Beyond lifetime criteria for offshore cranes

Prepared by
BAE Systems (Land and Sea Systems) Ltd
for the Health and Safety Executive

OFFSHORE TECHNOLOGY REPORT

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Beyond lifetime criteria for offshore cranes

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Executive Summary

The offshore oil and gas industry has been operating in the North Sea for the past 30 years, with the consequence that many of the early platforms are approaching the end of their design life. However, the economics of the offshore industry are such that there is a drive by Duty Holder’s to maximise their assets by extending their use. This report presents a review of current regulatory requirements and best practice to enable checklists to be produced to assist HSE (OSD) inspectors when reviewing/auditing a duty holder’s safety case justifying the continued operation of a pedestal crane once it has gone beyond its design life.

The approach considered the contents of the duty holder’s crane safety case submission, and how they would be affected by beyond design life issues. The report included the appraisal of the ongoing cross industry Step Change Initiatives to improve safety management performance on platforms that are below the industry average.

List of Abbreviations

ACoP	Approved Code of Practice
ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
BOP	Blow-out Protection
BS	British Standard
CBA	Cost Benefit Analysis
CCPS	Center for Chemical Process Safety
COSHH	Control of Substances Hazardous to Health Regulations 1994
FMECA	Failure Modes, Effects and Criticality Analysis
FoS	Factor of Safety
GOP	Gross Overload Protection
HAZID	Hazard Identification
HSC	Health and Safety Commission
HSE	Health and Safety Executive
LOLER	Lifting Operations and Lifting Equipment Regulations
NDT	Non-Destructive Testing
OIM	Offshore Installation Manager
OREDA	Offshore Reliability Database
OSD	Offshore Safety Division
PSF	Performance Shaping Factors

PUWER	Provision and Use of Work Equipment Regulations
QRA	Quantitative Risk Assessment
SHE	Safety, Health and Environmental
SLI	Safe Load Indicator
SMS	Safety Management System
SWL	Safe Working Load
UK	United Kingdom
UKOOA	UK Offshore Operators Association
WOAD	World-Wide Offshore Accident Databank

1 Introduction

1.1 Background

The offshore oil and gas industry has been operating in the North Sea for the past 30 years, with the consequence that the early platforms are approaching the theoretical end of their design life. However, due to economical considerations there is a drive by Duty Holder's (offshore operators) to maximise their assets by extending the platform useful production life.

In addition to extending the useful life of existing infrastructure, benefits are also achieved by deferring decisions about platform decommissioning. The cost of decommissioning can be substantial, and are in themselves an incentive for operators to find new uses to extend the lives of platforms providing the costs involved in doing so are not prohibitive.

The current legislation requires Duty Holder's/owners to carry out periodic and systematic review and reassessment of safety cases for their installations. This safety case as it is known covers all topside equipment and systems on the installation including cranes and their operation.

During operation of the crane, there is a potential for various crane failures such as uncontrolled movements, dropped loads, boom/structural collapse, etc., which might directly, or indirectly via damage to other equipment, lead to an increase in the risk of personnel injury and/or a major hazard occurring (i.e. fire/explosion).

The object of this report is to provide guidance to HSE inspectors to identify the additional safety case aspects that require to be addressed when considering cranes that are being proposed to operate beyond their intended design life.

In addition to the above, the offshore industry has also been involved with reducing manning levels on offshore platforms for the last two decades. This is made possible by the advances in technology, monitoring and surveillance techniques that have been introduced over that time. The various oil and gas production regimes that have emerged during this period have resulted in platforms being operated as either:

- Normally manned installation;

  i) with minimum manning commensurate with, and supported by, enhanced condition monitoring and surveillance or,

  ii) some short production periods with platform mothballed, or partially mothballed, when not in production

- Normally unmanned installation – remote controlled and visited at regular intervals.

1.2 Objectives of this Guide

The intent of any safety case submission must be to demonstrate compliance with HSE Safety Principles as defined in the relevant HSE Regulations.

The objective of this guide is to assist HSE (OSD) offshore inspectors when assessing the life limiting factors claimed by a Duty Holder/operator in their safety case submission to extend the life of a offshore pedestal crane. This guidance provides information on:

(a) procedures, factual information and schedules that should be reviewed when assessing safety cases and auditing Duty Holder's and their contractors

(b) items and aspects which should be addressed offshore

(c) targeted questions for inspectors to raise both at safety case stage and at subsequent offshore inspections/audits.

1.3 Scope and Extent of Guidance

This guidance document will cover offshore fixed pedestal cranes and their connections to the supporting structure, and identifies potential failure mechanisms that could limit the life of these cranes. The identified aspects and requirements regarding crane life extension are collated as follows;

(a) Generic safety critical elements and unattended risk criteria of offshore pedestal cranes which require to be considered by the Duty Holder, together with the likely mitigating arguments and standards they may claim in their QRA for continued operation of the crane, are discussed and guidance provided. (Appendix D)

(b) 'Prescriptive' aspects are entered directly into the checklist contained in Appendix A.

(c) Where questions are postulated on goal-setting aspects, they are presented in Appendix C formulated as an aide memoir for inspectors to note.

(d) Ageing aspects that are judged to be a potential problem area, and their likely consequential outcomes, are summarised to guide the inspectors. (Section 6 and Appendix D)

(e) Targeted questions are provided for inspectors to raise both at the Safety Case stage and at subsequent offshore inspections, to ensure that the operational and failure history of the crane(s) is verified by an acceptable process. (Appendix C)

(f) Procedures, information and schedules to be reviewed when assessing a Duty Holder's submission for crane life extension, to ensure that an acceptable process verifies its current condition. (Appendix C)

(g) Items and aspects that should be carried out during offshore and inspections are also included. (Appendix C)

(h) Appraisal of the various offshore industry STEP CHANGE initiatives concerning pedestal crane life extension is included. (Section 8)

1.4 Structure of Guide

Figure 1.1 below illustrates the arrangement of the material in this guide.

This guide is divided into two main parts;

- the front sections of the document that discuss, in general terms, the various issues affecting operation beyond the design life of cranes, and

- the checklists contained in the Appendices that could be used as part of an audit check specific to beyond the design life issues.

Any crane that has reached the end of its design life will require a safety justification for operation beyond its design life, with the validity of the justification demonstrated in the appropriate areas of the Safety Case, and the application of the justification implemented in the various control and procedures applied to the crane. Sections 1, 3 and 4 give general overviews and introduce the subject matter. The typical content of a safety case submission is discussed in Section 2, with further related topics discussed/expanded in Sections 5 and 6. Management Procedures and controls relating to the implementation of the claims made in the Safety Case are covered in Section 5 and 7. Section 8 reviews the cross industry STEP CHANGE initiative, while Section 9 covers the minor issues raised by human factors considerations.

References are given in Section 10. As far as possible, this guide is based on public – domain sources and all the references are either openly published or expected to be published in the near future.

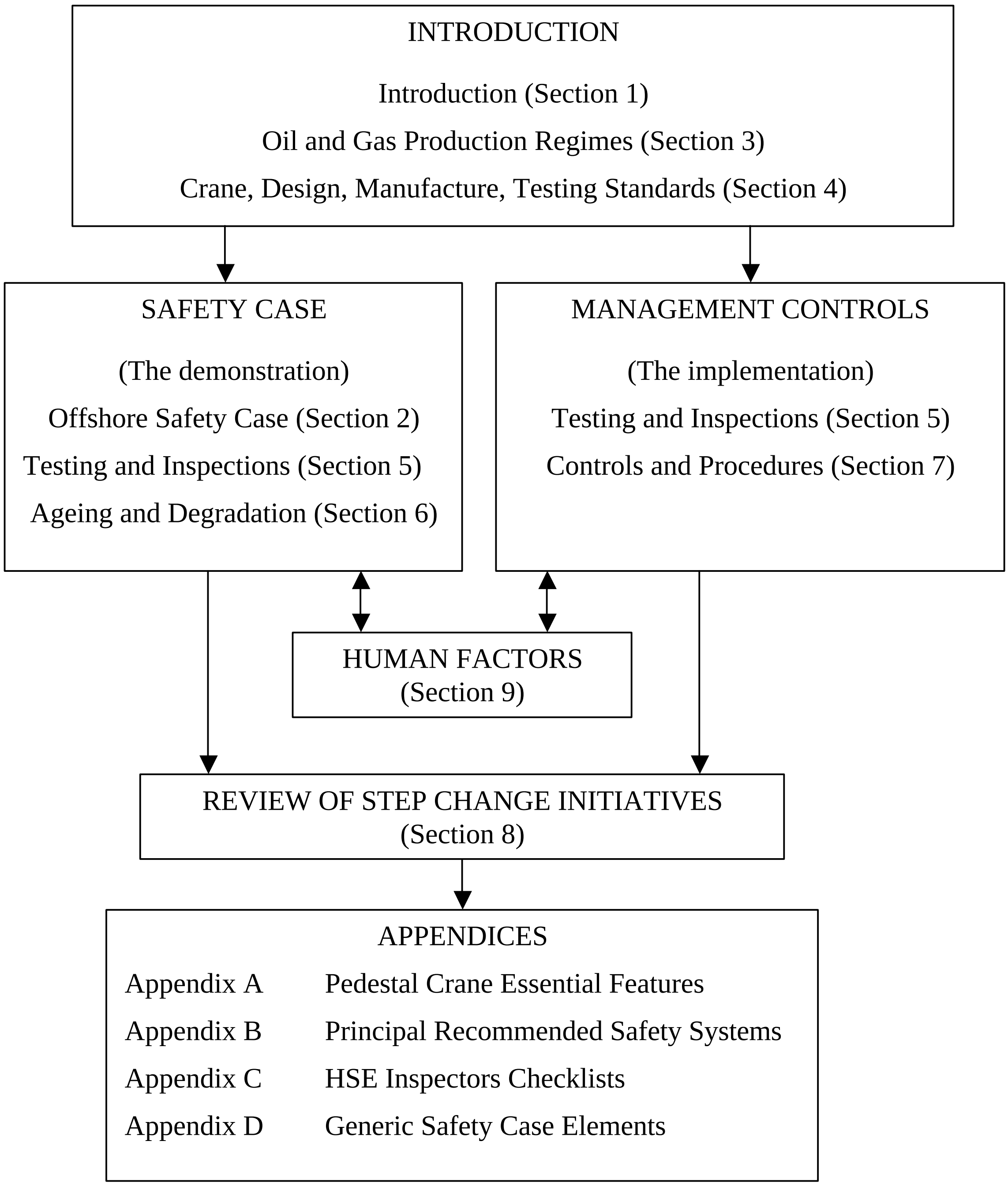

Figure 1.1 - Structure of the Guide

The essentials of the discussions in the front sections of this report are presented in a number of appendices. These appendices are presented in checklist format to assist HSE inspectors to produce a auditable record of their assessment to verify that the Crane Safety Case submission addresses all the appropriate issues, and confirms the claims made by Duty Holder's for operation beyond the design life:

- Appendix A – Pedestal Crane Essential Features
- Appendix B – Principal Recommended Safety Systems
- Appendix C – HSE Inspectors Checklists
- Appendix D – Generic Safety Case Elements

2 Offshore Safety Case (Cranes)

2.1 Introduction

For cranes that are being considered by the platform operators for extended life HSE inspectors are likely to be initially involved in assessing such a crane via the safety case submission. This section gives consideration to the safety case aspects judged to be appropriate for identifying structural, mechanical and operational safety critical areas of the crane which HSE inspectors should direct their attention. Consequently, below is a general discussion of the various topics that would be expected to be covered in a typical crane safety case. Many of the more significant topics have sections devoted to them later in the report where they are discussed in greater detail.

2.2 Guidance on the Contents of Crane Safety Cases

Justification for life extension should be based on assessment of the following crane life history documentation:-

- Original design specification.
- Operating history.
- Incident records.
- History of crane modification.
- Inspection and maintenance records.
- Fault analysis.

Using the above information to determine the current condition of the crane, all the relevant life limiting mechanisms must be assessed such that a greater operating life may be justified.

Continuing crane operation must be justified against its safety significant duties and incorporate the necessary safety features to protect the platform and personnel against dropped loads/swinging loads or related events. In addition to the crane safety features, comprehensive control procedures must be enforced when operating the crane.

2.2.1 Incomplete Records

For crane records that are complete and comprehensive, there is a sound basis for a life extension assessment, with a correspondingly high level of confidence in the accuracy of the findings. Conversely, little or no records would result in little or no confidence in a life extension assessment. Consequently, any shortfall in crane records must be rectified by other means and provide a level of confidence commensurate with the crane categorisation and statutory regulations.

2.3 Safety Categorisation of Cranes

With regard to the safety significance of a dropped load or equivalent hazard associated with the crane such as a jib collapse, collision or load toppling, each crane is considered to fall into one of the following three categories:

Category 1: Cranes of major safety significance. This is attributed to cranes where an unprotected fault sequence could cause a major platform safety hazard and/or personnel injury.

Category 2: Cranes of minor safety significance. This is attributed to cranes where an unprotected fault sequence could cause damage to safety critical equipment but the outcome would not result in a platform safety hazard and/or personnel injury.

Category 3: Cranes of no safety significance. This is attributed to cranes where an unprotected fault sequence could not cause damage to safety critical equipment nor result in a platform safety hazard or any risk to personnel.

The term ‘safety significance’, and hence the above categorisation, is with regard to incidents that will affect the platform and may escalate to have a significant effect on the overall safety targets for the platform as a whole. However, the above categorisations are not appropriate when injuries to personnel only are considered, since these are unlikely to affect the overall platform safety targets, or where the risk of personnel injury is as a consequence of a dropped load on a supply vessel. Consequently, the protection of crane drivers, slingers, etc., is covered by the appropriate Health and Safety legislation irrespective of the above categorisation.

