

## PRACTITIONER GUIDE

### Masts and Towers - Design and Appraisal

Number: PG 09/08

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Who Should Read this: All Top Level Budget Holders, Requirements Managers, Defence Estates Managers, Project Managers, Industry Suppliers and others with responsibility for defence projects and facility management services involving existing or new masts and towers.

When it takes effect: Immediately

When it is due to expire: 28 November 2013

This policy has been Equality and Diversity Impact Assessed in accordance with the Department's Equality and Diversity Impact Assessment Tool against:

**Part 1 Assessment Only (no diversity impact found).**

Document Aim:

The aim of this Practitioner Guide (PG) is to inform stakeholders, involved in the procurement and whole life management of masts and towers on the defence estate, on the minimum standards acceptable for the design and appraisal of mast and tower structures to ensure MOD meets its Statutory duties under the Health and Safety at Work etc Act.

**Key point to note:**

- **This Practitioner Guide updates and supersedes Technical Bulletin 00/07 ‘Design, appraisal and certification of masts and towers’.**

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## 1.0 Introduction

- 1.1 The contents of this Practitioner Guide (PG) are mandatory. No work involving expenditure on any Ministry of Defence (MOD) account is to be entered into without authority from the appropriate MOD officer for that location or facility.
- 1.2 Compliance with this PG is required to meet MOD's Statutory duties under the Health and Safety at Work etc Act and also the Management of Health and Safety at Work Regulations and The Work at Height Regulations.
- 1.3 This PG is to be brought to the attention of all Top Level Budget Holders, Requirements Manager Defence Estates Managers, Project Managers, Industry Suppliers and others with responsibility for Defence projects and facility management services involving existing or new masts and towers.
- 1.4 For MOD establishments occupied by the United States Visiting Forces (USVF), the responsibilities of works and facilities management services are jointly held by the USVF and DE Operations International USF Division. At base level this jointly managed organisation is to take appropriate action to implement the contents of this PG. Where this PG contains procedures which differ significantly from USVF practice, a DE Operations International USF Division 'Code of Practice' section is to be issued.
- 1.5 This PG provides guidance on the procedures to be adopted for the design of new masts, towers and other similar slender wind sensitive structures, including the appraisal of existing structures on the defence estate. Both '**design**' and '**appraisal**' are referred to in this PG as a **Professional Appraisal (PA)**. The process starts with the selection of Competent Persons to be engaged in undertaking a PA; it covers the checking of the structure prior to handover and acceptance onto the estate, and it continues with the management of the structure during its full life through to demolition. The objective is to ensure that MOD obtains best value for money from its mast and tower estate and complies with its various Statutory duties.
- 1.6 Minimum standards to be followed for condition inspections of masts and towers are provided in PG 10/08 'Masts and Towers – Condition Inspection'.
- 1.7 The objective of the Professional Appraisal (PA) is to verify whether the structure has adequate capacity against the applied loads and that the fixed access systems and platforms are fit for purpose.
- 1.8 The deliverables of the PA are to provide documentation and certification of the PA process (i.e. Forms R12, R13 and R14), ensuring compliance with Statutory duties.

## 2.0 Scope

- 2.1 The procedures outlined in this PG have been developed for masts and towers and other wind sensitive structures (see 2.3), typically used for supporting communication equipment, radar, CCTV, floodlighting and other ancillary equipment.
- 2.2 The procedures may be adopted for other structures not normally intended to be covered by this PG (see 2.4). However inclusion is to be subject to a risk assessment and consultation with the equipment sponsor/user, where appropriate. Further guidance may be sought from the Subject Contact Point.

2.3 'Wind sensitive structures' to be included in the scope of this PG are:

- a) Masts and towers greater than 6m in height (or less if of 'strategic importance');
- b) Lattice structures incorporating ladders or platforms requiring persons to work at height;
- c) Concrete or masonry towers/structures incorporating ladders or platforms requiring persons to work at height;
- d) Any other type of climbable structure, e.g. a pole or column incorporating an access system;
- e) Major poles, columns and flagpoles (i.e. greater than 6m in height and with or without guys);
- f) lowerable structures, including those with built-in lowering mechanisms (typically 'not climbable');
- g) Any 'wind sensitive structure' (of any height) that is adjacent to public areas such as roads, railways, footpaths or buildings (adjacent is defined as being within a distance less than one and a half times their height);
- h) Any other wind sensitive structure deemed appropriate or as identified by a Competent Person.

