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Introduction

This information sheet provides guidance to duty holders operating floating production storage and offloading units / floating storage units (FPSOs/FSUs) in the United Kingdom Continental Shelf (UKCS) on compliance with the relevant regulations for structural and maritime integrity management of such units.

This information sheet considers lessons learned from HSE and OPRED interventions on FPSOs/FSUs across the UKCS and aims to highlight some of the key areas needing attention from duty holders in managing the structural and maritime integrity of similar installations.

Background

The FPSOs/FSUs operating in the UKCS usually have integrity management regimes that utilise a combination of prescriptive periodic and risk-based inspection (RBI) schemes to manage installation integrity. Some of these units are beyond their original intended design life and continue to operate at their location.

There are several useful publications from the industry on integrity management and life extension of FPSOs/FSUs published by organisations including OEUK, the Energy Institute, and Classification Societies such as Det Norske Veritas (DNV), American Bureau of Shipping (ABS) and Lloyd's Register (LR).

However, there are wide variations in the implementation of such guidance in practice. During recent HSE & OPRED interventions, several issues affecting the integrity of FPSOs/FSUs have come to light such as:

- The lack of a suitable integrity management system to identify and mitigate ageing related and late life integrity issues.
- Lack of competence in matters related to maritime integrity.

- Failure to adhere to the defined integrity management program for hull and topside structures and other marine safety and environmental critical equipment (SECE).
- Excessive hull structure corrosion beyond design allowances.
- The lack of visibility of integrity inspection backlog (underwater hull, cargo and ballast tanks, moorings etc.) within the overall SECE maintenance backlog.
- Repeated deferrals of SECE preventive maintenance as well as fabric maintenance creating insurmountable backlogs and deterioration of existing conditions.
- Failure to consider the possibility of progressive structural collapse despite the presence of multiple and/or recurring defects affecting global hull girder integrity.
- Inadequate management and oversight of critical hull repairs including weld procedures, preparation, personnel qualifications and follow-up inspections.
- Vessel operation that exceeds permissible structural loading limits or failure to review and revise loading limits considering the current condition of the vessel and its systems when entering late life operation.
- Loss of containment/watertight integrity from hull structural cracks, passing valves and corroded piping systems.
- Lack of area specific flooding risk assessments and monitoring arrangements in the case of passing valves failing to meet leakage criteria.
- Potential oxygen ingress into cargo tanks through structural cracks / corroded pipes.
- Failure to manage hydrogen sulphide (H₂S) levels and lack of an effective strategy for suppressing sulphate reducing bacteria (SRB) throughout production and storage areas, resulting in the presence of H₂S levels significantly higher than previously assessed.
- The repairs/modifications to fire/blast rated bulkheads are sometimes not fire/blast rated thus compromising the overall fire structural integrity of the bulkhead and structural fire/blast protection.
- Loss of vessel specific operational knowledge due to high crew turnover or reduced manning levels or change of ownership.

- Obsolescence of control systems and lack of availability of spares and vendor support for maintenance and repair.
- Lack of suitable inspection, maintenance and testing program to replace statutory or in-service Flag / Class inspection regimes that would have been otherwise in place if the vessel had been under Flag / Class, e.g. Watertight / weather tight integrity.
- Lack of suitable means of achieving positive isolation for confined space entry to enable tank inspection & repair while the installation continues to produce.
- Lack of notification/transparency of critical anomalies to independent verification bodies (IVB) for their independent review and comments.
- Verification outcome often limited to confirmation of assurance activities rather than an affirmation that the SECEs remain in a state of good condition and repair.
- Failure to comply with the asset operational safety case, particularly in late life.

Relevant Legal Requirements

The following regulations and associated guidance are relevant to this topic:

- Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 Regulation 16(1) (c) (d). Relevant Guidance L154.
- Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996 (DCR), Regulation 4, 5(1)(a) (b) (c), 5 (2), 6, 7(1) (2) and 8 (1) (a) (b). Relevant Guidance L85.
- Management of Health and Safety at Work Regulations 1999, Regulation 3 (1) and (2) and Reg 5. Relevant Guidance L21.
- The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (OPPC Regs).
- The Offshore Chemicals Regulations 2002 (OCR Regs).
- The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 (OPRC Regs).
- Energy Act 2008 (Part 4a).

