HSE
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Self-elevating installations (jack up units)

OFFSHORE TECHNOLOGY REPORT

2001/051

Self-elevating installations (jack up units)

Edited under the HSE Technical Support Agreement by BOMEL Ltd
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HSE BOOKS

First published 2002

ISBN 0 7176 2517 6

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FOREWORD

This document provides technical information previously contained in the Fourth Edition of the Health and Safety Executive's *'Offshore Installations: Guidance on Design, Construction and Certification'* (1990 edition plus amendments)[(1)]. The 'Guidance' was originally published in support of the certification regime under SI289, the Offshore Installations (Construction and Survey) Regulations 1974[(2)]. However, SI289 was revoked by the Offshore Installations (Design and Construction, etc) Regulations, 1996, which also introduced the verification provisions into the Offshore Installations (Safety Case) Regulations, 1992. The 'Guidance' was formally withdrawn in its entirety on 30 June 1998 (see HSE OSD Operations Notice 27[(3)]).

The withdrawal of the 'Guidance' was not a reflection of the soundness (or otherwise) of the technical information it contained; some sections (or part of sections) of the 'Guidance' are currently referred to by the offshore industry. For this reason, after consultation with industry, relevant sections are now published as separate documents in the HSE Offshore Technology (OT) Report series.

It should be noted that the technical content of the 'Guidance' has not been updated as part of the re-formatting for OTO publication, although prescriptive requirements and reference to the former regulatory regime have been removed. **The user of this document must therefore assess the appropriateness and currency of the technical information for any specific application. Additionally, the user should be aware that published sections may cease to be applicable in time and should check with Operations Notice 27, which can be viewed at http://www.hse.gov.uk/hid/osd/notices/on_index.htm, for their current status.**

1. INTRODUCTION AND SCOPE

This Offshore Technology (OT) Report provides information on aspects of self-elevating Installations with movable legs capable of raising the hull above the surface of the sea.

The information is based on guidance previously contained in Section 33 of the Fourth Edition of the Health and Safety Executive's 'Offshore Installations: Guidance on Design, Construction and Certification'[(1)] which was withdrawn in 1998. As discussed in the Foreword, whilst the text has been re-formatted for Offshore Technology publication, the technical content has not been updated. The appropriateness and currency of the information contained in this document must therefore be assessed by the user for any specific application.

2. JACKING SYSTEM

Any jacking system should be capable of adequately lifting and supporting the Installation when it is in use. Consideration should be given to designing the jacking system to pre-load the foundation for the design conditions; the jack or jacks acting on any legs would need to be capable of applying a load equal to the maximum load for which the leg has been designed. For each leg, it is suggested that an indicator which will register the load on it at any time should be provided. Particular care should be taken in the detailing (e.g. points for the insertion or attachment of jacks) and choice of materials with a view to avoiding failure by fatigue or brittle fracture. A suitable means of de-icing would need to be incorporated, if considered necessary.

3. ELEVATING MECHANISM ATTACHMENTS

Where clearance between the legs and their housings allows a degree of relative movement between the legs and the platform, the arrangement of the leg/platform attachment would need to be based either on designs already proved satisfactory in service or justified by calculations that take full account of the effects, including inertia effects, of the lack of fixity at the attachment. It is suggested that the design should be such that modifications (e.g. the fitting of shims) are unnecessary to combat storm conditions.

4. LEGS

4.1 DESIGN CONDITIONS

It is suggested that legs should be capable of accommodating static and dynamic forces and movements resulting from the following circumstances:

a) Location moves.

   The legs need to be able to withstand the bending moment induced by rolling or pitching to 6^o single amplitude at the natural period of the unit, plus a suitable wind moment and 120 per cent of the gravity moment due to the angle of heel. Legs also need to be able to withstand the dynamic loads that may be caused by their unsupported length moving through the water. Design figures need to be supported by a model test or experience with similar units.

b) Lowering of legs to bottom.

   Legs need to be able to withstand the shock of touching bottom while the unit is afloat and subject to wave motions.

c) Legs with hull in elevated position.

   The legs need to be able to withstand the loads due to the most adverse conditions of loading, including any effects resulting from clearance between the legs and their housings or attachments.