2.3.1 Crane Reviews

A review of the routine lifting operations of each crane should be presented which establishes the safety significance of each crane and its suitability for routine use for the duration of the proposed life extension validity period.

The consequence of dropping a load should have been verified by site surveys. Judgements should have been made of the likely damage to occur to safety critical equipment, and where applicable, this should be supported by structural impact calculations.

Although personnel risk is covered elsewhere in this document an interface should exist, where the risk of personnel injury as a consequence of a dropped load is on a supply vessel, which identifies this as a possible hazard phenomena.

The site survey, review of platform design, the operating procedures and operating restrictions enable the crane to be categorised as defined above. This categorisation should be clear and unambiguous.

2.3.2 Substantiation of Crane Categorisation

When undertaking a crane safety case, review of the following points should be considered:

- For cranes of major safety significance (Category 1), comprehensive reviews of the design, including the protection equipment, and the inspection, maintenance and operating procedures and histories are required.

- For cranes of minor safety significance (Category 2), a detailed technical assessment may not be necessary on the basis of tolerable consequences of failure.

- For cranes where it is established that there are no safety implications (Category 3), no further assessment work will be required.

It should be noted that the above crane categories do not relate to the slew bearing categorisation used in Appendix III of OTO 96041 (Dec.1999) (Ref. 1).

2.3.3 Substantiation Required

The bounding event concerns the unprotected fault sequences that could result in the maximum energy dropped load hazard over an area which, potentially, could escalate into a major hazard (i.e. fire and/or explosion). The maximum energy impact from this event can be assumed to be that which results from the maximum scheduled load dropped from the crane's maximum associated hoist height. The affect of simultaneous dynamic loading on the crane underbase, from deck impact, and the rebound on the jib structure from load release should be assessed and be shown to be compliant to a recognised code.

2.4 Scope of Crane Reviews

Cranes which have the potential to damage hazardous areas as a consequence of a dropped load or related event, are required to comply not only with the statutory regulations for such equipment but also incorporate additional features. In some instances, it is necessary to protect the installation against dropped load damage or provide additional protection on the crane. Where necessary the safety features incorporated must be commensurate with the potential hazard. As well as including additional safety features on the crane, to protect against hazards, comprehensive control procedures must be enforced when undertaking critical lifts over potential hazardous areas (i.e. hydrocarbon and/or gas turbine/diesel generator fuel inventories).

The Duty Holder review of the lifting operations in relation to the above requirements should cover the following aspects:

- Review the structural and mechanical integrity of the crane against current British Standards and other applicable regulations.
- Assess the control, maintenance procedures and inspection associated with lifting operations.
- Review the crane operating history to establish the effects of ageing and degradation.
- Assess the protection provided against dropped loads, uncontrolled load lowering and related hazards such as collision, swinging loads and structural collapse that could occur as a consequence of lifting faults and operating errors.

2.4.1 Load Conditions

It is essential for a review of the crane that a load spectrum schedule should be produced in conjunction with the platform operations and maintenance departments, which identifies the significant loads routinely handled, their weight and approximate lifting frequencies. Pessimistically high operational frequencies may be assumed to provide an allowance for minor miscellaneous lifts. Also, lifts over hazardous areas that are classified as high integrity lifts should also be identified. Use should be made of the lifting history recorded by the SLI facility if one exists on the crane.

Any changes to the functional requirements of the crane that are intended over the proposed extended operating period that are outwith the crane's current design parameters must be identified and reasons for these changes stated.

2.4.2 Maintenance and Operating History

The safety case should give an overview of the operating history of Category 1 and 2 cranes, and include a description of incidents which could have a significant influence on the integrity of the crane. Modifications which have been introduced to overcome operational faults or significant defects identified as a consequence of undertaking the tasks included in the Maintenance, Inspection and Test Schedule should also be described.

Typically, the operating history will be revealed by inspection of maintenance and survey records such as:

- Non-destructive testing reports
- Maintenance Contractor's record of crane defects
- Verification body/competent person's inspection reports
- HSE (OSD) inspection reports

- Operational feedback information from Duty Holder
- Duty holder's modification submissions
- HSE and industry Safety Alerts
- LOLER defect report database [LOLER 1998 10 (1) Requirements (Ref. 2)] which is maintained by OD6.4

2.4.3 Control Procedures

The crane review should assess whether the control procedures:

- Cover all routine load lifting operations undertaken and identify those lifts that take place over hazardous areas.
- Provide sufficient information to enable the lifting operations to be performed safely (including emergency recovery procedures following a hung load, brake failure or other incidents).

See Section 7 of this report for further discussion on procedures and controls.

2.4.4 Structural and Mechanical Integrity

The structural assessment to demonstrate adequacy of the crane integrity must include assumptions for the duty conditions during the proposed extended operating period, e.g. that the duty conditions will remain within the original design envelope.

In recognition of the potential consequences of a dropped load from, or collapse of, a Category 1 crane, a reduction in the rated SWL of the crane is usually considered. This de-rating of the crane is the normal approach adopted by the Verification body. For Category 2 and 3 cranes, the acceptance criterion is as per the code requirements.

In addition to applying conservative strength and fatigue life to the design of the crane, high integrity may also be demonstrated by providing load path redundancy or protection against the effects of load path failure.

When conducting the crane review, where possible, the above should be analysed to the latest design codes.

The crane fatigue life requirement to the end of the platform life should include an allowance for possible operation during decommissioning.

2.4.5 Protection

The crane control and protection equipment should be in accordance with the recommended system stated in HSE OSD document OTO 96041 (Dec 1999) (Ref. 1). The principal recommended safety systems are listed in Appendix B of this report.

The crane safety case should review the protection systems available on the Category 1 and 2 cranes, by assessing the adequacy of protection offered by the systems against hazards generated by the identified faults.

Potential initiating events may be categorised as follows:

- Structural failures and mechanical failures
- Electrical failures and control failures
- Operator errors, including attachment (slinging) errors.

Initiating events should be derived from previous review work on other similar types of cranes and from the examination of the design of the crane. Potential operating errors should be identified by reference to the functions detailed in the operating and emergency instructions, and the proposed load spectrum schedule. Where necessary, the consequence of potential initiating events should be analysed by using failure mode and effect analysis worksheets and fault trees, where this has not already been undertaken as part of the overall installation's safety case.

The hazard classification, as a consequence of a major dropped load incidents involving the crane, for the area within the crane operating envelope requires to be established. To establish the hazard classification a hazard schedule should be produced which lists the following:

- The safety critical items within the crane envelope, above and below the decking.
- The consequence of a dropped load on the critical items.
- Mitigating factors.
- The hazards and the hazard classifications.

To assess the protection, an initial deterministic approach is recommended. This should comprise classifying the protection in accordance with a protection schedule. For fault sequences associated with major potential hazards, where the protection classifications are to lower orders than the hazard classifications and to improve protection is impractical, time at risk arguments may be developed. Mitigation may also be claimed where possible, e.g. the use of equipment meeting a high integrity FoS criteria may be claimed; this usually requires derating of the crane to support the claim.

The method employed to develop the time at risk argument should take into account the allowable hazard frequency, the probability of any existing protection being called upon to operate and the probability of the hazard occurring should the protection fail.

2.5 Criteria for the Review

The assessment of the protection offered by the crane systems against hazards generated by identified faults should be undertaken by the Duty Holder.

A deterministic assessment is required, followed by a probabilistic assessment of those faults for which the deterministic approach has identified inadequacies in protection against the fault. Target fault frequencies should be highlighted and justified if they do not meet the declared ALARP policy of the Duty Holder's goals set for individual personnel risk.

2.5.1 Structural

Structures are generally designed to end of life criteria as a minimum. However, changes to the crane's load spectrum schedule and the maximum estimated dynamic loading resulting from faults must be assessed against the original design parameters.

Where these parameters are shown to be exceeded, then an engineered change should be introduced by the Duty Holder, or a fitness of purpose case, supported by identified residual life monitoring techniques, be submitted for HSE/OSD assessment.

2.5.2 Ageing and Degradation

The main physical mechanisms of ageing include fatigue, wear and corrosion, and for some materials embrittlement. While fatigue, wear and corrosion are generally well understood by most engineers, embrittlement is specific to some materials exposed to particular environments. Hydrogen embrittlement is mainly a problem with high strength steels, and can occur on chains and ropes that are exposed for a sufficient time to a hostile environment. Embrittlement involves the loss of ductility because of a chemical change in the material brought about by either sulphide or saline environments. Obviously, for offshore (marine) applications the embrittlement brought about by saline environments are of most interest, where the crack propagation mechanism can occur under both cathodic and anodic conditions.

Physical ageing leads to a reduction in the safety margins of the crane and should be counteracted by a regime of detection, monitoring and mitigation to ensure that safety margins are not eroded to the extent that there is an increased risk to health and safety. Each mechanism as relevant to the safety critical areas of the crane, including the monitoring, inspection and maintenance systems in place to guard against future problems, should have been addressed in the Duty Holder's safety case to the appropriate detail.

Where there are any significant ageing or degradation problems identified, then a specialist evaluation assessment, as detailed in Section 6, will be required.

2.5.3 Review of Dropped Load Incidents

All dropped load incidents should be reviewed by the Duty Holder with the following information supplied as a minimum: (For reportable incidents only under RIDDOR)

- Incident reference number
- Date of incident
- Description of the incident
- Cause of the dropped load incident
- Consequence of dropped load (damage, injuries, etc.)
- Mass of the load dropped
- Height of load when failure occurred.
- Corrective actions, changes to operating procedures, etc.

2.5.4 Operating Rules

Operating constraints on Category 1 and 2 cranes must be identified in the operating procedures.

2.5.5 QRA in the Life of an Installation

To obtain the full benefit from the study, the QRA should be an on-going process throughout the life of an installation, as an integral part of its risk management. Ideally, one QRA should be prepared and evolved throughout the installation’s life. Typical stages when a QRA or an update are required are:

- Feasibility studies and Concept design: It is vital that safety specialists provide guidance on inherently safer approaches to designers and project engineers during the concept design. At the end of this stage the basic design and manning arrangements should have been decided. The best option is usually made on economic and practical feasibility criteria by the Duty Holder.

- Detailed design: The use of bridged linked installation or a buffer zone between the process area and the accommodation provides a more inherently safe design. Measures such as reducing the hydrocarbon inventory and gas turbine/ diesel fuel from crane load path prevents escalation of a dropped load hazard. Demanning or the use of not normally manned installations is an inherently safer approach based on segregating people from the hazards. This introduces some issues regarding the level of maintenance and the need to protect personnel when on board. Full QRA should be provided by the Duty Holder prior to hydrocarbons being brought onto the platform

- Operation. The full QRA of the final design should be revised to take account of the 'as built' state of the platform typically every 3-5 years. It should be used in decision-making as part of the on-going safety management system on the installation.

- Demanning. There is a tendency for QRA's to gain in complexity as the design progresses, but this should not be regarded as inevitable. It probably reflects the Duty Holder's growing confidence in the QRA and increasing reliance on risk based advice. In fact, there may be opportunities to simplify a QRA once design decisions have been made and particularly once the installation's drilling stage is complete e.g. Duty Holder's may elect to make the oil/gas production regime remote controlled with a roving multi-skilled crew intermittently servicing the platform for corrective maintenance or workover.

2.6 Risk Assessment

Risk assessment is an integral part of the management responsibility. The practice of basing safety activities on incident occurrences has been shown to be ineffective and inadequate. Risk assessment is a proactive technique and when employed effectively, is more likely to ensure continuous protection for all personnel involved with lifting operations.

The Management of Health and Safety at Work Regulations 1992 (Ref. 4) place a more generic requirement on Duty Holder's to conduct risk assessment. These regulations detail the purpose and general principles of risk assessment, and require a systematic approach to risk assessment for cranes.

The main purposes of safety case assessments is to form a view on whether or not a case has been made for the continued operation of the crane with:-

- its current and intended load spectrum schedule

- the maintenance regime in its specified platform production mode, and

- conforming to the Duty Holder's safety management systems.

The crane safety case is required to comply with the assessment principles for offshore safety cases stipulated in HSG181 1998 (Ref. 5).

The HSE principles document states the aspects that should be considered by the Duty Holder to ensure that a satisfactory safety case for the crane is submitted to HSE.

2.6.1 Interfaces with Other Plant/Systems

Other than the supporting structure and the power supplies, the crane is considered to interface directly only with the load being lifted. The crane interfaces indirectly with safety critical plant/systems when lifting loads above, or in the vicinity of, such items with hydrocarbon inventories or plant safety protection. The potential hazards to safety critical plant/systems should have been identified in the safety case.

2.6.2 Comparison Against Modern Standards

The Duty Holder’s review of the crane design, manufacture, maintenance and operation should show how it compares to modern standards. If the crane does not meet modern standards then its acceptability for continued operation should be justified, possibly by a programme of improvements and/or demonstration of a “Fitness for Purpose” case should be submitted by the Duty Holder.

3 Oil and Gas Production Regimes

3.1 General

Prior to covering the specific safety case issues and other related aspects that are of interest to the HSE inspector, consideration should be given to the various crane operating modes demanded by the installation's oil/gas production regimes, and their possible effects on crane operations beyond their design life. The potential production regimes under which the crane may be expected to operate are discussed below.

3.1.1 Normally manned installation

- With minimum manning commensurate with, and supported by, advances in technology
- For short production periods - platform mothballed when not in production.