Standards and Guidance

- Energy Institute's Guidelines for the Management of structural ALE issues for Monohull FPSOs, Oct 2019.
- OEUK Guidance on the Management of Ageing and Life Extension for UKCS Floating Production Installations, Issue1, May 2014.
- OEUK Guidance on the Management of Ageing and Life Extension for UKCS Oil and Gas Installations, Issue1, Apr 2012.
- HSE web page on ageing: Ageing and life extension of offshore installations (www.hse.gov.uk/offshore/ageing/index.htm).

Please see the references section for additional references.

Complying with the Legal Requirements

General

Duty holders must demonstrate that:

- The risks associated with the major accident hazards of Loss of Structural Integrity, Loss of Position and Heading, Loss of Watertight Integrity and Stability, Loss of Containment and, Formation of Flammable Atmosphere in tanks and machinery spaces of a floating installation are managed (identified, assessed, recorded, and controlled) and the residual risk remains ALARP throughout its operational life.
- There are suitable arrangements to manage the integrity of a floating offshore installation that can identify, prevent, and mitigate the onset of integrity issues arising during the operation of the installation in accordance with relevant regulations and industry standards identified above.
- The integrity management arrangements including inspection schemes and any changes to it shall go through the verification process.
- There are suitable arrangements for periodic review of the integrity of the installation by competent persons.
- There are suitable arrangements in place to ensure that the safety case thorough review process considers late life and ageing related integrity of the installation to confirm that the safety case continues to be fundamentally sound.

- Permit and consent holders for OPRED specific legislation must comply with the standards and conditions therein with a view to prevent releases and to ensure safe navigation for other marine users.

Design

FPSOs/FSUs in the UKCS need to have their safety cases accepted by the Offshore Major Accident Regulator (OMAR) before commencing operation. The design and management system information needed for accepting a safety case is covered in the Safety Case topic specialist assessment template and guidance documents available in the web page on OMAR operations and guidance (www.hse.gov.uk/offshore/omar/guidance.htm).

The safety case will remain a live document throughout the lifetime of an installation and therefore will need to be updated as and when there are changes to the structure, equipment or processes described in the case. Some of these changes may be considered as material changes needing formal assessment and acceptance by OMAR. Refer to *Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 – Guidance on Regulations, L 154* (www.hse.gov.uk/pubns/books/l154.htm) for further guidance.

The long-term operation of a floating installation at a permanent location without drydocking is seen to introduce some challenges. Duty holders should therefore consider the following aspects in the design/conversion stage of FPSOs/FSUs, wherever practicable:

- Site specific metocean data must be used for design purpose considering uncertainties in long term prediction of extreme values. The review and validation of metocean data must be carried out for life extension assessments of existing installations.
- The requirement for increased maintenance as the vessel ages over time and the corresponding additional personnel on board (POB) required for inspection, maintenance, and repairs, associated bed space and welfare arrangements.
- Additional evacuation, escape, and Life Saving Appliance (LSA) capacity needed when increasing POB.
- Changes to process fluids, equipment, and topside weight over time (eg: increase in produced water, H₂S content, additional process equipment).
- Ease of access for inspection, maintenance and repairs whilst on station in harsh weather conditions offshore. Design must cater for inspection in lieu of drydocking if no drydocking is planned for the duration of deployment.

- For components where no inspections are possible, considerations for ensuring sufficient integrity to last its operational life (e.g mooring buoy components, internal surfaces of mating cones).
- Ease of maintaining cathodic and/or sacrificial anode corrosion protection systems and internal tank coatings.
- Standards of isolation required for inspection, repair and maintenance of marine systems and cargo/slop tanks whilst the installation is in operation (production, storage and offloading).
- Capability to safely isolate tanks externally for confined space entry as far as reasonably practicable.

Asset Integrity Management

Duty holders shall ensure that they have an appropriate integrity management system in place along with suitably competent technical specialists responsible for the system to ensure the structural and maritime integrity of the installation.