2.4 'Wind sensitive structures' which are not normally covered by this PG are:

- a) Concrete and masonry towers or other structures, with staircase access, which do not involve persons having to work at height;
- b) Street lighting structures;
- c) Minor poles, columns and flagpoles (i.e. less than 6m in height and with or without guys);
- d) Statues and masonry columns;
- e) Mobile mounted masts, towers or other mobile support structures;
- f) Operationally deployed tactical masts, towers or other temporary support structures that are deemed equipment and not fixed assets;
- g) Any other asset deemed not appropriate, or as excluded by a Competent Person.

### 3.0 Requirement

3.1 All new structures are to have the appropriate certification (Forms R12, R13 and R14) completed before erection. No new structures or structures subject to major modification or redesign are to be accepted onto the estate without these documents and a valid Form R8 Mast and Tower Condition Inspection Certificate (see PG 10/08). The Forms R12 and R13 should be completed by the appraiser and handed over, along with the Form R14 as part of the procurement process.

3.2 All existing structures are to have the appropriate certification (Forms R12, R13 and R14) prepared, where they do not already exist.

3.3 **Competent Person.** A PA is to be carried out by or under the guidance of Competent Persons. Only Competent Persons are able to sign Forms R13 and R14. A Competent Person is to:

- a) Be a Chartered Engineer (Corporate Member of the Institutions of Civil or Structural Engineers, registered with Engineering Council UK), and;
- b) Have a minimum of six years relevant experience in the appraisal and construction of the type and complexity of the structure involved.

These requirements are to be applied in all cases, except where prior agreement is reached with the Subject Contact Point.

3.4 **Certification.** A Professional Appraisal (PA) is to be undertaken, checked and certified by the completion of the following model forms:

- a) Form R12 - Professional Appraisal Information;
- b) Form R13 - Professional Appraisal Certificate;
- c) Form R14 - Professional Appraisal Check Certificate.

The forms are to be signed and dated by the appropriate Competent Person. The forms may not have an expiry date unless specifically noted by the Competent Person. The model forms are included at Annex A.

If copies or electronic versions of the forms are required, these may be obtained from the Subject Contact Point. This PG is available on the Defence Estates web site, found in the 'Publications' area at the following address:

[www.defence-estates.mod.uk](http://www.defence-estates.mod.uk)

The forms are integral to the MOD's safety procedures for working at height. They must be immediately recognised and therefore their format must not be altered in any way.

3.5 **Scope of Appraisal.** The PA is to cover all aspects of the structure, including any means of incorporated access systems. Full requirements are provided at Annex B.

3.6 **Frequency of Appraisal.** A PA is to be undertaken on the following occasions:

- a) New structures: as part of the procurement process and prior to erection;
- b) Existing structures:
  - i) Where sufficient PA records for a structure are not available;
  - ii) Prior to a proposed change of use of the structure (such as a new item of equipment);
  - iii) Following an incident in which significant damage or structural distress has been noted by a Competent Person;
  - iv) By referral following a Condition Inspection; see PG 10/08;
  - v) Where changes to design codes will result in increased loading or a reduced load capacity of the structure.

3.7 For existing structures where inadequate records are available, a programme is to be established for undertaking a PA.

3.8 **Frequency of Condition Inspection.** The appraiser is to recommend the frequency of Condition Inspections as defined in PG 10/08.

3.9 **Category of Check.** The appraiser may use original design calculations and design information for assessing the structural strength of a mast or tower and present results in the form of a Usage Factor as explained in Annex B, Para 10.

Where the original design calculations and design information are not available, these are to be prepared by the appraiser using available original drawings as appropriate.

Where original design calculations and design information, and the original drawings are not available, the appraiser is to produce sufficient drawings to allow preparation of design calculations and design information.

A flow diagram explaining the check category for each structure is included at Annex C. Further guidance is available from the Subject Contact Point.

#### 4.0 **References**

PG 10/08 Masts and Towers - Condition Inspection

TB 00/06 Fixed access ladder systems

TB 00/15 Safety of guy fittings - guidance on the use of helical rope grips

TB 00/16 Standard mast and tower nomenclature

TB 00/17 Safety of guy fittings - guidance on the inspection of swageless terminations

JSP375 Volume 3 Chapter 7 - Working at Height on Restricted High Places

JSP434 Defence Construction in the Built Environment

## Annex A – Model Forms

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- R12 Mast and Tower Professional Appraisal Information
- R13 Mast and Tower Professional Appraisal Certificate
- R14 Mast and Tower Professional Appraisal Check Certificate



**Structure information:**

Establishment name	
Type of structure	
Height in metres	
Structure reference number	
Location of structure	

**Structural information:**

Description (including guy and termination type where applicable)	
Relevant design standards	
Imposed loading (list equipment and ancillaries)	
Environmental conditions	
Performance parameters (e.g. guy tensions, design life etc)	
Fixed access description	
Geotechnical data	
Foundation type	

