbers and types of machines, equipment and tools to be purchased, available specialised contracting services in the vicinity of the site shall be considered, in order to optimise their expected utilisation.

The Contractor shall develop a tool and equipment inventory and a workshop layout based on the requirements of the Principal, using this PTS for guidance only. The proposal shall then be presented to the Principal for approval.

All electrically-driven machine tools and hand tools shall be suitable for the local power supply standard of voltage and frequency, i.e. without additional transformers. Mobile diesel engine driven units shall have flame arrestors.

### 3. WORKSHOP AND SERVICE CENTRES

#### 3.1 GENERAL

If supporting services cannot be obtained locally, then each location should establish a workshop to deal with emergency repair, day-to-day maintenance and shutdown work. Irrespective of the ownership of the facility it is essential to establish that the necessary facilities are available for the expected workload.

For each location, a fit-for-purpose, well-designed and properly located workshop fulfils an important function for the maintenance organization. In many environments a number of maintenance activities are carried out more efficiently and safely in the workshop than in the field.

#### 3.2 CENTRALIZATION

The Principal shall decide what maintenance facilities should be available centrally or locally. The following guidelines are given to assist in this decision.

Generally, centralization of the engineering maintenance disciplines together in the main workshop provides for better utilisation of men, machines and tools.

For larger locations, the possibility of setting up satellite service centres and combining these with process centres should be assessed. Their closeness to the process centres allows good communication between operators and the plant maintenance crews.

For medium-sized locations, satellite tool caddies would be the better alternative. These should contain sufficient tools to allow the maintenance crews to carry out minor repairs on site, without having to bring back everything to the main workshop.

#### 3.3 LOCATION

The main workshop should be located at a safe distance from the plant in accordance with PTS 34.17.00.32. It should be closely linked with the material store and if possible combined with it under one roof. Inspection, rotating equipment and other advisory services should be in fairly close proximity. Access to the workshop from outside the plant, particularly for delivering materials, should be considered.

#### 3.4 SIZE AND LAYOUT

For medium-sized locations, a suggested size and layout of a centralized workshop complex with adjoining material warehouse is shown in Appendix 1, for guidance only.

In considering the size and layout of a workshop, the following points should be considered:

- the volume and nature of the maintenance work to be done at the workshop;
- easy movement of equipment into and out of the workshop;
- clear identification of IN and OUT bays;
- easy movement of equipment during repairs, e.g. movement between the machine shop and welding area;
- separation of the noise-making and "dirtier" activities from the others, e.g. pipe/plate handling, welding;
- accessibility to documentation. Drawings, spare parts and historical data, either in electronic and/or hard copy form, should be easily available;
- offices should be located to allow close supervision.

#### 3.5 MAIN ACTIVITIES

The main activities of the mechanical workshop can be divided into three sub-shops:

- machine shop;
- fabrication shop;
- millwright or overhaul shop.

In the machine shop, main activities include the following:

- 1) machining of pump casings, tube sheets, machining of gasket grooves, eccentric boring, line boring, facing, turning, etc.;
- 2) machining square, rectangular, facing, drilling, key way cutting, etc.;
- 3) turning, facing, different types of threading, shaft machining, casing boring, inside threading;
- 4) balancing of rotors.

In the fabrication shop, main activities include the following:

- 1) pipeline welding and inspection;
- 2) structural fabrication;
- 3) retubing or renewal of heat exchangers, repair of exchanger shells, tube sheet repairs, etc.;
- 4) repair of machine components, rebuilding, etc.;
- 5) plasma arc cutting;
- 6) arc air gouging;
- 7) various gas welding, brazing, etc.;
- 8) limited sheet metal work
- 9) hard facing.

In the millwright shop, main activities include the following:

- 1) repair and overhaul of all kinds of pumps, mixers, valves and other equipment;
- 2) repair/testing/reconditioning of mechanical seals;
- 3) repair/reconditioning and testing of various types of safety relief valves.