The integrity management system can be based on prescriptive periodic and / or risk-based inspection (RBI) schemes. It is to be noted that Classification society requirements will not necessarily cover every structural element and piece of equipment and duty holders will need to assess any gaps and ensure that their integrity management systems do address such gaps.

It is good practice to prepare and maintain a Marine Asset Register with oversight from competent marine personnel, as it is sometime seen that equipment loses visibility in the maintenance management system over time leading to lack of maintenance/repairs or missing key service documentation. An accurate asset register should provide transparency on the components in each system, its location and information such as the inspection, maintenance, and repair history. Periodic audit of such registers would help to identify any missing information and to take timely remedial measures.

The integrity management system must ensure arrangements are in place to record, inspect, review and replace defined life repairs as necessary.

It is good practice to prepare an annual integrity summary document for each installation that reviews the inspection history, maintenance / repairs / outstanding anomalies / inspection backlogs / modifications, any analytical works done, and any relevant incidents in the past one year, summarising the current integrity status of the installation and clearly spelling out the main integrity threats. It should also summarise the key integrity activities planned for the year ahead.

For an overall framework for structural integrity management, duty holders may consider *ISO 19901-9:2019, Specific requirements for offshore structures-Part 9:*

Structural integrity management, even though this document is primarily applicable for bottom founded offshore structures and their topsides.

For specific guidance on the integrity management of FPSOs and FSUs, duty holders may refer to *OEUK Guidance on the Management of Ageing and Life Extension for UKCS Floating Production Installations, Issue1, May 2014* and Energy Institute's *Guidelines for the Management of structural ALE issues for Mono-Hull FPSOs, Oct 2019*.

For guidance on mooring integrity management, refer to the OEUK Mooring Integrity Guidelines and HSE mooring integrity information sheet OIS 4/2013 *Offshore Installation Moorings* (www.hse.gov.uk/offshore/infosheets.htm).

Guidelines on the marine assessment of F(P)SOs, Assessment Criteria and Questionnaire published by OCIMF provides guidance on marine safety risks and guidance for independent auditors of hull and marine systems of FPSOs.

Some additional factors to be considered for FPSOs/FSUs include, but not limited to, the following:

Structural Integrity

Duty holders must ensure that:

- The integrity management system addresses ageing and late life integrity threats including structural fatigue damage.
- The inspection scope, methodology and frequency defined within the integrity management system are rational and appropriate for the age and condition of the vessel.
- The defined integrity inspection programs are carried out to plan and its efficacy audited at regular intervals. During late life this may require additional resources e.g. Walk to work (W2W) vessel or extended turnaround (TAR).
- A holistic review of open anomalies is carried out at suitable intervals to identify any underlying issues, global integrity threats and the potential for progressive collapse.
- The defined permissible hull loading limits (shear force, bending moment, deflection) remain valid considering the configuration, age and any observed structural deterioration or defects.
- Risk assessment of structural anomalies considers the potential for loss of containment (eg. Oxygen ingress, hydrocarbon/toxic gas release etc.). It is important that duty holders take note of the HSE safety bulletin *High concentration of hydrogen sulphide (H₂S) in cargo and slop tanks*, (www.hse.gov.uk/safetybulletins/hydrogen-sulphide.htm).

- Repairs carried out to structures or equipment are appropriate to meet the respective performance standard criteria (e.g., required fire rating when repairing a fire bulkhead).
- Senior management maintains visibility of all SECE and non-SECE inspection and repair backlogs, which remain within acceptable limits.

Stability & Watertight Integrity

Duty holders must ensure that:

- An integrity inspection plan for external hull envelope is developed and implemented, especially when underwater inspection in lieu of drydocking (UWILD) is planned.
- Watertight integrity of the hull envelope is maintained by implementing suitable arrangements for integrity inspection of ship side valves and associated pipework in line with HSE Offshore Information Sheet 4/2011: Flooding risk to machinery spaces (www.hse.gov.uk/offshore/infosheets.htm). Whilst the information sheet covers only machinery spaces, the principles are applicable to all ship side connections.
- The integrity management system includes the inspection and maintenance of all marine systems including ballast, bilge and seawater systems to prevent communication with the sea or between tanks and to ensure functionality and availability in emergency situations. All watertight doors and openings require suitable maintenance and test regimes in place.
- All systems including remote tank gauging, sounding pipes, valve hydraulics, valve indications, ballast/cargo control systems, loading instrument etc., required to manage stability and hull stress during various operational phases are subject to suitable inspection, maintenance and testing regime.