**Statement of principles and other relevant information:**





Structure reference number

**Sketch:**

**Certified by:**

Name of Appraisal Engineer	
Professional Qualification(s)	
Organisation (name and address)	
Signature	
Date	



**TO BE COMPLETED BEFORE ERECTION OR MODIFICATION OF STRUCTURE**

**Structure information:**

Structure reference number	
Establishment name	
Location of structure	
Type of structure and height (m)	

**Statement by Appraisal Engineer:**

Category of Check (tick relevant category) :    1        2        3   

I certify to the best of my knowledge and belief that the appraisal of this structure complies with all relevant statutory requirements, British Standards or Eurocode.

It is my opinion that the structure will, if constructed as appraised and maintained to the required standard, have adequate resistance to collapse and the capability to carry the design loading safely and within permissible deflection limits.

**List of calculations:**

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**List of drawings:**

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**Certified by:**

Name of Appraisal Engineer	
Professional Qualification(s)	
Organisation (name and address)	
Signature	
Date	



**TO BE COMPLETED BEFORE ERECTION OR MODIFICATION OF STRUCTURE**

**Structure information:**

Structure reference number	
Establishment name	
Location of structure	
Type of structure and height (m)	

**Statement by Check Engineer:**

Category of Check (tick relevant category) :    1        2        3   

I certify that I have examined the appraisal of this structure.  
 It is my opinion that the structure will, if constructed as appraised and maintained to the required standard, have adequate resistance to collapse and the capability to carry the design loading safely and within permissible deflection limits.

**List of calculations:**

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**List of drawings:**

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**Certified by:**

Name of Check Engineer	
Professional Qualification(s)	
Organisation (name and address)	
Signature	
Date	

# Annex B – Professional Appraisal Report

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1. If, within a Professional Appraisal (PA) report, reference is made to another report, then the appropriate section of that report may, if practicable, be reproduced within the PA report with the source acknowledged. Alternatively it is to be listed in Annex A of the PA report.
2. Identical structures on an establishment, which are subject to the same loading parameters, may be covered by a single report, although individual Forms R13 and R14 are to be completed for each structure.
3. The PA is to consider the following aspects:
  - a) the site;
  - b) the structure geometry, fabric and surface protection system;
  - c) the support guys and back stays, where relevant;
  - d) the foundations and all associated ground anchorage points;
  - e) the access system and fixed fall arrest equipment;
  - f) the raising and lowering mechanisms, where relevant;
  - g) the equipment supports and associated brackets, cabling supports and cable trays;
  - h) the lightning protection and aircraft warning light system;
  - i) compliance with a project specification (for new structures).
4. The contents of the report are to be set out as follows:
  - a) **Introduction** - including a general description of the location of the structure(s) and contact details of relevant parties;
  - b) **Inspection Summary** - details of inspection teams including names of Competent Persons, dates and equipment used. Details of structures inspected including the reference number, description, height, date of inspection and Form R8 expiry date;
  - c) **Structural Analysis** - sources of data, the basis of the applied loading, approach to analysis and definition of how the capacities of structural members and connections are expressed (see Para 10);
  - d) **Results of Analysis** - overall summary, in tabular format, of Usage Factors for the principal structural components, primary connections and foundations;
  - e) **Conclusions and Recommendations** - (for existing structures outline remedial works where required).
5. Annexes to the report are to include the following:
  - a) **References** - all source documents and codes used in the appraisal process;
  - b) **Appraisal Certification** - completed and signed Forms R12, R13 and R14;

- c) **Drawings** - copies of all existing drawings referred to (where practicable), in addition to the drawing produced in accordance with TB 00/16 Standard mast and tower nomenclature;
  - d) **Calculations** - indexed, numbered and signed in accordance with relevant checking procedures;
  - e) **Computer Output** - indexed, numbered and referenced to the relevant calculation sheets.
6. **Guyed Structures.** The recommended guy tensions, together with the method of site measurement, are to be specified as part of the PA process. If fitted, include inspection comments of swageless terminations with respect to TB 00/17 Safety of guy fittings - guidance on the inspection of swageless terminations.
7. **Access Systems.** The PA is to state what access system is provided, with reference to TB 00/06 Fixed access ladder systems. The appraisal is to also consider and comment on both the functionality and structural adequacy of the fixed access system.
8. **Use of Standards and Codes.** In design of new mast and tower structures and appraisal of existing, both the derivation of environmental loading conditions and the determination of structural response, are to be undertaken in accordance with British Standard BS 8100: Lattice Towers and Masts and in line with industry best practice. Where it is considered appropriate by an appraiser to use an alternative standard, prior agreement is to be reached with the Subject Contact Point. For other structure types where BS 8100 is not applicable, the appropriate design standards are to be adopted.