3.1.2 Normally unmanned installation – remote controlled

- With neither workover rig nor accommodation in use.
- The crew onboard for a period exceeding one day (workover mode) and planned work: accommodation and facilities significantly reinstated.

The demand on the crane for each of the above regimes are different, in that its operating patterns vary to accommodate annual outages and visits to the platforms for corrective and planned maintenance and workovers. All these variants combine to impose different load spectrums on the cranes through its operating life, resulting in different ageing and degradation mechanisms.

Physical ageing leads to a reduction in the safety margins of the crane. Consequently, it must be ensured that the crane's safe margins are not eroded to the extent that there is a risk to the operator's health and safety beyond agreed limits. This may be achieved by the Duty Holder demonstrating the existence of a regime of detection, monitoring and mitigation to justify continued operation of the crane.

To service the various oil and gas production regimes, roving teams of multi-skilled personnel have been trained and qualified on all aspects of platform operation and maintenance, including evacuation and rescue.

Given the dominance of human factor errors on fault sequences leading to hazardous events, detailed modelling of human factor issues must be addressed in the platform Duty Holder's quantitative risk assessment which justifies the continued operation of the crane and associated load handling.

The offshore industry STEP CHANGE initiative has sponsored a framework for introducing 'best practice' and safety related decision making, with the end objective of proposing that the industry adopt a common safety case methodology for probabilistic risk assessment which will justify crane life extension. This should result in a better qualification of uncertainties and provide enhanced QRAs in justification of continued operation of offshore cranes beyond their design life.

An appraisal of the progress by the various STEP CHANGE task groups in meeting their deliverables is provided in Section 8.

This document is to provide guidance to HSE (OSD) QRA assessors and HSE inspectors to audit a platform crane for compliance with the HSE and statutory regulations currently in place regarding crane life limiting factors. This guide addresses the potential aspects that a Duty Holder may put forward in justification of a proposal to extend the life of the crane beyond its calculated design life.

3.2 Applicable Aspects of the Production Regimes

The following aspects of the production regimes have a specific impact when considering operating cranes beyond their design life.

- Crane load spectrum imposed by platform operating regime.
- Adoption of best practice.
- Training and qualification frequency of operating and maintenance personnel.
- Detection and monitoring of critical components to ensure that safety margins are not eroded beyond agreed limits.

4 Design, Manufacture & Testing Standards

4.1 General

As part of the assessment for considering using a crane beyond its design life, the original codes, testing standards, etc., specified at the time of crane manufacture require to be reviewed to ascertain there were no shortcomings during the original supply of the crane.

The crane under consideration should have been designed to the appropriate standards at the time, using relevant materials and well established methods of manufacture, construction and testing. Records should be checked to confirm that the appropriate testing authorities were satisfied that all aspects and tests were in necessary with the standards.

The principal standards for the design, manufacture, construction and testing of the crane must be recorded in the Duty Holder's safety case.

The Offshore Installations (Safety Case) Regulations 1992 Schedule (Ref. 6) requires that the Duty Holder provide the following:-

- General description
- Location and environment
- Structure and Layout
- Primary functions (loads and frequency handled by crane)
- Safety features and systems

This information should be supported with drawings, diagrams and schematics. The level of detail, the quality of drawings, etc, should be sufficient to support and facilitate understanding of the case demonstrating safety of load handling and the constraints in relation to the crane's intended use.

General Description: should provide an overview and clear understanding of the crane installation and its load handling activities. This should relate the current operational parameters and highlight any derating of the original specified design.

Location and Environment: should include a location plan showing the hazardous zones (as per IP designated areas) which may be significant in terms of risk evaluation, together with a summary of the local environmental information for the area and any extreme conditions which might affect the crane's operations. The foregoing *hazardous zones* relate areas where there is a risk of leaks of hydrocarbon products as the result of a dropped load and should not be confused with *electrical zones*.

Structure and Layout: should include a description of the structure of the crane and its underbase, location on the platform, orientation, adjacent equipment and location of the temporary refuge.

Primary Functions: for each lifting and slewing function the description (or references) should include equipment, controls, arrangements, policies, procedures and supporting design criteria as appropriate, with emphasis on the role in prevention, control and mitigation of major accident hazards, frequency of use and any periods of inactivity/extended periods of non-use. The control and communication arrangements should be specified.

Special attention should be paid of maximum and minimum operating conditions (wind loading, sea state, temperature, etc), performance standards, safety margins and redundancy.

Hazardous substances and inventories: This should be a summary of all hazardous substances handled by the crane and inventories of hydrocarbons on or adjacent to the crane's load route which could contribute to the escalation of a dropped load event into a major accident.

Safety features and systems: systems which protect the plant and personnel against a load drop, uncontrolled load lowering or collision should be identified.

HSE OSD Document OTO 96041 (Dec 1999) (Ref. 1), Appendix I and II lists the principal features which should be described in the Duty Holder's case for the crane. These have been reproduced as Appendices A and B to this report.

4.2 Crane Duties and Performance

4.2.1 Duties

The following crane parameters should be stated by the Duty Holder (or be available for auditing):

- Safe working load (as applied to inboard lifting duties) related to both minimum and maximum operating radius, length of boom, and to the number of rope falls used in the load hoist system.

- The crane de-rated duties for dynamic lifting operations appropriate to specified sea states should be permanently indicated in the crane operators' cabin.

- The full range of crane duties for inboard and outboard (from the sea) lifting, should be included in the crane operating manual and be loaded into the crane's safe load indicator system.

The following operating limitations should be stated (or be available for auditing):

- Component strength
- Sea-state
- Off-lead (vessel excursion)
- Side-lead
- Wind speed
- Dynamic coefficients
- Snow/ice build up
- Temperature

4.2.2 Performance

It is essential that under-performance during the following conditions is prevented:

- The hook speed should be fast enough to prevent re-impacting of the load with the supply vessel for the specified sea states. The height of the adjacent containers on the deck of the supply vessel should be taken into account (low hoist speeds may restrict the number of falls of rope that can be used for a particular sea-state and hence limit the lifting capacity of the crane).
- The speed of slew and luff hoist should be sufficient to enable the crane operator to keep the load line sensibly plumb within the excursion envelope of the supply vessel and within the specified off-lead and side-lead parameters.
- Selection of two or more crane services should not cause undesirable motions of the hook.
- The prime mover should be prevented from stalling or overheating during utilisation of maximum power conditions, with the crane in the most adverse configuration.
- Uncontrolled overhauling and/or free fall of the load hoist and luffing hoist systems and uncontrolled slewing motion of the crane are unacceptable.
- All safety systems and cut-outs etc should remain active even if the prime mover fails to keep running.

4.3 Design Codes

The following, which is not exhaustive, is a list of the principal applicable standards:

BS 464: 1998 – Specification for thimbles for wire rope

BS 443: 1982 – Galvanised coatings on wire

BS 2903: 1998- Specification for high tensile steel hooks for chains, slings, blocks and general engineering purposes

BS 5744: 1979 – Safe use of cranes

BS 302: 1968 – Wire ropes for cranes, excavators and general engineering purposes

BS 970: 1972 - Wrought steels for mechanical and allied engineering purposes

BS 1397:1979 - Industrial safety belts, harnesses and lanyards

BS 2452: 1954 – High pedestal or portal jib cranes

BS 2573: Rules for design of cranes

Part 1: 1983 Specification for classification, stress calculations and design criteria for structures.

Part 2: 1980 Specification for classification, stress calculations and design of mechanisms.

BS 2830: 1973 - Suspended safety chairs and cradles for use in the construction industry

BS 2902:1957 – High tensile steel chain

BS 2903: 1980 – High tensile steel hooks for chains, slings, blocks and general engineering purposes

BS 3113: 1959 – Alloy steel chain Grade 60

BS 3114: 1975 - Alloy steel chain Grade 80

BS 3458: 1985 - Alloy steel chain slings

BS 3481: Flat lifting slings

Part 2:1983 Flat woven webbing slings

BS 3551: 1962 – Alloy steel shackles

BS 3692: 1967 – Specification for ISO precision hexagon bolts, screws and nuts Metric units (Grade 10.9 Steel (slew bearing fasteners)
(This standard has largely been superseded by a series of BS EN standards of which BS EN 24014: 1992 and BS EN 24032: 1992 are typical examples. These BS EN standards have mechanical properties in accordance with BS EN 20898-1: 1992 and BS EN 20898-2: 1992 which are different to the mechanical properties in BS 3692: 1967. This document is therefore rendered obsolescent but should remain available for the servicing of existing designs which are recognised to have a long working life)

BS 3810: 1970 – Glossary of terms used in material handling

BS 4278: 1984 – Specification for eyebolts for lifting purposes

BS 4360: 1986 – Weldable structural steel

BS 4395: Specification for high strength friction grip bolts and associated nuts and washers for structural engineering

Part 2: 1969 Higher grade bolts and nuts and general grade washers

BS 4429: 1987 – Rigging screws and turnbuckles for general engineering and lifting purposes

BS 4536: 1970 – Heavy duty pulley blocks for use with wire rope

BS 4878: 1973 – Large 'V' pulleys

BS 4928: 1985 – Man made fibre ropes

BS 4942: 1981 – Short link chain for lifting purposes

BS 528: 1975 – Ferrule secured eye terminations for steel wire ropes

BS 5594: 1986 – Leaf chains, devices and sheaves

BS 5655; 1983 – Eye bolts

BS 5744: 1979 – Safe use of cranes

BS 6570:1998 – Code of practice for the selection , care and maintenance of steel wire ropes

BS 5827: 1991 – Patent lifting equipment mobile

BS 6166: 1986 – Lifting slings

BS 6994: 1988 Steel shackles for lifting and general engineering purposes.

BS7035: 1989 – Code of practice for socketing of standard steel wire ropes

BS 7121: 1998 – Code of practice for safe use of cranes

BS 7262: 1990 – Automatic safe load indicators (European Standard EN 12077-2)

BS 7671: 1992 – Requirements for electrical installations. IEE Wiring Regulations. 16th Edition

BS MA 79: 1978 – Specification for jib cranes, ship mounted type

ISO 4406: 1999 - Hydraulic fluid power – method for coding level of contamination by solid particles

ATEX Directive, Machinery Directive - The equipment and protection systems intended for use in potentially explosive atmospheres Regulations 1996

4.4 Relevant Legislation

The principal regulations and some relevant guidance are:

- The Health and Safety at Work Act etc. 1974
- The Health and Safety at Work Act etc. 1974 (Application Outside Great Britain) Order 1995, SI 1995/263
- Provision and Use of Work Equipment Regulations (PUWER), SI 1998/2306
- The Lifting Operations and Lifting Equipment Regulations 1998, SI 1998/2307
- The Management of Health and Safety at Work Regulations 1992, SI 1992/2051
- The Supply of Machinery (Safety) Regulations 1992, SI 1992/3073 – Amendment SI 1994/2063
- The Noise at Work Regulations 1989
- ACoP L103 – Commercial diving projects inshore
- ACoP L104 - Commercial diving projects offshore
- AODC 052 rev.1 – Diving Systems Inspection Guidance Note (Design)

4.5 Design Parameters

Where available as many of the design parameters listed below should be provided by the Duty Holder. However, it is recognised that much of the information below may not be available for older cranes, in which case the Duty Holder should provide a statement form an Independent Verification body or competent person regarding the fitness for purpose of the existing design.

- Safety Factors (shear and tensile);
- Impact Factor;
- Design Load;
- Safe Working Load;
- Lifts per Year;
- Design Life of Crane;
- Fatigue Life Cycles
- Corrosion Allowance

5 Testing and Inspections

5.1 General

This section discusses the beyond design life parameters that effect testing and inspection, and the issues that may lead to changes in the testing and inspection regimes currently in use.

The testing and inspection regime to conform the current condition of the crane should have been described by the Duty Holder along with the effects of all identifiable ageing and degradation processes over the projected life extension period. Particular attention should have been paid to passive items e.g. piping systems and electrical cabling in the crane control systems, which may not be tested directly during routine inspections or maintenance. Projected changes in material properties and component wear–out processes over the projected life extension period should also have been considered by the Duty Holder.

5.2 Testing and Inspection Procedures

Any changes to the testing and inspection procedures should have taken account of the following;

- The operating history should have been reviewed, particularly from the point of view of changes in the past (i.e. demanning regime) and proposed changes in the future.

- The maintenance, test and inspection history should also been reviewed, along with any proposed changes in the future. Availability of spares for ageing components should have been considered.

- Non-standard operational events should have been reviewed (i.e. workovers etc), particularly with respect to trends.

- Changes in design standards since construction should have been addressed, and an assessment should have been made of the consequences of any such changes.

- Any potential for loss of integrity (i.e. safety critical component wear-out and/or fatigue limits) should have been identified and a demonstration provided that they are not being approached during the proposed extended life of the crane.

- The original design calculations for the crane and other items in its load path should have identified the various component allowable life limiting stress and fatigue limits required by applied code. The actual life limiting parameters may, however, be determined by the worst postulated dynamic scenarios under the fault conditions identified by the hazard assessment which are not covered by code. Additionally, these dynamic conditions may also vary during the life of the crane due to changes introduced to the load spectrum schedule in regard to weight, size and frequency. These dynamic scenarios could take the crane beyond its design basis and require engineered protection or make downrating necessary before continued operation would be acceptable.

Appendix C provides a checklist of the issues discussed above, and includes aspects that should have been covered by the Duty Holder for compliance with Offshore Installations (Safe Case) Regulations 1992 (Ref. 6).