### 3.6 MAIN FACILITIES

Apart from the workshop equipment suggested in later sections, each main workshop should have the following facilities:

- two electrically operated overhead cranes with a capacity of 10 t each should be provided for the mechanical and electrical workshops. A separate pneumatically or electrically operated overhead crane with a capacity of 5 t can serve the welding area. Refer to PTS 34.17.00.32 for crane load design;
- relief valve testing shall be done in an enclosed area to be provided with pneumatic or electrically operated lifting facilities of which the runway beam shall be extended into the mechanical workshop;
- water and tool air shall be available as ring mains throughout the workshop building;
- steaming facilities to be provided;
- proper drainage systems to be included;
- social amenities shall be included;
- offices inside the workshop shall be restricted to direct supervisory personnel, and the necessary documentation and data communication/computer terminals;

- extension of the documentation room to include sufficient space for training, particularly of the interactive self-teaching type, should be considered.

### 3.7 MAINTENANCE EQUIPMENT AND TOOLS

Based on practical experience gained in several production facilities, a selection of types and sizes of workshop equipment is proposed to cover a normal range of maintenance work.

Before any machinery, equipment or tools are procured, their expected utilisation should be considered in relation to local contractor services and outsourcing possibilities. Because of changing technology, the type, number and sizes of installed equipment, as well as available specialised services, should be occasionally reviewed.

After the type and size of equipment or tool has been selected, only the best available for the purpose, in terms of quality and cost, shall be purchased. Service and spare parts availability in the location shall also be investigated.

Though this PTS sectionalizes the maintenance equipment and tools into workshop and field, the actual split shall be decided at each location. Several equipment items and tools can be employed both in the field and in the workshop. In many cases, for centralization purposes, storage and custody can be better administered by a central workshop tool store.

## 4. WORKSHOP EQUIPMENT AND TOOLS

### 4.1 WORKSHOP MACHINES

Workshop machinery should be inspected by a specialised inspection agency at the Manufacturer's works and after installation (some of these agencies also provide services in the evaluation of quotations when a company specialist is not available).

The suggested selection of lathes is based on the experience that the majority of the machine work can be accommodated by a lathe with a centre distance of 500 mm. A second lathe with a centre distance of approximately 1 000 mm could be selected to accommodate the maximum diameter expected. To accept impellers complete with long shafts and allow the impeller to swing over the bed, a very large lathe of heavy construction would be required. Although, for accuracy reasons, as many surfaces as possible should be machined during one clamping operation, a lathe with considerably smaller centre distance may be employed if the workpiece is turned around in the lathe after machining from one side has been completed.

Computer operated numeric control lathes or milling machines should be considered, as these enhancements are of only marginal incremental cost (10 percent). However, the point to consider is whether operators are familiar with or can be trained in using the new machine.

A balancing machine should be acquired, but the actual size of the machine to be installed depends on the size and equipment envisaged to be balanced. The balancing of high-speed rotors and/or large compressors and turbines should normally be left to an outside agency or, if required, the Manufacturer.

All machinery should be delivered with six sets of complete instruction manuals, spare parts documents, wiring diagrams, hydraulic system schemes, etc. to enable trouble-shooting at site.

The list of suggested workshop machines is given in (4.3) and specifications are given in Appendix 2.

### 4.2 WELDING EQUIPMENT

For welding activities and handling of cylinders, reference shall be made to "Recommendations for Safety in Welding and Cutting", published by the HSE Committee.

### 4.3 LIST OF WORKSHOP EQUIPMENT SUGGESTED FOR A MEDIUM SIZE SITE

(For a description of the equipment see Appendix 2)

- |         |                                                                                                                                  |
|---------|----------------------------------------------------------------------------------------------------------------------------------|
| Item 1  | Lathe, universal, centre distance approximately 500 mm                                                                           |
| Item 2  | Lathe, universal, centre distance approximately 1 000 mm                                                                         |
| Item 3  | Lathe, Medium duty, centre distance approximately 2 000 mm but less than 3 000mm.                                                |
| Item 4  | Milling machine, universal, horizontal, table size 1 000 mm x 250 mm<br>Milling machine, universal, table size 1 000 mm x 300 mm |
| Item 5  | Milling machine, universal, table size 350 mm x 250 mm                                                                           |
| Item 6  | Shaping machine, medium-duty, nominal stroke 450 mm                                                                              |
| Item 7  | Slotting machine, stroke approximately 160 mm                                                                                    |
| Item 8  | Radial drilling machine, 40 mm and 75 mm                                                                                         |
| Item 9  | Drilling machine, pedestal type, 32 mm (2 pcs)                                                                                   |
| Item 10 | Drilling machine, bench type, 13 mm (2 pcs)                                                                                      |
| Item 11 | Balancing machine (optional)                                                                                                     |
| Item 12 | Horizontal and vertical Boring machines (optional)                                                                               |
| Item 13 | Lapping machine                                                                                                                  |