For structures located overseas, the appropriate national or international design standards are to apply, except where the structure is to be handed over (at any stage) to MOD and used by MOD personnel; in which case the structure is to also be verified against the requirements of the relevant British Standards and designed to comply with both.

9. **Client Specified Appraisal Criteria.** Eurocode 3 Part 3-1 (BS EN 1993-3-1) Design of Steel Towers and Masts is due for publication as the UK National Annex on 31 March 2009. Until BS8100 is formally superseded the following BS 8100 parameters are to be used unless prior approval is obtained from the Subject Contact Point:
- a) Unless directed otherwise, all design loading is to be based on a 50-year return period as specified in BS 8100: Parts 1 or 4 as appropriate. The primary meteorological parameters are to be established to suit the actual location of the structure.
  - b) With reference to BS 8100: Part 1: Section 2, the following minimum or maximum where their effects are beneficial, parameters are to be used for the completed structures:

i) Partial safety factor on wind speed and ice thickness	$\gamma_V = 1.25^*$
ii) Partial safety factor on dead load:	
where dead load effects increase wind load effects	$\gamma_{DL} = 1.10$
where dead load effects reduce wind load effects	$\gamma_{DL} = 0.90$
iii) Quality classification for new structures	Class A
iv) Partial safety factors on design strength for:	

mast column and tower members	$\gamma_m = 1.10$
guys and their fittings	$\gamma_m = 1.98$
ceramic insulators	$\gamma_m = 1.98$
antenna radials and associated rigging	$\gamma_m = 1.65$

\*BS 8100: Part 4: Section 5: Clause 5.1.1 requires all structures with a partial safety factor on wind speed and ice thickness ( $\gamma_v$ ) of more than 1.22 to be checked by dynamic response procedures. A dynamic response check is not required in normal circumstances due to the selection of a  $\gamma_v = 1.25$ , and need only be undertaken if the appraiser deems it necessary to comply with the overall fit for purpose requirement. Where, in the opinion of the appraiser the adoption of a lesser value of  $\gamma_v$  is considered reasonable (for say some non-strategic type structures in isolated locations), this is to be agreed in advance with the tower and equipment sponsor.

c) The strength assessment of structural components is to be undertaken in accordance with BS 8100: Part 3.

10. **Presentation of Calculation Results.** The results of all calculations are to be presented in the form of a Usage Factor for the principal structural components, primary connections and foundations, defined as follows:

$$\text{Usage Factor (UF)} = \frac{\text{Applied Loads}}{\text{Capacity}}$$

Applied loads and capacities are to be calculated using the appropriate design standards. Calculations are to address deflections, performance and, where appropriate, dynamic behaviour.

Calculations associated with the stability of the structure's foundations against overturning, sliding, uplift or bearing are to also be presented in terms of a Usage Factor. An appropriate factor of safety (as proposed by the appraiser and, if necessary, after consultation with the Subject Contact Point) is to be applied to the nominal capacity.

11. **Standard Design or 'Off-the-Shelf' Type Structures.** Similar structures are often installed at a number of different locations. A PA is to be carried out for each structure, ensuring that site-specific environmental, loading and local conditions have been addressed. Separate certification is to be produced for each structure. Some structures may be offered with verification based upon wind tunnel or other manufacturer prescribed tests appropriate for the proposed location of the structure. In such cases, full certification is still to be prepared for each structure, but a detailed safety case is to be prepared in lieu of design calculations.
12. **Availability of Information for Existing Structures.** Many existing structures on the defence estate do not have full information concerning the type and depth of foundations, ground conditions or structural component material properties. The Competent Person undertaking the PA is to make an assessment of the need to undertake site investigations such as trial pits or the testing of material samples. The main considerations that may be used in this assessment are as follows:
- a) during a site inspection, no indication of distress is apparent;
  - b) when structures have stood for a considerable time;