6 Ageing and Degradation

6.1 Introduction

The life of any engineering component may be described by what is termed a mortality curve, sometimes called a bathtub curve, which has three distinct phases.

In the first phase we can expect some initial failures due to manufacturing faults that become apparent as soon as the crane is put to use. The majority of these are normally revealed during commissioning.

The second phase, i.e. the period of useful life, is probably the best understood and should present the least failures during the life of the crane provided appropriate operational and maintenance procedures are in place and followed.

The final phase of the curve reflects the old-age phase, or wear-out as it is usually termed in the case of engineering components, where various ageing and degradation mechanisms may in themselves, or in combination, lead to failure of crane components. The main problem experienced with the wear-out phase in the crane life is that the types of failure and the components affected are generally outwith the experience of the personnel responsible for the crane during its useful life phase. In addition, the crane maintenance procedures don't usually cover the wear-out phase.

The ageing and degradation mechanisms experienced by cranes vary in degree due to environment, usage, maintenance, etc. The more significant potential failure mechanisms, in terms of consequence, are detailed in Appendix D.

6.2 Ageing and Degradation

The maintenance and operating history of the crane must be presented and be examined in order to identify potential ageing and degradation mechanisms. The main physical mechanisms of ageing include fatigue, wear and corrosion, and for some materials embrittlement. Physical ageing leads to a reduction in the safety margins of the crane and should be counteracted by a regime of detection, monitoring and mitigation to ensure that safety margins are not eroded to the extent that there is an increased risk to Health and Safety. Each mechanism relevant to the critical areas of the crane, including the monitoring, inspection and maintenance systems in place to guard against future problems, should have been discussed in the safety case to an appropriate level of detail.

No significant ageing or degradation problems should be evident. Integrity inspections should be carried out and recorded in accordance with HSE Report OSD INS JM/010A, Crane Inspection Sheets – Specialist Evaluation Assessment [status sheets (A) for lattice boom pedestal crane] (Ref. 7). Where there are any significant ageing or degradation problems identified, then a specialist evaluation assessment to enable HSE to decide whether the crane is:

- probably satisfactory but some improvements may have to be recommended, with possible issue of HSE improvement notice required with some restrictions or limitations on use being stated or,
- unacceptable, warranting the issue of a HSE improvement notice and possibly a HSE prohibition notice if there is sufficient evidence that safety is being compromised.

NOTE: Reference 7, OSD Crane Specialist Inspection Evaluation Document (ref. OSD.CRA.INS.JM/O10A) details the assessment criteria for the above.

Offshore cranes should be inspected on a routine periodic basis as determined by the Duty Holder and his appropriate competent person appointed under SI 2307 (Ref. 2). The time elapsed between inspections may vary dependant on the Duty Holder's team responsible for the crane including the competent person, and their perception of the risk as derived from the QRA.

By comparing the findings of periodic QRA and SMS reviews with the original design basis, the crane usage of design life can be determined. Where uncertainties exist concerning degradation or life limiting factors, assessment of crane SLI lifting history recording facility and other condition monitoring records should have been undertaken by the Duty Holder e.g.

- Gearbox – monitor for water ingress and sample for particulate and metal particles, both in gearbox oil and bearing grease, for indication of wear.
- Load Spectrum Schedule Change – where the schedule has been amended from its original operating demand on the crane, fault condition dynamic loading (beyond its design code) on the crane structure needs to be analysed, and if high stress members are identified under the fault condition, the high stress regions need to have a NDT 'fingerprint' taken with re-inspection on a regular interval as determined by the competent person to monitor for degradation and confirm and establish 'fitness for purpose'.

The Duty Holder would be expected to provide a much increased level of surveillance towards the crane's 'wear out phase' at the approach of the end of the crane's design life. Failure/accident data on the crane's safety critical components obtained during its mid-service life do not provide indication of the onset of a component reaching the wear out phase of the typical mortality (bathtub) curve for the component. It is essential that stricter performance targets are therefore maintained by the Duty Holder during this wear out phase of the crane.

Inherent unrevealed faults should also be addressed in the crane safety case, and during the wear out phase of its life cycle, there is a greater propensity for unrevealed faults, particularly for second line of crane protection. HSE inspectors should confirm that the Duty Holder has appropriate inspection and test regimes in place to ensure that the crane has the necessary integrity margins to operate beyond its design life.

6.3 Condition Monitoring

Generic safety critical elements of the crane, with the crane life limiting mechanisms for each of these elements, are presented in Appendix D, together with the likely mitigating arguments and standards the Duty Holder may claim in their QRA for the continued operation of a crane beyond their design life. The safety case assessor should satisfy himself that the Duty Holder has taken cognisance of all the potential failure effects stated in Appendix D which result from the following life limiting mechanisms:

- Fatigue (loading)
- Creep (when crane operating over high temperature zones, GT exhausts, flare booms, etc.)
- Corrosion
- Erosion
- Brinelling (slewrings and bearings)
- Impact damage
- Ageing
- Leakage (ingress of water/condensation effects)
- Vibration
- Loose fittings (electrical, mechanical, hydraulic and pneumatic systems)
- Buckling
- Brittle fracture (high strength steel is prone to hydrogen cracking)

The control strategy and surveillance of normally unattended installations involves the remote monitoring of plant and process behaviour by characterising parametric signatures using digital signal processing and measurement techniques. Electrical, electronic, mechanical, hydraulic, pneumatic, vibration and thermal measurements of both static and dynamic nature give real-time identification of plant performance and forecast trends for predictive behaviour, sensitivity, efficiency, optimal operation, fault detection, early warning diagnosis, maintenance scheduling and risk assessment.

Such condition monitoring should be used by the Duty Holder on Normally Unattended Installations to warn when the various margins on life limiting parameters are being approached or exceeded.

6.3.1 Frequency Domain Information

Frequency domain information comprises machinery vibration, motor current, pressure pulsation and other dynamic measurements that can be tracked and plotted for individual frequency components versus amplitude. The frequency spectrum is used to detect cyclic nature by relating the spectral peak to a defect frequency. While the foregoing would provide

6.3.2 Lube Oil Analysis

Analysis of wear debris carried in the oil stream can provide an insight into the operating condition of components. Typically, data will cover viscosity, percentage insolubles, base number, water and particulate from which different metals can be identified.

6.3.3 Thermography

By using an infra red camera abnormal temperatures can be located of various items such as electrical components or flare plume impinging on plant and structures. Thus indication of a serious fault can be detected.

6.3.4 Corrosion Detection

Electrochemical corrosion detection probes and other monitoring techniques can be used to indicate corrosion events at strategic locations. Other monitoring techniques include:

- Test coupons
- Linear polarisation resistance
- Electrical resistance probes
- Zero resistance ammeters

Or non-invasive techniques such as:

- Ultrasonics
- Field signature methods

The application of the above condition monitoring techniques has grown in importance over recent years to become central to the maintenance management function and the detection of the onset of component wear out beyond its safe limit. This provides, if adopted by the Duty Holder, an invaluable tool to loss prevention and monitoring of safety critical parameters in support of their crane life extension safety case.

6.4 Applicable Aspects of Crane Ageing and Degradation

The following aspects of the crane ageing and degradation specifically apply when using cranes beyond their design life.

- Maintenance and operating history.
- Physical ageing mechanisms; fatigue, creep, corrosion, erosion, brinelling, wear and failure due to vibration and seal leakage.
- Detection and monitoring to ensure that safety margins are not eroded beyond agreed limits.
- Integrity inspections in accordance with HSE Report OSD INS JM/010A, Crane Inspection Sheets – Specialist Evaluation Assessment (Ref. 7) [status sheets (A) for lattice boom pedestal crane].
- Time elapsed between inspections based on perception of risk derived from the QRA and agreed by a competent person.
- Crane usage of design life.
- Evidence of wear in gearbox and bearings from debris and metal particles in oil and grease samples.
- Fault condition dynamic loading.
- Electrical insulation testing/earth leakage monitoring.
- Drift in control and instrumentation calibration.

7 Controls and Procedures

7.1 General

The Duty Holder should ensure a safe system of work in crane and deck operations. It is good practice to provide written procedures for the selection and use of equipment. The objective of such procedures should be to produce instructions addressing how risks identified by assessment will be eliminated or adequately controlled. This philosophy should be applied to both routine, complex and specialised lifting operations.

Following a review of lifting and rigging operations under the Step Change initiative, Sparrows Offshore have made their publication 'Offshore Crane Operator and Banksman/Slinger Integrated Safe Operating Procedures' available to the industry. Although not a mandatory document this currently represents an example of 'best practice' which could be adopted by Duty Holder's as part of an integrated crane operating procedure.

Account should also have been taken of the implementation of the risk, COSHH and manual handling assessments.

Detailed guidance on the lifting and crane operating procedures is contained in HSE OSD Document OTO 96041 (Dec 1999) (Ref. 1). A list of pedestal crane essential features is provided as Appendix A of this guide. The Duty Holder should attempt as far as possible to comply with these features.

7.2 Applicable Aspects of Management Controls

The following aspects of management controls specifically apply when using cranes beyond their design life:

- Procedures addressing how the operating and maintenance risks, identified by a QRA assessment, will be eliminated or adequately controlled

- Offshore crane operator and banksman/slinger integrated safety operating procedures should be followed, an example of this type of procedure is that produced by Sparrow Offshore.

- Pedestal crane essential features and guidance on lifting and crane operating procedures contained in HSE OSD Document OTO 096 041 'Technical Guidance - fixed cranes and lifting equipment' (Ref. 1).

8 Review of Step Change Initiatives

The cross industry Step Change Initiative is committed to deliver a 50% improvement in the whole offshore industry's safety performance in three years starting from 1998 by identifying and adopting best practice. However, at February 2000 significant progress has yet to be made to meet this target.

Areas identified as being necessary to improve safety performance are:

- Target existing safety management tools on areas with below average performance to bring up to industry average.

- Focus on key issues for sustainable gains.

Appraisal of the following task groups indicates the following progress in meeting their deliverables:

- **Drilling Safety Task Group** – This group was set up as part of the Global Drilling Safety Group and has established the following sub-groups:

  - Dropped objects – Work complete and an effective programme produced that has seen reductions in the number of dropped objects.
  - Safety observation systems
  - Rig floor safety
  - Safety leadership training
  - Communications
  - Cross company learning

- **Safety Leadership Training Group** (this is a sub-group of the cross-industry drilling safety group) has been set up to develop training for supervisors and others with safety leadership responsibilities. A video for the promotion of safety leadership and the group is now developing a leadership course syllabus and training provider qualification. The International Association of Drilling Contractors common principles are used to provide consistency.

- **Common Induction Process Group –** A new standard has been produced to significantly extend the offshore content of the induction process for new starts. This will engage all supervisors in training and assessment of their own team members during the ‘Green Hat’ period.

The document comprises two volumes:

Volume 1 – Guidelines for operators & employees – employing company based induction, installation specific induction, team & on-the-job induction

Volume 2 – OPITO approval standards – basic offshore safety induction & emergency training.

- **Behavioural Factors in Safety Management Group –** deliverables are:

  - A description of what the desirable behaviour would look and feel like.
  - An agreed framework and set of principle for behavioural factors in safety management.
  - A toolbox of the practical behaviour modification tools that are currently available, with information on their strengths and weaknesses, and sources of further information and guidance.
  - An implementation plan to achieve rapid and effective application of the tools.
  - Performance indicators for monitoring the impact of behaviour modification tools.

A survey report was published by the Aberdeen University. The main consequence of this report was the setting up of the OIM Network. Certain issues identified which will need to be addressed to enhance safety performance include:

- Standardisation and simplification of the rules, policies and procedures across the industry especially in light of the increasing use of contractors.
- Improved training and competence for all personnel and contractors staff, and standard competency assessment schemes for all personnel.
- Improved corporate and senior management support of the offshore workforce, and improvements in communications between onshore and offshore management.
- Involving personnel at all levels in safety and empowering them with ownership and responsibility for safety .Establish clear policy for the use of positive and negative reinforcement of behaviour, and then establishing effective behaviour systems to promote safe behaviours.

- **OIM Network –** this has developed and issued the safety triangle and has sponsored the setting up of the Safety Representatives Network. The group is participating in the implementation of the smart card Offshore Passport and is participating in the behavioural issues task group.

The safety triangle was the first deliverable with limits defined by its three sides Representing:

- The law – legislation and statute.
- Policies and procedures – the written safety management systems of each company.
- Training and competence – the training and competence each individual requires to carry out a task.

Elected Safety Representatives Network – objectives are:

- To enhance communication between all elected safety representatives and their respective companies.
- To highlight health, safety, welfare and environmental issues or concerns and collectively search for best solutions.
- To actively engage everyone who is involved in the oil and gas industry, i.e. standby boats, helicopter crews etc.
- To gather and share common information across the industry.
- To ensure commitment from companies and all levels of their management to support Step Change and the SI 971 Network.
- To be involved in realistic targets and goals.
- To foster better co-operation between companies concerning safety matters.
- To give support and encouragement to representatives under pressure.
- To act as a springboard for constituents concerns.
- To build relationships across the industry.
- To promote further workforce involvement in safety.
- To ensure better access to information relevant to safety.
- Encourage an improved relationship with the HSE.
- Enhance involvement in setting the Sep Change in Safety Agenda.
- Several workshops have been held to build on the above objectives.

- **Offshore Passport and Personnel Tracking Steering Group –** during 1998, two Groups developed a concept for a personnel tracking and passport system that could be used across the UK oil and gas industry.