Cargo & Inert Gas/Hydrocarbon Blanketing Systems

Duty holders must ensure that:

- There is no formation of a flammable atmosphere within cargo tanks, deck, or machinery spaces due to:
 - Oxygen ingress into the tanks or;
 - Release of hydrocarbon rich inert gas/toxic gases on the main deck or;
 - The return of hydrocarbon gases to machinery spaces.
- There is no loss of containment due to insufficient integrity of cargo and offloading systems.

- The integrity of all piping, valves, and deck/bulkhead penetrations associated with cargo, blanketing and offloading systems is maintained adequately to prevent loss of containment. This must include all drain connections to the tanks, manholes, tank hatches, crude oil washing ports and Ullage Temperature and Interface (UTI) vapour locks, heating coils, inert gas & hydrocarbon blanketing systems, cargo handling systems, hydraulic lines etc.
- Periodic reviews are conducted to detect long-term changes such as variations in process characteristics, or in the composition and physical properties (e.g., density) of production fluids stored in cargo or slop tanks and to implement any necessary modifications to ensure continued integrity.
- Integrity of offloading systems (Offloading Hose, Marine Breakaway Couplings (MBC), Offshore Hose Transfer Point, Tanker Mooring Hawsers etc) is based on an operator's inspection, maintenance, testing, recertification and retirement policy, which takes into account original equipment manufacturer (OEM) recommendations, industry guidance and facility-specific factors (metocean, cargo, number of operations etc).

Station Keeping

Duty holders must ensure that there is a suitable mooring integrity management system which ensures that:

- An integrity strategy for the station-keeping system is developed in line with industry guidance such as Oil & Gas UK Mooring Integrity Guidance or equivalent. Further guidance is provided in HSE OIS 4/2013 on mooring.
- The mooring integrity risk assessment considers degradation mechanisms, failure modes and suitability of the maintenance routines for all components in the load path including turret, turret bearings, winches, winch brakes and foundation bolts.
- Maintenance management arrangements cater for functionality, availability and reliability of components associated with propulsion system and/or thrusters where they are essential for maintaining heading and/or position, systems including power generation, control systems and computers.
- An inspection methodology and program suitable to identify the onset of degradation and failure mechanisms associated with the components of the mooring system and emergency towing arrangements as identified in the integrity risk assessment is developed and implemented. The acceptance criteria are to be clearly documented (e.g. turret bearing wear).

- A periodic integrity review is carried out for the station keeping system that includes all components in the load path by a competent person.
- Life extension assessments of mooring systems must account for surface conditions (e.g. pitting) and material loss to estimate strength and remaining fatigue life.

Operational Integrity Management

Duty holders must ensure that:

- Operations remain within original design basis, and any deviations are assessed, and appropriate actions are implemented.
- There is an effective competency management system to demonstrate competency of the personnel undertaking the relevant tasks both offshore and onshore, and to retain installation specific operational knowledge over time. Minimum levels for the number of persons in each technical discipline need to be identified to manage operational and foreseeable emergency scenarios and a management of change assessment should be carried out when competency levels fall below this identified minimum.
- Where there are issues which span various disciplines, all involved disciplines are identified and actively involved in the decision making with respect to risk management. For example, failures in instrumentation may lead to structural overloading.
- Obsolescence reviews are carried out periodically for both control systems (e.g. cargo, telemetry, heading control, tank gauging) and hardware.
- A suitable monitoring and auditing arrangement is in place to carry out independent assessment of all maritime safety risks. Guidelines on the marine assessment of F(P)SOs from OCIMF provide guidance for auditors.
- Senior management have visibility of barrier health indicators against major accident hazards.
- The verifier is kept informed of critical anomalies and / or any observed degradation of barrier performance on an ongoing basis to ensure that SECES remain in a state of good repair and condition.

