Title	Structural Response to Seismic Events		
Publication Date	8/7/2019	**Document Identification**	Offshore Information Sheet 4/2019
Review Due	8/7/2022	**Internal Reference**	2019/195825
Target Audience	All stakeholders	**Document Owner**	HSE ED4.2
		Open Government Status	Fully Open

Introduction

This information sheet provides guidance on compliance with the law for controlling risks associated with seismic events. Duty holders should be able to demonstrate that fixed structures and compliant structures such as tension leg platforms (TLP) and articulated towers and their safety and environmental critical elements are sufficiently robust when subjected to foreseeable seismic events. Compliant offshore structures such as TLPs and articulated towers are not 'vertically compliant' and hence require seismic assessment due to vertical ground motion.

The related topics of Risk Assessment and Evacuation, and Escape and Rescue (EER) are covered by separate disciplines and are not included in this guidance.

Background

The United Kingdom Continental Shelf (UKCS) is in a low to moderate seismic region. However seismic response cannot be ignored for installations in the 'Southern' and 'Northern' North seas. The strongest known earthquake in the UK occurred in 1931 in the Dogger Bank. It had a magnitude of 6.1. Similar magnitudes of earthquakes have causes substantial damage and causalities. The 1992 Cairo earthquake of magnitude 5.8 completely destroyed around 350 buildings and killed 545 people.

Seismic events can cause rapid horizontal and vertical ground movement as well as liquefaction of ground, seaquakes and tsunamis. The risk of liquefaction can be considered to be low in UKCS. Seaquakes caused by p-waves propagating through water may not be significant for the floating installations in the UKCS.

Large tsunamis caused solely due to earthquakes can be considered as unlikely in the UKCS. However, they can be, and have in the past been, caused by submarine slides. Submarine slides themselves can be caused by even small earthquakes. This information sheet does not offer any advice on designing against tsunamis, and the risk due to tsunami on coastal populations can be considered to be substantially high.

In the UKCS the capacity of offshore installations have sometimes been justified by comparing the base shear due to seismic event with that due to wave loads, ignoring the

fact that part of the substructure or jacket near the top may experience seismic forces higher than those due to waves.

Legal requirements

The following regulations and associated guidance are relevant to vessel impact:

- Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996 (DCR), Regulation 4(1), 5(1)(a, b & e), 8(1). Relevant guidance L85 38(d) & 48
- Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995 (PFEER), Regulations 4(1), 5(1), 5 (2)(a – d), 9(1)(b). Relevant ACOP ang Guidance L65 42(a), 47, 49(a)(I, ii, v & vi)
- Management of Health and Safety at Work Regulations 1999 Regulation 3(1)
- Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 Regulation 16(1)(d)

Standards and guidance

- ISO 19900:2013 Offshore Structures - General requirements
- ISO 19901-2:2017 Petroleum and natural gas industries - Offshore Structures: Seismic design procedures and criteria
- ISO 19902:2007 Fixed Steel Offshore Structures
- ISO 19903:2006 Fixed Offshore Concrete Structures
- ISO 19905-1:2016 Site-specific assessment of mobile offshore units -- Part 1: Jack-ups

Complying with the legal requirements

The following paragraphs supplement the requirements given in the standards and guides quoted above.

1. Seismic Risk Category – In particular, all normally attended installations in the Southern North Sea and Northern North Sea should be designed or checked using Seismic Risk Category SRC 3. However, regional seismic hazard maps can be used in lieu of site-specific seismic assessments. Seismic Risk Category SRC 2 may be used for not normally unattended installations.
2. Mobile installations such as jack-up platforms should be checked for both extreme and abnormal levels of earthquakes appropriate to all the locations they are likely to be operating in.
3. Site specific response may be calculated using empirical relationships between other soil properties and dynamic shear modulus or shear wave velocities (see reference 6 below).
4. All unbraced parts of the jacket, module or deck support frames should be checked for seismic loads.
5. Deck accelerations should be calculated for all normally attended installations in the Southern North Sea and Northern North Sea. Simplified methods may be used to modify the acceleration spectra at sea bed level.
6. Walk down procedures may be used to identify vulnerable equipment supports.

7. Relative movements should be considered for link bridges between relatively flexible structures such as jack-ups and other fixed structures.

References

1. ISO 19900:2002 Offshore Structures - General requirements
2. ISO 19901-2:2004 Petroleum and natural gas industries - Offshore Structures: Seismic Criteria
3. ISO 19902:2007, Fixed Steel Offshore Structures
4. ISO 19903:2006 Fixed Offshore Concrete Structures
5. ISO 19905 –1 :2016 Site-specific assessment of mobile offshore units -- Part 1: Jackups
6. V (Karthi) Karthigeyan, Dynamic Shear Modulus of Soils, Foundation Stiffness and Damping for Seismic Analysis of Jack-Ups, 12th International Conference The Jack-Up Platform: Design, Construction & Operation 15th – 16th September 2009 City University London, UK