A contract has been signed between OPITO (who will act as the Advantage tracking system), and ORACLE Corporation UK Ltd (as database / software developers) and CIS, Aberdeen (as 'Smart Card' system designers). This is capable of storing 40 pages and provides:

Central database linked to existing Duty Holder personnel tracking systems, with smart card for each individual.

A source of data on individuals' survival training, medical and trip history.

A potential source of competency information.

A source of information for Duty Holder's to check that requirements to travel offshore have been met.

- **Safety Observation Systems Working Group**

The drilling safety group has developed guidelines for the safety observations systems (i.e. STOP) based on the observed best practices. It has subsequently been recognised that an introduction to safety observation systems would be beneficial to a wider audience. Three deliverables have now been produced:

"Look this way" booklet – Describes the basic principles of safety observation systems. This is intended to raise the awareness of safety observation systems and creates opportunities for discussion at safety meetings, toolbox talks etc.

Pocket Cards – The card summarises key elements of safety observation systems and supports the above booklet by providing a checklist to assist effective safety observation.

Posters – These support the above and can be downloaded from the Step Change Web-site.

- **Task Risk Assessment Work Group** - a guidance document to be produced by the end of 2000 which will include:

  - To include supporting material and existing industry reference (e.g. UKOOA's risk related decision support / HSE's consultative document reducing risks, protecting people).

  - To include recommendations on personnel training.

  - To include key performance indicators for the process.

  - To include the who, what, why, when and where.

  - To take account of relevant regulatory requirements e.g. COSHH.

  - Ensure workforce workshop issues are addressed.

Industry initiative sponsored by UKOOA has developed a framework for safety related decision-making and the report, Issue No.1 was published in May 1999. These guidelines will help managers create a more transparent decision making process. This will assist in ensuring that risks to offshore personnel and the environment are reduced to a minimum practical level. 'Goal setting' can result in more complex decision making process and these guidelines assist in clarifying available options.

The framework can assist decision–makers to identify an appropriate basis for decision making. They provide a means to assess the relative importance of codes and standards, best practice, engineering judgement, risk analysis, cost benefit analysis, company values and societal values when making decisions. This will promote dialogue and engagement with all stakeholders and also assist in identifying where improvements can be achieved in managing health and safety risks.

- **Industry Safety Performance Work Group**

Work of the group is now complete. Now merged with Accident Statistics Working Group.

The following baseline performance data has now been established:

- Baseline performance data
- List of companies contributing to cross industry statistics
- Lagging indicators
- Potential matrix 1997 data
- Leading indicators
- Guidelines on the application of cross industry performance indicators
- Industry safety performance measures
- Guidelines for Personal Safety Performance Contract – This contract, a commitment to oneself, is intended to visibly demonstrate personal concern for safety as an equal to business performance. The intent is to directly impact safety behaviour in an organisation and contribute to a step change in performance in the industry.

- **Standard Lifting and Crane Operating Procedures Group** – Objectives are:

- To promote best practice in crane/deck operations by developing common integrated safe operating procedures for crane operations.
- To promote the use of the procedures, along with a common competence standard for deck operators.

This group has also produced the following OPITO standards of competence:

- Performing offshore facility deck operations – Level 2 (deck crew personnel)
- Lifting operations offshore – Level 2 (crane operator personnel).

Sparrows Offshore leading this initiative and have made available their "Offshore Crane Operator and Banksman/ Slinger Integrated Safe Operating procedures" to others in the oil and gas industry. Sparrows are also undertaking, sponsored by themselves, reviews of lifting operations on installations not only within their client base but also other installations. Early indications from initial and follow up inspections are that there is a considerable downturn in lifting incidents during 1999. Other Duty Holder's are being encouraged to take advantage this Sparrows initiative.

- **Effective Communications Working Group –** is actively exploring ways to increase company awareness of Step Change and has issued questionnaire to determine preferred methods.

- **Commercial Issues Work Group** - This group has assessed commercial issues and resulting work pressures involved in producing and selling gas. A first pass has been completed and will be presented to the Leadership Forum. This is based on Acro's experience. At a later stage the group will examine other client/ contractor issues.

- **Common Operating Standards Work Group –** This group is working to harmonise standards and procedures of companies with installations in the southern part of the North Sea. Work on helicopter embarkation and disembarkation procedures is complete.

- **Safety Benchmarking Group –** This group's work is held pending HSE approach to companies operating in the English sector for safety performance data for an Incident Potential Matrix.

- **Guidelines for Safety Case Communication** - The work of this group was completed in 1998. An information package was distributed in the offshore industry and a document titled "Communicating the Safety Case" has been issued. These guidelines are designed to help understanding of the offshore worker of how the safety case relates to their job. The advice they offer will assist ideas to be developed for communicating the safety case through a wide range of media.

- **Safety Management System Interface Guidelines –** this group has completed its work. Issue 3 of booklet on 'Safety Management System Interface Guidelines' was issued in October 1993 and updated in 1999. The purpose of establishing SMS interfacing arrangements is to ensure that standards of safety achieved by any one party through the application of its SMS are not compromised by another or others, whilst undertaking shared activities. This new guide takes account of the varying degrees of risk and thus sets out best practice in terms of the process of establishing SMS interfacing arrangements.

- **OMHEC –** is a committee comprising of representatives from countries with offshore operations around the North Sea, i.e. Norway, Denmark and the Netherlands. One of the major issues that the committee members have been involved in over the last two years have been the development of the UK Lifting Operation and Lifting Equipment Regulations (LOLER). OMHEC has currently established two Working Groups which constitute OMHEC's advice on the questions of training of personnel involved in lifting operations and competency and the role, independence and competency of the competent person/enterprise of competence. OMHEC's objectives are to contribute to improved safety in offshore lifting operations and be the arena for work to harmonise good practice in lifting operations in the North Sea offshore area.

9 Human Factors

There are few distinct Human Factors criteria that need to be addressed for operating cranes beyond their design lifetime that would not have been considered as part of the original safety case and supporting QRA. However there are three significant areas that may arise out of beyond lifetime extensions which may have an indirect impact on the crane operators and maintainers:

The first of these areas is where, as part of the justification for beyond lifetime extension, the operating limits (envelope) for the crane have been changed from those in operation prior to the lifetime extension. This would give rise to a number of concerns:

- There must be clear communication/warnings/detailing of the changed operating limits for the crane, particularly for operators who have used the particular crane before and may have expectations based on the previous operating limits;

- Where a particular crane will be used as part of a not normally manned installation, the risk of an operator attempting to operate the crane outside of its new operating limits is likely to be increased due to lack of familiarity and infrequency of use.

The second area where care needs to be taken is where a modification is made to the crane to allow continued operation beyond lifetime:

- Communication of the modification status needs to be carefully managed to ensure that all maintainers and operators are aware of the modification and that all documentation is in place offshore to support changed maintenance or operating procedures.

Finally there is the consideration of the effects of increased frequency of revealed and unrevealed faults which will be associated with the crane operation in the wear out phase. As the frequency of faults associated with the crane increases (even though they may not be critical), this may have an effect on the operator perception of a ‘tolerable’ level of background faults. Against this increased background ‘noise’ of faults, occasional critical faults may be missed. Similarly there may be faults occurring that would not normally be seen by the maintainers and operators, and which they do not have the requisite experience to recognise or deal with.

To counter these effects there would need to be a level of re-education of operators and maintainers to ensure that their awareness of the ‘critical’ faults is maintained, and what to expect in terms of wear out faults is known. This would need to be supported by the correct level of expertise in terms of maintenance personnel and detailed maintenance procedures.

10 REFERENCES

1. HSE OSD Document OTO 96041 – Offshore Lifting and Handling Appliances 1999 – "Recommendations on Design, Construction and Operation"
2. SI 2307 - Lifting Operations and Lifting Equipment Regulations 1998. (LOLER)
3. SI 2306 – Provisions and Use of Work Equipment Regulations 1998 (PUWER)
4. Health and Safety at Work Regulations 1992
5. Assessment principles for offshore safety cases – HSE – HSG 181 1998.
6. Offshore Installations (Safety Case) Regulations 1992
7. HSE OSD Document Reference OSD.CRA.INS.JM/010A - Crane Inspection Sheets, Specialist evaluation assessment.
8. HSE Report OTO 99041 – 'Recommendations/guidance on operation and safe use of offshore lifting equipment'

Appendix A Pedestal Crane Essential Features

Principal Feature	Essential	Desirable	Optional
Crane Duty			
To agreed relevant design codes	Yes[1]		
Limited by component strength	Yes		
Limited by sea-state	Yes		
Limited by Offlead and/or side lead angles (vessel excursion)	Yes		
Limited by wind speed	Yes		
Foundation Loading			
Maximum loads generated by lifting operations – free standing/fixed/tied-down	Yes		
Maximum loads generated by travelling – with/without load on hook	Yes		
Performance			
Hoist speed – sufficient for hook to clear vessel and deck cargo without re-impact	Yes		
Speeds of boom hoist and slew – sufficient to follow excursion of supply vessel	Yes		
Prevention of uncontrolled overhauling/free fall of load hoist/boom hoist	Yes		
Prevention of uncontrolled slewing	Yes		
Prime mover stall prevention – power management system	Yes		

Principal Feature	Essential	Desirable	Optional
Braking Systems			
All service brakes to be spring set (fail to safe) type	Yes		
At least one dynamically rated brake to act directly at the load/boom hoist drum (For man-riding operations only)	Yes		
Secondary braking – downstream of drum (essential for man-riding)		Yes	
Boom hoist pawl			Yes
Brakes protected against environmental and other contaminants	Yes		
Drums/Sheaves			
Grooved drums			Yes
Controlled rope spooling	Yes		
Captive rope system (at drums and sheaves) under tight/slack rope conditions	Yes		
Minimum D/d ratio (pitch) 18:1 (or other recognised code)	Yes		
Rotation of drum – direct sighting and/or via indicator to crane operator			Yes
Ropes/Terminations			
Low rotational multi-strand for fastline/whip hoist		Yes	
Six strand rope for boom hoist		Yes	
Pendant ropes – if fitted			Yes
Direct access to rope anchorage's/terminations		Yes	
Ropes constructed to recognised Standards	Yes		
Terminations to recognised Standards, e.g. BS7035	Yes		
Operators Compartment			
Clear line of sight from boom tip to supply vessel deck	Yes		
Window wipers/washers/de-misters	Yes		
Internal temperature controls	Yes		
Safety glass windows	Yes		
Rear viewing for travelling mobile cranes	Yes		

Principal Feature	Essential	Desirable	Optional
Controls			
Hand controllers centre to neutral on release	Yes		
Hand controller movements directional and proportional with the crane motions		Yes	
Layout/operations to recognised ergonomic principles	Yes		
Safety Systems			
Gross Overload/Over-moment Protection (GOP)	Yes		
SLI with data recorder desirable	Yes		
Wave following/Constant tension system		Yes	
Slew torque limiters			Yes
Prime mover stall and overspeed prevention (rig saver) system	Yes		
Emergency load release		Yes	
Emergency stop	Yes		
Over-hoist/Over-lower Warning/Cut-out	Yes		
Max/Min radius Warning/Cut-out	Yes		
Boom back stops – shock absorbing type	Yes		
PA/Radio communication – two way		Yes	
Fire & Gas systems	Yes		
Drum rotational indication/direct viewing of drums by operator			Yes
Aircraft warning lighting	Yes		
Load/boom speed lower indicator – mechanical transmission cranes only		Yes	
Operations in Potentially Explosive Atmospheres			
Flameproof diesel engines to recognised standards, e.g. OCMA requirements	Yes		
Electrical system to recognised standards, e.g. ATEX Directive	Yes		

Principal Feature	Essential	Desirable	Optional
Materials – Primary Load Path			
Fine grain	Yes		
Chemical properties to agreed recognised standards	Yes[1]		
Mechanical properties and testing to agreed recognised standards	Yes[1]		
Special materials – by agreement			Yes[1]
Welded Structures – Primary Load Path			
Welding to agreed recognised standards	Yes		
Welds to be continuous		Yes[5]	
Slewbearing			
Slewbearing designed to agreed offshore standards – pedestal crane	Yes		
Retainers/retaining ring - pedestal crane		Yes	
Grease sampling facility	Yes		
Rocking test (bearing play check)	Yes		
Built-in condition monitoring		Yes	
Inspection/condition monitoring procedures	Yes[4]		
Access & Egress			
Built-in – to facilitate routine checks and maintenance, etc.		Yes	
Emergency escape – regardless of position/configuration of crane	Yes		
Slew Bearing Fasteners			
Properties to BS3692 Grade 10.9, or agreed equivalent standard	Yes		
Through bolt type fixing		Yes	
Minimum bolt length – 5d (where d = diameter of bolt shank)		Yes	
Rolled threads after heat treatment		Yes	
In-situ load monitoring facility		Yes	
Agreed tightening and monitoring procedures	Yes[1]		

Principal Feature	Essential	Desirable	Optional
Hydraulic Systems			
Components/piping/fittings in non-corrosive materials			Yes
Closed type reservoir fill/breather system			Yes
Corrosion Protection			
Seizure prevention of critical components – pins, springs, control valves, etc.	Yes		
Corrosion prevention of critical fasteners – slew bearing	Yes		
Corrosion prevention of principal fasteners		Yes	
Seal welding/closure of primary structural welds against crevice corrosion		Yes	
Hooks/Hook Blocks			
Designed and proof tested to recognised standards	Yes		
Positive captive holding of slings (no unsolicited shedding)	Yes		
Storm/Sea Transit Conditions			
Method of crane securement to agreed written procedures	Yes[1]		
Survey and Inspection			
Pertinent to regular, infrequent or long periods of inactivity of the crane	Yes		
Documentation			
Operating – procedures, limitations, etc.	Yes		
Inspection/maintenance/service	Yes[4]		
Man-Riding Operations			
Man-riding operations	Yes		

Notes:

1. "Agreed/Agreement" is taken to be that assigned to the Duty Holder/Competent Person and the Crane Manufacturer or supplier. All agreements should be documented.
2. The recommendations tabulated above, are considered to be practical and in keeping with established good practices. The listings are not exhaustive and variations are expected to arise according to crane type, operational service and location.
   Variances, technical, operational or otherwise, should be agreed with the Duty Holder/ Competent Person and the Crane Manufacturer/supplier
3. The Crane Manufacturer/supplier should warrant the crane for operational services and environmental and/or installation limitations specified by the Duty Holder/Competent Person.

