

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

TELECOMMUNICATION TOWERS AND GUYED MASTS

PTS 32.71.00.14

FEBRUARY 2011



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This revision of PTS **32.71.00.14 – Telecommunications Towers and Guyed Masts (February 2011)** 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 **32.71.00.14 (July 1996)** will be removed from PTS binder / e-repository from herein onwards.

Document Approval

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Revision History

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SUMMARY OF CHANGES

Section	Description of Changes
2. Types Of Structure	Add : "or combination of both elements."
2. Types Of Structure	Add : "A self supporting towers is tall structure which generally consists of free standing basement, concrete or lattice steel A guyed mast is a tall structure that receives support from guy lines. Guyed masts are generally lighter and less costly than self-supporting towers. Guyed masts are frequently used for radio masts either by supporting aerials (for VHF and UHF) on the top or by using the entire structure as an antenna (for VLF, LF, MF, HF). They can also be sued to support all types of wire aerials (for VLF, LF, MF and HF). In latter cases, the entire structure often needs to be insulated against ground. In the case of a mast radiator or radiating tower, the whole mast or tower is itself the transmitting antenna."
2. Types Of Structure	Add : "There are also other types of antenna supports and structures like:- • Poles • Buildings • Disguised cell-sites • Mast radiators • Telescopic, pump-up and tilt over towers"

3. Design Standards and Features	Add : “Below are some of the Telecommunication towers and guyed masts design features, regards with economic and aesthetic considerations:- • A guyed mast is cheaper to build than a self supporting tower of equal height • A guyed mast needs additional land to accommodate the guys and is thus best suited to rural locations where land is relatively cheap. An un-guyed tower will fit into a much smaller plot • A steel lattice tower is cheaper to build than a concrete tower of equal height • Two small towers may be less intrusive, visually than one big one especially if they look identical • Towers look less ugly if they and the antennas mounted on them appear symmetrical • Additional requirement as part of the safety is installing the lightning arrestor. The lightning arrestor is to provide protection to the tower especially antennas or any active components installed to the tower from severe and catastrophic damages. • Masts for HF/shortwave antennas • Access for riggers • Aircraft warning features • Wind –induced oscillations • Hazard to birds”
4.2 Wind Loads	Add : “The wind load on a tower or mast is the combined effect of the wind pressure on its structural components and on the antennas which it supports. The design escalates the wind load from 10 meters above ground to the top of the structure.”
4.5 Types of Construction	Add : The fundamental of the tower and guyed mast design are considering such factors:- • Environmental effects of the tower design – wind flows and ice build up • Material and labor requirements • Air flow dynamics”
7. Hazard Warning	Add : Additional requirement as part of the safety is installing the lightning arrestor. The lightning arrestor is to provide protection to the tower especially antennas or any active components installed to the tower from severe and catastrophic damages.
8. Procurement	Add : Supports in term of technical, service and maintenance might required and to be spell out inside the procurement document package. This is to ensure continuous support and quality assurance from the contractors.

PREFACE

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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.

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1. INTRODUCTION

1.1 SCOPE

This PTS gives guidance on minimum requirements for onshore and offshore towers and guyed masts used for telecommunications systems.

Towers or guyed masts normally form part of a total telecommunications network. Hence this PTS should be read in conjunction with PTS 32.71.00.10, PTS 32.71.00.11, PTS 32.71.00.12 and PTS 32.71.00.13.

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 PETROANS Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them.

This PTS is intended for use in oil and gas facilities and in other areas associated with these activities.

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 shall 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 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 shall 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.

1.3.2 Specific definitions

The word **structure** indicates either a guyed mast or a self-supporting tower.

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 (12).

2. TYPES OF STRUCTURE

Structures are used to raise antennas to the necessary height to provide reliable radio communication, radar, and marine navigation services. The structures may be either self-supporting towers or guyed masts or *combination of both elements*. Within each category there are various types, dependent upon the end use, e.g.:

- a) Fixed;
- b) Transportable;
- c) Rapid raise for emergencies;
- d) Temporary.

A self supporting towers is tall structure which generally consists of free standing basement, concrete or lattice steel

A guyed mast is a tall structure that receives support from guy lines. Guyed masts are generally lighter and less costly than self-supporting towers. Guyed masts are frequently used for radio masts either by supporting aerials (for VHF and UHF) on the top or by using the entire structure as an antenna (for VLF, LF, MF, HF). They can also be used to support all types of wire aerials (for VLF, LF, MF and HF). In latter cases, the entire structure often needs to be insulated against ground. In the case of a mast radiator or radiating tower, the whole mast or tower is itself the transmitting antenna.

A guyed mast usually requires a large area of ground (as a guide: some 80% of the square of its height) to accommodate the guy wires and anchors. In urban areas the cost of the land may outweigh savings on the structure. Another disadvantage of guyed masts is the risk of vehicles or cranes damaging the guy wires or anchors. This is particularly relevant in industrial sites or in areas where plant and equipment are being transported.