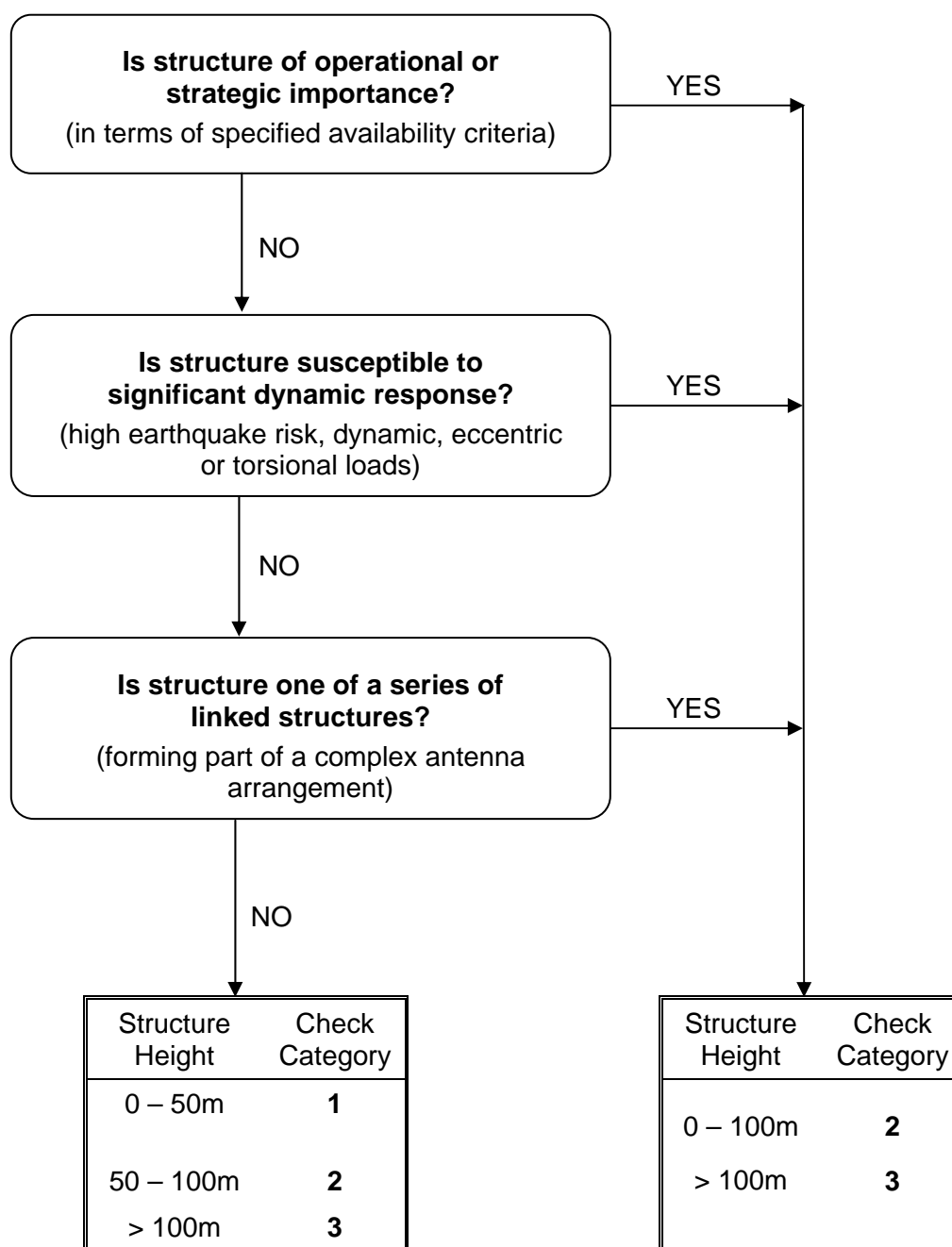
- c) when a conservative assumption of the foundation type, ground conditions and material properties indicates that structural stability, ground bearing and section capacities are within acceptable limits.

If the conditions outlined above are considered to apply, then the PA output will be Forms R13 and R14, and a statement in the report that the structure and foundation are considered adequate and that special attention is given to examining for any signs of distress during subsequent Condition Inspections.

If however, having made these assumptions, unacceptable Usage Factors are found to exist, then site excavation or material testing may be necessary. If the site investigation or test results indicate that the adequacy of the sub-strata or super-structure strength cannot be established, then outline remedial works are to be considered.

When the section capacities of the super-structure are within acceptable limits but a conservative assumption of the foundation type and ground conditions indicates that foundation stability or ground bearing capacities are not acceptable, then the PA output will be the appraiser's completed and signed Forms R13 and R14, clearly stating that the foundations have been excluded from the appraisal.

# Annex C – Professional Appraisal Check Categories



Category 1 Check	Category 2 Check	Category 3 Check
The PA is to be checked by a different Competent Person within the same organisation.	The PA is to be checked by a different Competent Person within a separate department of the same organisation or from within an independent organisation.	The PA is to be checked by a Competent Person within an independent organisation. Drawings only will be made available to the check engineer who is to prepare calculations as necessary.