4. Inspection, Maintenance and Pre-start procedures, should be in concert with the use of the crane, i.e. frequent use, infrequent use or, crane left idle for long periods – 1 month or greater.
5. Continuous welds may be required on certain structural parts of the crane for protection of the internals against corrosion.

Appendix B Principal Recommended Safety Systems

Code designation A is a requirement of ACoP

Code designation B is a requirement of HSE Report OTO 96041 – Offshore Lifting and Handling Appliances 1999 – “Recommendations on Design, Construction and Operation” (Ref. 1).

	System	Code	Comment	Crane Configuration			Cranes used for deck lifts only
				Rope luff	Ram luff	fixed	All types
#1	GOP	B	Used for boat lifts	Yes	Yes	Yes	N/A
2	SLI	A	All lifts	Yes	Yes	Yes	Yes
3	Data Recorder	B	For slewring deferrals	Yes	Yes	Yes	Optional
#4	Auto Tension	B	Used for boat lifts	Yes	Yes	Yes	N/A
#5	Slew torque limiters	B	Used for boat lifts	Yes	Yes	Yes	If Required
#6	Emergency load release	B	Used for boat lifts	Yes	Yes	Yes	N/A
7	Over-hoist limits	A		Yes	Yes	Yes	Yes
8	Over-lower limits	A		Yes	Yes	Yes	Yes
9	Overspeed control	B		Yes	Yes	Yes	Yes
10	Min/max radius limits	A		Yes	Yes*	Yes	Yes

	System	Code	Comment	Crane Configuration			Cranes used for deck lifts only
				Rope luff	Ram luff	fixe d	All types
11	Slewing limits	A	Where applicable	Yes	Yes	Yes	Yes

Notes:

Where the fitting of these systems is not practicable on existing cranes, then a risk assessment should be carried out by a competent person which indicates the measures employed to mitigate the hazards associated with operating the crane without such systems in place.

* Minimum radius may be achieved by fully stroking the luff rams to their physical limits. At maximum radius, there should be approximately 75 mm of free stroke remaining in the rams, i.e. the rams should not bottom-out when operating at maximum radius.

Appendix C HSE Inspectors Checklists

These checklists are intended to assist HSE (OSD) inspectors when reviewing/auditing a Duty Holder's proposal to extend the operational life of a pedestal crane beyond its design life. The checklists cover issues specific to life extension, and should be used as a working tool to assist in checking the extent of the Duty Holder's Safety Case for the life extension of the crane.

The checklist should be considered in conjunction with the following documents:

a) HSE Report OTO 96041 – Offshore Lifting and Handling Appliances 1999 – "Recommendations on Design, Construction and Operation" (Ref. 1).

b) HSE Report OSD.CRA.INS.JM/010A, Crane Inspection Sheets (Ref. 7) – Specialist Evaluation Assessment (status sheets (A) for lattice boom pedestal crane)

Where possible audit questions should be addressed during the review of the safety case, with the remainder of the questions being addressed at the Duty Holder's onshore or offshore facitilities.

The contents list of the topics addressed by this checklist is provided below:

1.0 Policy/Objectives

2.0 Design, Manufacture and Testing

3.0 Management Procedures and Controls

4.0 Operating and Maintenance History

5.0 Structural and Mechanical Integrity

6.0 Protection Against Dropped Loads

Checklist Audit of Pedestal Crane Safety Case for Operation Beyond its Design Life

1.0 Policy/Objectives

Guidance:

1 Where the Duty Holder proposes to operate a pedestal crane on an offshore installation beyond its design life, then the following should be stated in the safety case which is submitted to HSE.

- Production regime (manned and/or demanned) and timescale to end of production.
- Platform decommissioning regime.
- Crane load spectrum schedule to meet the above demand.

It may be that the Duty Holder's Safety Management System for the installation has previously been audited by HSE. Should this be the case, then the OSD inspector should note the findings of the SMS audit, prior to the 'crane beyond design life' audit, as some of the recorded findings will enable a number of issues to be closed out.

1.0 Policy/Objectives (continued)

		Yes	Partly	**No**	**N/A**
a	Has the Duty Holder's Safety Management System for the installation production regime, under which the crane is to be operated beyond its design life, undergone an audit by HSE?	☐	☐	☐	☐
b	Has the QRA for the above production regime been assessed by HSE?	☐	☐	☐	☐
c	Has the Duty Holder submitted a safety case for operation of the crane beyond its design life which is solely based on 'fitness for purpose' of the crane?	☐	☐	☐	☐
d	Has the Duty Holder an approved safety case for the whole installation which aligns with the proposed crane extended life?	☐	☐	☐	☐

1.0 Policy/Objectives (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Normally manned installation: • Minimum manning. • Short production periods/mothballed.		☐
Normally unmanned status: remote controlled • Neither workover rig or accommodation in use. • Crew onboard for period exceeding one day (workover mode) and planned work. (accommodation and facilities significantly reinstated).		☐
Crane load spectrum.		☐
Safety Management System		☐
Platform decommissioning		☐

2.0 Design, Manufacture and Testing

Guidance:

The crane should have been designed to recognised codes and standards, using well understood materials and well established methods of manufacture, construction and testing. Records should be checked to confirm that the appropriate testing authorities were satisfied that all aspects and tests were in accordance with the necessary standards.

The principal standards for the design, manufacture, construction and testing of the crane must be recorded in the Duty Holder's safety case. This is essential to form a "footprint" for evaluation of areas such as remaining fatigue life, etc.

The Duty Holder's safety case for the crane life extension should be supported with drawings, diagrams and schematics. The level of detail, the quality of drawings, etc, should be sufficient to support and facilitate understanding of the case demonstrating safety of load handling and the constraints in relation to the crane's intended use.

General Description: should provide an overview and clear understanding of the crane installation and its load handling activities. This should relate the current operational parameters and highlight any derating of the original specified design.

Location and Environment: should include a location plan showing the hazardous zones (as per IP designated areas) which may be significant in terms of risk evaluation, together with a summary of the local environmental information for the area and any extreme conditions which might affect the crane's operations. The foregoing *hazardous zones* relate areas where there is a risk of leaks of hydrocarbon products as the result of a dropped load and should not be confused with *electrical zones*.

Structure and Layout: should include a description of the structure of the crane and its underbase, location on the platform, orientation, adjacent equipment and location of the temporary refuge.

Primary Functions: for each lifting and slewing functions the description (or references) should include equipment, controls, arrangements, policies, procedures and supporting design criteria as appropriate, with emphasis on role in prevention, control and mitigation of major accident hazards Frequency of use and any periods of inactivity/extended periods of non-use, and the control and communication arrangements should be specified.

Special attention should be paid of maximum and minimum operating conditions (wind loading, temperature, etc), performance standards, safety margins and redundancy.

Hazardous substances and inventories: This should be a summary of all hazardous substances handled by the crane and inventories of hydrocarbons on or adjacent to the crane's load route which could contribute to the escalation of a dropped load event into a major accident.

Safety features and systems: systems which protect the plant and personnel against a load drop, uncontrolled load lowering or collision should be identified.

HSE OSD Document OTO 96041 (1999) (Ref. 1), Appendix I and II lists the principal features which should be described in the Duty Holder's case for the crane.

2.0 Design, Manufacture and Testing (continued)

The following design parameters should be provided by the Duty Holder (or be available for auditing):

Safety Factors (shear and tensile);	Lifts per Year;
Impact Factor;	Design Life of Crane;
Design Load;	Fatigue Life Cycles

The following crane duties should be stated by the Duty Holder (or be available for auditing):

- Safe working load (as applied to inboard lifting duties) related to both minimum and maximum operating radius, length of boom, and to the number of rope falls used in the load hoist system.
- The crane de-rated duties for dynamic lifting operations appropriate to specified sea states should be permanently indicated in the crane operators' cabin.
- The full range of crane duties for inboard and outboard (from the sea) lifting, should be included in the crane operating manual and be loaded into the crane's safe load indicator system.

The following operating limitations should be stated:

- Component strength
- Sea-state
- Offlead (vessel excursion)
- Sidelead
- Wind speed
- Dynamic coefficients
- Snow/ice build up (if applicable)
- Temperature

It is essential that underperformance under the following conditions is prevented:

- The hook speed should be fast enough to prevent re-impacting of the load with the supply vessel for the specified sea states. The height of the adjacent containers on the deck of the supply vessel should be taken into account (low hoist speeds may restrict the number of falls of rope that can be used for a particular sea-state and hence limit the lifting capacity of the crane).
- The speed of slew and luff hoist should be sufficient to enable the crane operator to keep the load line sensibly plumb within the excursion envelope of the supply vessel and within the specified offlead and sidelead parameters.
- Selection of two or more crane services should not cause undesirable motions of the hook.
- The prime mover should be prevented from stalling or overheating during utilisation of maximum power conditions, with the crane in the most adverse configuration.
- Uncontrolled overhauling and/or free fall of the load hoist and luffing hoist systems and uncontrolled slewing motion of the crane are unacceptable.
- All safety systems and cut-outs etc should remain active even if the prime mover fails to keep running.

2.0 Design, Manufacture and Testing (continued)

		Yes	Partly	No	N/A
a	Does the records show that the crane was designed to recognised codes and standards, using well understood materials and well established methods of manufacture, construction and testing?	☐	☐	☐	☐
b	Do records confirm that the appropriate testing authorities were satisfied that all aspects and tests were in accordance with necessary standards?	☐	☐	☐	☐
c	Has the current and intended crane installation status, and its load handling activities been related to that of the original design?	☐	☐	☐	☐
d	Do the duty conditions during the proposed extended operating period remain within the cranes original design envelope; this includes the maximum postulated loading resulting from unsolicited loading?	☐	☐	☐	☐

2.0 Design, Manufacture and Testing (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Principal standards for design, manufacture, construction and testing.		☐
Location plan showing IP designated hazardous zones.		☐
Crane structure and layout (underbase, location on platform, adjacent equipment, temporary refuge).		☐
Primary functions for lifting and slewing (equipment, controls and communications).		☐
Load spectrum schedule.		☐
Periods of inactivity/extended periods of non-use.		☐
Changes in design parameters (safety factors, impact factor, design load, lifts per year, design life of crane, fatigue life cycles).		☐
Crane component fatigue cycles at end of proposed extended life.		☐
Safe working load as applied to:		
Inboard lifting duties		☐
Minimum operating radius		☐
Maximum operating radius		☐
Number of falls of ropes used in load hoist system		☐
Crane de-rated duties for dynamic lifting operations appropriate to sea states.		☐
Range of crane duties for outboard lifting.		☐
Safe load indicator limits		☐

2.0 Design, Manufacture and Testing (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Limitations:		
Component strength		☐
Sea-state		☐
Offlead		☐
Side-lead		☐
Wind speed		☐
Dynamic coefficients		☐
Snow/ice build-up		☐
Temperature		☐
Performance:		
Hook speed.		☐
Speed of slew and luff.		☐
Hook motion on selection of two or more services.		☐
Stalling or overheating of prime mover with crane in most adverse configuration.		☐
Uncontrolled overhauling and/or free fall of load hoist and luffing system.		☐
Uncontrolled slewing motion.		☐

3.0 Management Procedures and Controls

Guidance:

The Duty Holder should ensure a safe system of work in crane and deck operations. It is good practice to provide written procedures for the selection and use of equipment. The objective of such procedures should be to produce instructions addressing how risks identified by assessment will be eliminated or adequately controlled. This philosophy should be applied to both routine and specialised lifting operations.

Following a review of lifting and rigging operations under the Step Change initiative, Sparrows Offshore have made their publication 'Offshore Crane Operator and Banksman/Slinger Integrated Safe Operating Procedures' available to the industry. Although not a mandatory document this currently represents an example of 'best practice' which could be adopted by Duty Holder's as part of an integrated crane operating procedure.

Account should also have been taken of the implementation of the risk, COSHH and manual handling assessments.

Detailed guidance on the lifting and crane operating procedures is contained in HSE OSD Document OTO 99041 (1999) (Ref. 1).

It is essential for a review of the crane that a load spectrum schedule should be produced in conjunction with the platform operations and maintenance departments, which identifies the significant loads routinely handled, their weight and approximate lifting frequencies. Pessimistically high operational frequencies may be assumed to provide an allowance for minor miscellaneous lifts over hazardous areas.

The crane review should assess whether the management control procedures:

- Cover all routine load lifting operations undertaken and identify those lifts that take place over hazardous areas.
- Provide sufficient information to enable the lifting operations to be performed safely (including emergency recovery procedures following a hung load, brake failure or other incidents).

3.0 Management Procedures and Controls (continued)

Operating constraints on Category 1 and 2 cranes must be identified in the operating procedures.