There are also other types of antenna supports and structures like:-

- *Poles*
- *Buildings*
- *Disguised cell-sites*
- *Mast radiators*
- *Telescopic, pump-up and tilt over towers*

3. DESIGN STANDARDS AND FEATURES

The design standards which shall be used are ANSI/EIA/TIA-222-E 1991 or BS 5950, Part 1, 1990. The wind load shall be determined in accordance with BS 8100, or Code of Practice 3, Ch. V, Part 2 - 1972, depending on the type of structure. The choice of standard may be dependent upon local regulations, geographic location and the availability of suppliers in the area.

There are other factors involved in calculating the loads on structures which are dependent on the geometry of the structure and other considerations but generally the use of the American Standard will result in a slightly lighter structure than one built to the British Standard. The Contractor shall state in his tender submission which design standards he intends to use and the estimated weight of the structural steel to be supplied.

All elements of the structure shall be hot dip galvanised in accordance with BS 729 or ASTM A 123 or ISO 1459.

The cost of a tower or mast is approximately proportional to the square of the height. Hence the lowest height shall be selected consistent with achieving the radio link objectives. The cost of an offshore tower also depends on the installation method. A tower concept shall be selected which requires minimum offshore resources during installation and construction.

Below are some of the Telecommunication towers and guyed masts design features, regards with economic and aesthetic considerations:-

- *A guyed mast is cheaper to build than a self supporting tower of equal height*
- *A guyed mast needs additional land to accommodate the guys guy wires and is thus best suited to rural locations where land is relatively cheap. An un-guyed tower will fit into a much smaller plot*
- *A steel lattice tower is cheaper to build than a concrete tower of equal height*
- *Two small towers may be less intrusive, visually than one big one especially if they look identical*
- *Towers look less ugly if they and the antennas mounted on them appear symmetrical*
- *Additional requirement as part of the safety is installing the lightning arrestor. The lightning arrestor is to provide protection to the tower especially antennas or any active components installed to the tower from severe and catastrophic damages.*
- *Masts for HF/shortwave antennas*
- *Access for riggers*
- *Aircraft warning features*
- *Wind –induced oscillations*
- *Hazard to birds*

Other technical equipment such as:

- Telecommunications equipment shelters,
- Surveillance cameras, and
- Security lighting should not be installed on the structure.

However, if this is unavoidable, special attention shall be given to ensuring safe access to such equipment. Specifically this requires:

- An adequate working platform
- A means of equipment removal and replacement, taking account of the weight.

4. DESIGN CONSIDERATIONS

4.1 WINDSPEED

Since the wind force on a structure depends on the square of the wind speed, the specification of wind speed is critical in determining the weight, rigidity, and cost of a mast or tower. Every effort should be made to specify the realistic maximum wind speed for the location based on a 3 second gust value. In some countries national or regional building codes may specify design wind speed and conditions.

There are two wind speeds which are important for the design: the maximum wind speed in which twist and sway shall be maintained within the specified limits; and the survival wind speed in which the twist and sway specification shall be temporarily exceeded during extreme gusts but the structure shall return to normal afterwards. These correspond to the 10 and 50 year maximums, respectively.

In both the American and British Standards, the design wind load is based on the 50 year return wind speed for the site. The value is the highest wind speed 10 m above grade for open, level country. However, this value shall be modified by the following variables to make allowance for specific site conditions:

- a) An allowance for wind direction, topography and vegetation;
- b) A structure height factor;
- c) A gust response factor;
- d) A drag factor that is a function of the shape of the members and the solidity ratio of the basic structure.

For offshore towers, a 100 year maximum wind speed may be used to be consistent with the design of the main structure or complex.

4.2 WIND LOADS

The wind load on a tower or mast is the combined effect of the wind pressure on its structural components and on the antennas which it supports. The design escalates the wind load from 10 meters above ground to the top of the structure.

Antenna manufacturers will normally indicate the wind load for their products at an indicated wind speed. A grid has approximately 65 to 70% less exposed area than a solid dish of the same diameter whilst a radome fitted to a solid dish improves the dynamic wind flow and hence reduces wind pressure. The Supplier is responsible for combining the total load and for any recalculation of the antenna load at the specified wind speed for the structure.

4.3 TWIST AND SWAY

All structures move in the wind to some extent. The directivity of the antennas shall determine the allowable twist and sway. In the absence of specific requirements it is normal to limit these values to 0.5 degrees which should give adequate performance of most radio systems under extreme wind conditions. In the case of offshore towers, the twist and sway is also affected by the platform or substructure and this shall be allowed for in the specification.

Twisting of guyed masts can be reduced by using spreader bars or anti-torque devices between the mast structure and the upper end of the guy wires.

4.4 SAFETY FACTOR

The normal safety factor for a new structure should be 1.7. Structures which have been in use for some time may be loaded so that the safety factor has been reduced. Structures with a safety factor lower than 1.4 should be examined in more detail.