4.2 MATERIAL SELECTION

High strength steels are commonly used for construction of the legs. Special consideration should be given to the greater susceptibility of such materials to cracking and enhanced fatigue rates due to hydrogen damage. These may occur in adverse circumstances resulting from:

- inappropriate welding procedures;
- excessive levels of cathodic protection;
- local presence of free H_2S.

Research has been carried out into these aspects but all potential sources of hydrogen should be monitored carefully. Some conclusions from research into hydrogen-assisted cracking in high strength steels immersed in seawater are given in OTO Report 2001 015. See also OTO Report 2001 011.

For new Installations, it is suggested that:

a) Materials should be selected having regard to their susceptibility to hydrogen embrittlement.

b) Individual batches of proposed materials for areas prone to hydrogen cracking, e.g. lower sections of the legs and spudcans, should be tested to ensure their resistance to hydrogen embrittlement at appropriate cathodic protection levels, which should take due account of the expected environment, e.g. anaerobic conditions and presence of H_2S.

c) Welding procedures, pre- and post-weld heat treatment (e.g. hydrogen release heat treatment or stress relieving) and NDT would need to take due account of potential delayed cracking problems. Final NDT should take place a sufficient time after welding to identify delayed cracking (typically 48 hours or more for high strength steels).

d) Assembly methods should be arranged so that stress and hardness levels in the heat affected zones of welds in high strength steel are kept to values shown to be acceptable in the tests described in b) above.

e) Quality Assurance programmes should take account of all of the above and include schedules for ensuring that specification details (e.g. the processing and heat treatment of high strength steels) are met.

5. RAW WATER TOWERS

It is suggested that raw water towers should be considered as primary structures and should be designed and constructed accordingly. Particular attention would need to be paid to fatigue.

6. SURVEYS (SELF-ELEVATING INSTALLATIONS)

6.1 GENERAL CONSIDERATIONS

It is suggested that consideration be given to the following points:

- General survey requirements should apply and, in particular, a review of in-service experience and trend analysis should be undertaken after each round of structural surveys.
- Requirements for future surveys should be defined, taking into account the findings of the first bullet point. Where appropriate, it is suggested that detailed NDT surveys of vulnerable areas on legs and within spudcans be undertaken at intervals not exceeding 2 years.
- There should be consideration of special surveys to check on weld repairs which have involved high strength material, particularly in the areas prone to hydrogen-cracking.
- Consideration should be given to special surveys of legs which have been submerged in mud or silt. To assist with these surveys the owner would need to maintain records which include the depth of penetration, the type of soil, the duration, the state of the CP system and any modifications made to it to accommodate the changed circumstances.

6.2 SPECIAL ISSUES FOR HYDROGEN EMBRITTLEMENT/CRACKING

It is suggested that consideration be given to the following points:

- For new Installations, tests should be undertaken to determine the susceptibility of the materials used to hydrogen embrittlement/cracking at the existing CP levels. (The simplest method available is slow strain rate testing). See also Section 4.2 second bullet point.
- Surveys of structures containing high strength steel (yield stress > 650MPa) in an enclosed construction, e.g. the spudcans, would need to include a methodical search for evidence of hydrogen assisted cracking. Survey schedules would need to be amended accordingly and surveyors be particularly aware of the problems associated with hydrogen-assisted cracking. Cracks in high strength material found during survey should be assessed before being removed/repaired. Unless the mechanism of cracking can be reliably established by other means, crack samples would need to be removed and be subjected to metallurgical investigation. Cracks should not be dismissed as arising due to previously undetected fabrication defects.
- CP surveys of vulnerable areas should be undertaken on a routine basis (annually is suggested as a minimum) to ensure that the levels are not such as to give rise to hydrogen embrittlement/cracking. CP systems should be modified as necessary to maintain close control of the CP voltage at all times, within the limits determined by the susceptibility of the steels in the structure.

The above should apply also when the jack-up unit is working alongside or over a fixed Installation to which it may be connected electrically, either directly or unintentionally.

Printed and published by the Health and Safety Executive
C0.50 06/02

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OTO 2001/051

£10.00

ISBN 0-7176-2517-6

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