Thorough Review (TR) of Safety Case

A thorough review of the safety case should identify any significant changes to operations, equipment and any new knowledge from the industry or regulatory bodies

since the previous thorough review. Duty holders must therefore review their TR process to improve its effectiveness in line with the HSE inspection guide.

The HSE web page, OMAR operations and guidance - Thorough reviews - (www.hse.gov.uk/offshore/omar/guidance.htm) provides more detailed information on thorough reviews.

The duty holders may make use of the inspection guides for each topic available in the HSE website, Inspection of offshore installations and operators- Inspection guides (www.hse.gov.uk/offshore/inspection.htm) in reviewing the technical adequacy of different disciplines.

The safety case assessment templates available in the web page OMAR operations and guidance, safety cases (www.hse.gov.uk/offshore/omar/guidance.htm) also provide information on details expected to be in the safety case.

The thorough review process must account for changes in design parameters, ageing of the installation and changes in operating conditions that may influence the safe operation of the installation to confirm that the safety case, with any necessary updates, is still adequate, and is likely to remain so until the next thorough review.

Asset Life Extension

A formal life extension assessment should be carried out for installations reaching the end of their original design life to establish suitability for continued safe operation. Such assessments must demonstrate that *all major accident risks have been re-evaluated, and* the level of integrity of the installation is as high as is reasonably practicable at all times, such that risks to people on the installation, arising from matters of integrity, are kept as low as reasonably practicable.

Depending on the outcome of the above assessments, a material change submission to the safety case may be necessary at that point.

References

American Bureau of Shipping (ABS) (ww2.eagle.org)

Guidance note on Life extension methodology for floating production installations, May 2021

Requirements for hydrocarbon blanket systems, Jan 2025

Det Norske Veritas (DNV) (www.dnv.com)

DNV-RP-E308, Mooring integrity management, Oct 2021

DNV-OTG-17, Inspection planning of MOUs in-service by use of RBI methodology, Aug 2019

DNV-OTG-27, Life extension of floating production installations, Feb 2022

DNV-CG-0172, Allowable thickness diminution for offshore floating units, Oct 2022

DNV-CG-0608, Bottom survey guidance for mobile offshore units, May 2022

Energy Institute (www.energyinst.org)

Guidelines for the Management of structural ALE issues for mono-Hull FPSOs, Oct 2019

Health and Safety Executive (HSE) (hse.gov.uk)

Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 – Guidance on Regulations, L154 (www.hse.gov.uk/pubns/books/l154.htm)

Ageing and life extension of offshore installations
(www.hse.gov.uk/offshore/ageing/index.htm)

OMAR operations and guidance - Thorough reviews -
(www.hse.gov.uk/offshore/omar/guidance.htm)

Inspection of offshore installations and operators- Inspection guides
(www.hse.gov.uk/offshore/inspection.htm)

High concentration of hydrogen sulphide (H₂S) in cargo and slop tanks - Safety bulletin (www.hse.gov.uk/safetybulletins/hydrogen-sulphide.htm)

Offshore Installation Moorings, Offshore information sheet 4/2013
(www.hse.gov.uk/offshore/infosheets.htm)

International Organization for Standardization (ISO) (www.iso.org)

ISO 19901-9:2019, Specific requirements for offshore structures - Part 9: Structural integrity management.

Lloyd's Register (LR) (www.lr.org)

Guidance notes for life extension of floating offshore installations at a fixed location, March 2023,

Offshore Energies UK (OEUK) (oeuk.org.uk)

Guidance on the management of ageing and life extension for UKCS floating production installations, Issue1, May 2014

Guidance on the management of ageing and life extension for UKCS oil and gas installations, Issue1, Apr 2012

Mooring integrity guidance, 2014,

Tandem offloading guidelines, Issue 3, 2014

Oil Companies International Marine Forum (OCIMF) (www.ocimf.org)

Guidelines on the marine assessment of F(P)SOs, assessment criteria and questionnaire

Guidelines for offshore tanker operations

Cargo guidelines for F(P)SOs

International safety guide for oil tankers and terminals (ISGOTT)

Single point mooring maintenance and operations guide (SMOG)

This guidance is issued by the Offshore Major Accident Regulator (OMAR). Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.