The operational risk assessment should demonstrate consideration of factors such as:

- The levels of supervision required.
- Working under suspended loads.
- Working over water.
- Working in confined and restricted spaces.
- Working at heights.
- The levels and methods of communication required.
- Visibility and sight lines which operatives have.
- Measures to prevent the load striking object or any person.
- Attaching/detaching and securing of loads.
- Training and competence levels of operatives.
- Positioning and installation of equipment.
- Adequate access and egress.
- Sufficient headroom.
- The proximity of other operations/personnel.
- The prevention of accidental overturning (mobile cranes only).
- The effect of weather conditions on the operation and personnel involved with these operations.
- The proximity of other objects/hazards.
- The potential to overload the equipment.
- The correct choice of equipment.
- The adequacy and suitability of landing areas.

3.0 Management Procedures and Controls (continued)

The hazard survey should identify:-

- The type of equipment in use.
- The potential for equipment being used outwith the limitations specified by the manufacturer/supplier.
- The potential for equipment being used that has not been designed/manufactured in accordance with the approved specifications.
- The potential for equipment being used outwith the limitations specified by the Duty Holder.
- The potential for equipment being used as part of a system which has been designed to tackle a specific 'one off' operation.
- Any inadequacy in the provision of instructions for use of the equipment.
- The potential for equipment being used which has not been tested/examined in accordance with regulations/requirements.
- The potential for non-competent and unauthorised personnel using the equipment.
- Any inadequacy in the manufacture and storage of equipment.
- Any inadequacy in the provision of procedures for the operation of the equipment.
- Equipment failure modes and consequential effects.
- The potential of equipment failure due to overuse or overload.
- Any inadequacy in the repair/refurbishment process.
- Any inadequacy in the inspection/examination or testing process.
- The potential consequence of human error or aberrant human behaviour.
- Any inadequacy in the provision of training.
- Any inadequacy in the provision of supervision.
- Any inadequacy in the process of determining the nature and characteristics of the loads being lifted.
- Any inadequacy in the levels of necessary communications.

3.0 Management Procedures and Controls (continued)

		Yes	Partly	No	N/A
a	Does the load spectrum schedule cover platform operations and maintenance loads routinely handled during the proposed residual life of the crane?	☐	☐	☐	☐
b	Does the lifting procedures adopt best rigging and lifting industry practice?	☐	☐	☐	☐

3.0 Management Procedures and Controls (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Hazarous areas (as defined in IP standard)		☐
Hydrocarbon inventories		☐
Gas turbine/diesel fuel inventories		☐
OTO 096041 (1999) recommendations		☐
Non-destructive testing		☐
Colour coding system for loose gear		☐
Specialised lifting operations		☐
Routine lifting operations		☐
Regulatory requirements		☐
Proof testing		☐
Environmental conditions		☐
Equipment standard or non-standard		☐
Communications		☐

3.0 Management Procedures and Controls (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Validity		☐
Load centre of gravity		☐
Rigging		☐
Laydown area		☐
Unprotected process plant/machinery		☐
Control of hazardous substances		☐
Interlocks		☐
Load restraints to deck		☐
Dynamic loading		☐
Training		☐
Multi-skilled training		☐
Unfamiliarity with equipment		☐

4.0 Operating and Maintenance History

<u>Guidance:</u>

The Duty Holder should have reviewed the operation and maintenance history of the crane to establish the effects of ageing and degradation.

Lifts that are classified as high integrity lifts should also be identified. Use should be made of the lifting history recorded by the SLI facility if one exists on the crane.

Any changes to the functional requirements of the crane that are intended over the proposed extended operating period that are outwith the crane's current design parameters must be identified and reasons for these changes stated.

The safety case should give an overview of the operating history of Category 1 and 2 cranes, and include a description of incidents which could have a significant influence on the integrity of the crane. Modifications which have been introduced to overcome operational faults or significant defects identified as a consequence of undertaking the tasks included in the Maintenance, Inspection and Test Schedule should also be described.

Typically, the operating history will be revealed by inspection of maintenance and survey records such as:

- Non-destructive testing reports
- Maintenance Controller's record of crane defects
- Verification body/competent person's inspection reports
- HSE (OSD) inspector's reports
- Duty holder's modification submission
- HSE and industry Safety Alerts
- LOLER defect report database [LOLER 1998 10 (1) Requirements (Ref. 2)] which is maintained by OD6.4

All dropped load incidents should reviewed by the Duty Holder's with the following information supplied as a minimum (For reportable incidents only under RIDDOR):

- Incident reference number
- Date of incident
- Description of the incident
- Cause of the dropped load incident
- Consequence of dropped load (damage, injuries, etc.)
- Mass of the load dropped
- Height of load when failure occurred.
- Corrective actions, changes to operating procedures, etc.

4.0 Operating and Maintenance History (continued)

The maintenance and operating history of the crane must be presented and be examined in order to identify potential ageing and degradation mechanisms. The main physical mechanisms of ageing include fatigue, wear and corrosion. Physical ageing leads to a reduction in the safety margins of the crane and should be counteracted by a regime of detection, monitoring and mitigation to ensure that safety margins are not eroded to the extent that there is an increased risk to Health and Safety. Each mechanism relevant to the critical areas of the crane, including the monitoring, inspection and maintenance systems in place to guard against future problems, should have been discussed in the safety case to a appropriate level of detail.

No significant ageing or degradation problems should be evident. Integrity inspections should be carried out and recorded in accordance with HSE Report OSD.CRA.INS.JM/010A (Ref. 7), Crane Inspection Sheets – Specialist Evaluation Assessment [status sheets (A) for lattice boom pedestal crane]. Where problems are evident, then one of the actions detailed below should be implemented by HSE OSD regarding the crane status:

- probably satisfactory but some improvements may have to be recommended, with possible issue of HSE improvement notice required with some restrictions or limitations on use being stated or,
- unacceptable, warranting the issue of a HSE improvement notice and possibly a HSE prohibition notice if there is sufficient evidence that safety is being compromised.

Offshore cranes should be inspected on a routine periodic basis as determined by the Duty Holder and his appropriate competent person appointed under SI 2307 (Ref. 2). The time elapsed between inspections may vary dependant on the Duty Holder's team responsible for the crane including the competent person, and their perception of the risk as derived from the QRA.

- Gearbox – monitor for water ingress and sample for particulate and metal particles, both in gearbox and bearing grease, for indication of wear.
- Load Spectrum Schedule Change – where the schedule has been amended from its original operating demand on the crane, fault condition dynamic loading (beyond its design code) on the crane structure needs to be analysed, and if high stress members are identified under the fault condition, the high stress regions need to have a NDT 'fingerprint' taken with re-inspection on a regular interval as determined by the competent person to monitor for degradation and confirm and establish 'fitness for purpose'.

The Duty Holder would be expected to provide a much increased level of surveillance towards the crane's 'wear out phase' at the approach of the end of the crane's design life. Failure/accident data on the crane's safety critical components obtained during its mid-service life do not provide indication of the onset of a component reaching its the wear out phase of the typical mortality (bathtub) curve for the component. It is essential that stricter performance targets are therefore maintained by the Duty Holder during this wear out phase of the crane.

Inherent unrevealed faults should also be addressed in the crane safety case, and during the wear out phase of its life cycle, there is a greater propensity for unrevealed faults, particularly for second line of crane protection. HSE inspectors should confirm that the Duty Holder has appropriate inspection and test regimes in place to ensure that the crane has the necessary integrity margins to operate beyond its design life.

4.0 Operating and Maintenance History (continued)

Generic safety critical elements, unattended risk criteria, crane life limiting mechanisms for each of these elements are presented in Appendix D, together with the likely mitigating arguments and standards the Duty Holder may claim in their QRA for the continued operation of a crane beyond their design life. The inspector should satisfy himself, when auditing the safety case, that the Duty Holder has taken cognisance of all the potential failure effects stated in Appendix D which result from the associated life limiting mechanisms.
The control strategy and surveillance of normally unattended installations involves the remote monitoring of plant and process behaviour by characterising parametric signatures using digital signal processing and measurement techniques. Electrical, electronic, mechanical, hydraulic, pneumatic, vibration and thermal measurements of both static and dynamic nature give real-time identification of plant performance and forecast trends for predictive behaviour, sensitivity, efficiency, optimal operation, fault detection, early warning diagnosis, maintenance scheduling, and risk assessment. A stored spectrum can be nominated as the baseline for a particular speed /load. This baseline is used to compare absolute and relative alarms against either the spectrum or its harmonics. Setting relative alarm baseline creates an alarm envelope that can be overlaid on a plot. Values breached will be enunciated in the alarm banner. The application of the above condition monitoring techniques has grown in importance over recent years to become central to the maintenance management function and the detection of the onset of component wear out beyond its safe limit. This provides, if adopted by the Duty Holder, an invaluable tool to loss prevention and monitoring of safety critical parameters in support their crane life extension safety case.

4.0 Operating and Maintenance History (continued)

		Yes	Partly	No	N/A
a	Have high integrity lifts been identified?	☐	☐	☐	☐
b	Has the crane been Categorised in accordance with its safety significance specified in Part 6 of this checklist (Protection Against Dropped Loads)?	☐	☐	☐	☐
c	Has the operating history been reviewed?	☐	☐	☐	☐
d	Have maintenance and survey records been reviewed?	☐	☐	☐	☐
e	Have dropped load incidents been reviewed?	☐	☐	☐	☐
f	Has integrity inspections revealed any ageing and degradation that either a HSE improvement notice or prohibition notice is justified?	☐	☐	☐	☐

4.0 Operating and Maintenance History (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Safe load indicator facility		☐
Crane modifications		☐
Non-destructive testing reports		☐
Maintenance controllers records		☐
Verification body/competent person's inspection reports		☐
HSE inspector's reports		☐
Duty holder's modification submissions		☐
HSE and industry Safety Alerts		☐
LOLER defect report database		☐
Dropped load incident reports (RIDDOR)		☐
Ageing and degradation mechanisms		☐
HSE Reoprt OSD INS JM/010A, Crane Inspection Sheets (Ref. 7)		☐
Safety Management System Audits		☐
Performance targets		☐
Load spectrum schedule changes		☐
Lube oil samples		☐
Grease samples		☐

4.0 Operating and Maintenance History (continued)

HSE improvement notice(s)		☐
HSE prohibition notice		☐
HSE OSD Document OTO 096041 (1999) (Ref. 1)		☐
Condition monitoring		☐
Critical components		☐
QRA		☐
Component integrity margins to operate beyond crane design life to proposed life extension		☐
Alarm setings for 'wear-out'		☐
Digital signal processing		☐
Vibration monitoring		☐
Electrical monitoring		☐
Thermal measurements		☐
Stress monitoring		☐

5.0 Structural and Mechanical Integrity

Guidance:

Review the structural and mechanical integrity of the crane against current British Standards and other applicable regulations, where the work has not been previously undertaken and is available for review (i.e. where the design safety case is available).

The structural assessment to demonstrate adequacy of the crane integrity must include assumptions for the duty conditions during the proposed extended operating period, e.g. that the duty conditions will remain within the original design envelope.

In recognition of the potential consequences of a dropped load from, or collapse of, a Category 1 crane, a reduction in the rated SWL of the crane is usually considered. This de-rating of the crane is the normal approach adopted by the Verification body. For Category 2 and 3 cranes, the acceptance criterion is as per the code requirements.

In addition to applying conservative strength and fatigue life to the crane design, high integrity may also be demonstrated by providing load path redundancy or protection against the effects of load path failure.

When conducting the crane review, where possible, the above should be analysed to the latest design codes.

The crane fatigue life requirement to the end of the platform life should include an allowance for possible operation during decommissioning.

Structures are generally designed to end of life criteria as a minimum. However, changes to the crane's load spectrum schedule and the maximum estimated dynamic loading resulting from faults must be assessed against the original design parameters.

Where these parameters are shown to be exceeded, then an engineered change should be introduced by the Duty Holder, or a fitness of purpose case, supported by identified residual life monitoring techniques, be submitted for HSE OSD assessment.

The main physical mechanisms of ageing include fatigue, wear and corrosion and for some materials embrittlement. Physical ageing leads to a reduction in the safety margins of the crane and should be counteracted by a regime of detection, monitoring and mitigation to ensure that safety margins are not eroded to the extent that there is an increased risk to health and safety. Each mechanism as relevant to the safety critical areas of the crane, including the monitoring, inspection and maintenance systems in place to guard against future problems, should have been addressed in the Duty Holder's safety case to the appropriate detail.

Where there are any significant ageing or degradation problems identified, then a specialist evaluation assessment (HSE Report OSD INS JM/010A, Crane Inspection Sheets – 'Specialist Evaluation Assessment' (Ref. 7) refers) will be required to enable HSE to decide whether the crane is:

- probably satisfactory but some improvements may have to be recommended, with possible issue of HSE improvement notice required with some restrictions or limitations on use being stated or,
- unacceptable, warranting the issue of a HSE improvement notice and possibly a HSE prohibition notice if there is sufficient evidence that safety is being compromised.