|         |                                                                                        |
|---------|----------------------------------------------------------------------------------------|
| Item 14 | Test bench for safety and relief valves                                                |
| Item 15 | Hydraulic press, 100 t                                                                 |
| Item 16 | Surface table, 1 800 mm x 1 200 mm, complete with accessories                          |
| Item 17 | Thread cutting machine (2 types)                                                       |
| Item 18 | Metal cleaning cabinet                                                                 |
| Item 19 | Cleaning table (optional)                                                              |
| Item 20 | Grit blasting cabinet (optional)                                                       |
| Item 21 | Hot air oven                                                                           |
| Item 22 | Induction heating apparatus                                                            |
| Item 23 | Hack-sawing machine                                                                    |
| Item 24 | Band-sawing machine - medium duty (vertical and horizontal)                            |
| Item 25 | Pipe-bender, hydraulic, hand-operated or electric                                      |
| Item 26 | Plate-bending machine (optional)                                                       |
| Item 27 | Plate-shearing machine (optional)                                                      |
| Item 28 | Surface and cylindrical Grinding machines, bench type, wheels 150 mm dia.              |
| Item 29 | Surface and cylindrical Grinding machines, pedestal type, wheels 200 mm or 300 mm dia. |
| Item 30 | Gasket cutter                                                                          |
| Item 31 | Hydraulic test pump (2 pcs)                                                            |
| Item 32 | 3 transformers or rectifiers for stick welding and TIG welding                         |
| Item 33 | Rectifier with constant potential for gas metal arc welding                            |
| Item 34 | Mobile diesel-powered AC/DC welding generator                                          |
| Item 35 | Electrode cabinet (2 pcs)                                                              |
| Item 36 | Cylinder manifold for oxygen and gas                                                   |
| Item 37 | Plasma cutting machine (optional)                                                      |
| Item 38 | Fuel gas welding and cutting set                                                       |
| Item 39 | Pipe cutting and bevelling machine                                                     |
| Item 40 | Plate cutting machine, mobile (optional)                                               |
| Item 41 | Fume extraction unit, mobile (optional)                                                |
| Item 42 | Preheat and post-weld heat treatment equipment (optional)                              |
| Item 43 | Work benches                                                                           |
| Item 44 | Tool cabinets                                                                          |
| Item 45 | Bench vice                                                                             |
| Item 46 | Pipe vice                                                                              |
| Item 47 | Branch drilling machine (e.g. for "hot tapping")                                       |
| Item 48 | High-pressure cleaning equipment                                                       |
| Item 49 | Oxygen/acetylene carriage                                                              |
| Item 50 | Pipe cutter and beveller, portable                                                     |
| Item 51 | Air compressor                                                                         |
| Item 52 | Sump pump                                                                              |
| Item 53 | Rotary grinder for valves                                                              |
| Item 54 | Heat exchanger tube end puller                                                         |
| Item 55 | Tube expanding equipment                                                               |
| Item 56 | Portable in-situ flange facing machine (internally and externally mounted)             |
| Item 57 | Portable in-situ milling machine                                                       |
| Item 58 | Tool, drill and cutter grinding machines                                               |
| Item 59 | Profile cutting machine (for fabrication works)                                        |

- Item 60      Plate rolling machine
- Item 61      Bolt-tensioning equipment (optional); see Appendix 4

## **5. FIELD TOOLS AND EQUIPMENT**

### **5.1 GENERAL**

The requirements for field tools and equipment differ even more than for workshops. The type, sizes, and quantities needed at each location should be determined by the maintenance staff at each location.

A suggested list of field tools and equipment has been given in Appendix 3.