5.0 Structural and Mechanical Integrity (continued)

		Yes	Partly	No	N/A
a	Is the crane fatigue life requirement to the end of the proposed platform life adequate, and does it include an allowance for decommissioning?	☐	☐	☐	☐
b	If the crane is identified to be Category 1 by the QRA, do the single proof components and single failure critical components comply with the FoS requirements given the age and degradation of the critical components?	☐	☐	☐	☐
c	Are the critical components to be subject to condition monitoring during the residual life of the crane?	☐	☐	☐	☐
d	Where the crane fails to meet the latest code requirements, has a ‘fitness for purpose’ safety case been made?	☐	☐	☐	☐

5.0 Structural and Mechanical Integrity (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Component fatugue life requirements to the proposed crane end life (single proof and single failure critical components)		☐
QRA		☐
Safety Management System performance targets		☐
Condition monitoring		☐
Ageing and degradation		☐
Integrity inspection		☐
Factor of Safety		☐
Compliance with latest codes		☐
Fault condition dynamic loading		☐
Environmental conditions		☐
External hazards		☐

6.0 Protection Against Dropped Loads

Guidance:

With regard to the safety significance of a dropped load or equivalent hazard associated with the crane such as a jib collapse, collision or load toppling, each crane is considered to fall into one of the following three categories:

Category 1:	Cranes of major safety significance. This is attributed to cranes where an unprotected fault sequence could cause a major platform safety hazard and/or personnel injury.
Category 2:	Cranes of minor safety significance. This is attributed to cranes where an unprotected fault sequence could cause damage to safety critical equipment but the outcome would not result in a platform safety hazard and/or personnel injury.
Category 3:	Cranes of no safety significance. This is attributed to cranes where an unprotected fault sequence could not cause damage to safety critical equipment nor result in a platform safety hazard or any risk to personnel.

A review of the routine lifting operations of each crane should be presented which establishes the safety significance of each crane and its suitability for routine use for the duration of the proposed life extension validity period.

The consequence of dropping a load should have been verified by site surveys. Judgements should have been made of the likely damage to occur to safety critical equipment, and where applicable, this should be supported by structural impact calculations.

Although personnel risk is covered elsewhere in this document an interface should exist, where the risk of personnel injury as a consequence of a dropped load is on a supply vessel, which identifies this as a possible hazard phenomena.

The site survey, review of platform design, the operating procedures and operating restrictions enable the crane to be categorised as defined above. This categorisation should be clear and unambiguous.

Whilst undertaking the QRA, the Duty Holder should have assessed the protection provided against dropped loads, uncontrolled load lowering and related hazards such as collision, swinging loads and structural collapse that could give rise as a consequence of lifting faults and operating errors.

The assessment of the protection offered by the systems against hazards generated by identified faults should be undertaken by the Duty Holder.

A deterministic assessment is required, followed by a probabilistic assessment of those faults for which the deterministic approach has identified inadequacies in protection against the fault. Target fault frequencies should be highlighted and justified if they do not meet the declared ALARP policy of the Duty Holder’s goals set for individual personnel risk.

6.0 Protection Against Dropped Loads (continued)

When undertaking a crane safety case, review of the following points should be considered:

- For cranes of major safety significance (Category 1), comprehensive reviews of the design, including the protection equipment, and the inspection, maintenance and operating procedures and histories are required.
- For cranes of minor safety significance (Category 2), a detailed technical assessment may not be necessary on the basis of tolerable consequences of failure.
- For cranes where it is established that there are no safety implications (Category 3), no further assessment work will be required.

It should be noted that the above crane categories do not relate to the slew bearing categorisation given in HSE Document OTO 96041 - rev.1999 (Ref. 1).

The bounding event concerns the unprotected fault sequences that could result in the maximum energy dropped load hazard over a area which, potentially, could escalate into a major hazard (i.e. fire and/or explosion) The maximum energy impact from this event can be assumed to be that which results from the maximum scheduled load dropped from the crane's maximum associated hoist height. The affect of simultaneous dynamic loading on the crane underbase, from deck impact, and the rebound on the jib structure from load release should be assessed and be shown to be compliant to a recognised code.

It is necessary to protect the installation against dropped load damage or provide additional protection on the crane. Where necessary the safety features incorporated must be commensurate with the potential hazard. As well as including additional safety features on the crane, to protect against hazards, comprehensive control procedures must be enforced when undertaking critical lifts over potential hazardous areas (i.e. hydrocarbon and/ or gas turbine/diesel generator fuel inventories).

The crane safety case should review the protection systems available on the Category 1 and 2 cranes, by assessing the adequacy of protection offered by the systems against hazards generated by the identified faults.

The crane control and protection equipment should be in accordance with the recommended system stated in HSE OSD Document OTO 096041 (1999) (Ref. 1). The principal recommended safety systems are listed in Appendix B.

Potential initiating events may be categorised as follows:

- Structural failures and mechanical failures
- Electrical failures and control failures
- Operator errors, including attachment (slinging) errors.

Initiating events should be derived from previous review work on other similar types of cranes and from the examination of the design of the crane. Potential operating errors should be identified by reference to the functions detailed in the operating and emergency instructions, and the proposed load spectrum schedule. Where necessary, the consequence of potential initiating events should be analysed by using failure mode and effect analysis worksheets and fault trees, where this has not already been undertaken as part of the overall installation's safety case.

6.0 Protection Against Dropped Loads (continued)

The hazard classification, as a consequence of a major dropped load incidents involving the crane, for the area within the crane operating envelope requires to be established. To establish the hazard classification a hazard schedule should be produced which lists the following:

- The safety critical items within the crane envelop, above and below the decking.
- The consequence of a dropped load on the critical items
- Mitigating factors.
- The hazards and the hazard classifications.

The crane safety case is required to comply with the assessment principles for offshore safety cases stipulated in HSG181 1998 (Ref. 5).

The HSE principles document states the aspects that should be considered by the Duty Holder to ensure that a satisfactory safety case for the crane is submitted to HSE.

Other than the supporting structure and the power supplies, the crane is considered to interface directly only with the load being lifted. The crane interfaces indirectly with safety critical plant/systems when lifting loads above, or in the vicinity of, such items with hydrocarbon inventories or plant safety protection. The potential hazards to safety critical plant/systems should have been identified in the safety case.

Given the dominance of human factor errors on fault sequences leading to hazardous events, detailed modelling of human factor issues must be addressed in the platform Duty Holder's quantitative risk assessment which justifies the continued operation of the crane and associated load handling.

The offshore industry STEP CHANGE initiative has sponsored a framework for introducing 'best practice' and safety related decision making, with the end objective of proposing that the industry adopt a common safety case methodology for probabilistic risk assessment which will justify crane life extension. This should result in a better qualification of uncertainties and provide enhanced QRAs in justification of continued operation of offshore cranes beyond their licensed life.

6.0 Protection Against Dropped Loads (continued)

		Yes	Partly	No	N/A
a	Does the Duty Holder's hazard assessment place the crane in Category 1 – cranes of major significance?	☐	☐	☐	☐
b	Has the consequences of dropping loads been verified by site survey and supported by structural impact calculations?	☐	☐	☐	☐
c	Has the QRA taken account of platform design, the operating procedures and the operating restrictions?	☐	☐	☐	☐
d	Has human factor analysis been carried out and the human performance limiting values been used in the crane fault trees?	☐	☐	☐	☐
e	Have all the crane risks been demonstrated to be tolerable, controlled and ALARP?	☐	☐	☐	☐
f	Has the Duty Holder introduced additional protection measures to reduce the risk to ALARP, and have these engineered or administrative protective measures been demonstrated to meet statutory safety requirements?	☐	☐	☐	☐

6.0 Protection Against Dropped Loads (continued)

ISSUES TO BE ADDRESSED	COMMENTS/WORKING NOTES	X
Crane safety categorisation		☐
Crane hazard categorisation		☐
Structural impact assessment		☐
Human factor limiting values		☐
Human Performance Shaping Factors (PSFs), internal and external influences which will modify the likelihood of human error occurrence. Examples include, poor user interface design, stress, training levels.		☐
Deterministic fault assessment, which models a sequence of events, starting from a defined set of initial conditions, according to predictive methods, which determines a unique outcome for those initial conditions.		☐
Fault tree analysis		☐
Cost benefit analysis		☐
Demonstration of ALARP		☐
Bounding event unprotected fault sequence		☐
Escalation into major hazard		☐
Potential hazardous area		☐
Hydrocarbon inventories		☐
Gas turbine/diesel generator fuel		☐
Engineered protection measures		☐
Management control protection measures		☐

Appendix D Generic Safety Case Elements

The following matrices present the generic safety critical elements for an offshore crane. Table 1 identifies the life limiting mechanism applicable to each critical design element, and the associated level of risk. Table 2 extracts the high risk safety critical elements, together with the applicable standards and the likely mitigation arguments that the Duty Holder's may claim in their QRA for the continued operation of their crane beyond its design life. The tables are intended to assist the HSE (OSD) inspector, satisfying himself, when auditing/assessing the safety case, that the duty holder has taken cognisance of all the identified potential failure effects, and has presented valid mitigation that the life limiting margins are neither being approached nor exceeded. Table 2 is presented in an alternative format that may prove more appropriate for recording and retaining audit comments.

The Beyond Lifetime Criteria should be considered in conjunction with the following documents:

a) HSE Report OTO 96041 – Offshore Lifting and Handling Appliances, 1999 – "Recommendations on Design, Construction and Operation" (Ref. 1).

b) HSE Report OSD.CRA.INS.JM/010A, Crane Inspection Sheets (Ref. 7) – Specialist Evaluation Assessment (status sheets (A) for lattice boom pedestal crane).

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Structure: Boom						
Fatigue	High	Could lead to a collapse of the boom and a dropped load.	Operational Records, NDE, Inspection, PD6493 Assessment	BS2573: Part 1: 1983: Section 8 and Lloyds Rules		non ductile behaviour, crane likely to be at the end of its fatigue life
Corrosion	High	Could lead to a collapse of the boom and a dropped load.	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules		Corrosion more likely due to unrectified paint defects
Damage	High	Could lead to a collapse of the boom and a dropped load.	Securing arrangements for boom in stowed position			Unattended minor damage may progress to more serious defects. Procedures should include ensuring that the boom is securely stowed when out of service
Loose Fittings	High	Could lead to the boom becoming detached and may lead to a dropped load.	Type of fitting, maintenance, inspection			
Structure: Whip Hoist Structure						
Fatigue	High	Could lead to a collapse of the whip hoist jib and a dropped load.	Operational Records, NDE, Inspection, PD6493 Assessment	BS2573: Part 1: 1983: Section 8 and Lloyds Rules		non ductile behaviour, crane likely to be at the end of its fatigue life
Corrosion	High	Could lead to a collapse of the whip hoist jib and a dropped load.	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules		Corrosion more likely due to unrectified paint defects
Damage	High	Could lead to a collapse of the whip hoist jib and a dropped load.	Securing arrangements for jib in stowed position			Unattended minor damage may progress to more serious defects. Procedures should include ensuring that the whip hoist is securely stowed when out of service
Loose Fittings	High	Could lead to the whip hoist jib becoming detached and may lead to a dropped load.	Type of fitting, maintenance, inspection			
Structure: Boom Bearing						
Damage	High	Could lead to a collapse of the boom and a dropped load.	Evaluate risk and strengthen/de-rate if required.			

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Structure: Apex/A-Frame						
Fatigue	High	Possible collapse of the apex/A-frame and a dropped load/boom.	Operational Records, NDE, Inspection, PD6493 Assessment	BS2573: Part 1: 1983: Section 8 and Lloyds Rules		non ductile behaviour, crane likely to be at the end of its fatigue life
Corrosion	High	Possible collapse of the apex/A-frame and a dropped load/boom.	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules		Corrosion more likely due to unrectified paint defects
Damage	High	Could lead to a collapse of the apex/A-frame and a dropped load/boom.	Evaluate risk and strengthen apex if required.			Unattended minor damage may progress to more serious defects.
Loose Fittings	High	Could lead to components on the apex/A-frame becoming detached and may lead to a dropped load.	Type of fitting, maintenance, inspection			
Structure: Superstructure						
Fatigue	High	Could lead to a structural failure collapse or loss of crane.	Operational Records, NDE, Inspection, PD6493 Assessment	BS2573: Part 1: 1983: Section 8 and Lloyds Rules		non ductile behaviour, crane likely to be at the end of its fatigue life
Corrosion	High	Could lead to a structural failure collapse or loss of crane.	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules		Corrosion more likely due to unrectified paint defects
Damage	High	Could lead to a structural failure collapse or loss of crane.	Evaluate risk and strengthen locally if required.			Unattended minor damage may progress to more serious defects.
Structure: Substructure						
Fatigue	High	Could lead to a structural failure collapse or loss of crane.	Operational Records, NDE, Inspection, PD6493 Assessment	BS2573: Part 1: 1983: Section 8 and Lloyds Rules		non ductile behaviour, crane likely to be at the end of its fatigue life
Corrosion	High	Could lead to a structural failure collapse or loss of crane.	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules		Corrosion more likely due to unrectified paint defects
Damage	High	Could lead to a structural failure collapse or loss of crane.	Evaluate risk and strengthen locally if required.			Unattended minor damage may progress to more serious defects.

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Structure: Base-Plate Connections						
Fatigue	High	Could lead to a structural failure collapse or loss of crane.	Operational Records, NDE, Inspection, PD6493 Assessment	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules		non ductile behaviour, crane likely to be at the end of its fatigue life
Corrosion	High	Could lead to a structural failure collapse or loss of crane.	Protective Coating, inspection/replacement , Strengthening of vulnerable areas or de-rating	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules		Corrosion more likely due to unrectified paint defects
Damage	High	Could lead to a structural failure collapse or loss of crane.	Evaluate risk and strengthen locally if required.			Unattended minor damage may progress to more serious defects.
Structure: Pedestal/Pintle						
Fatigue	High	Could lead to a structural failure collapse or loss of crane.	Operational Records, NDE, Inspection, PD6493 Assessment	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules		non ductile behaviour, crane likely to be at the end of its fatigue life
Corrosion	High	Could lead to a structural failure collapse or loss of crane.	Protective Coating, inspection/replacement , Strengthening of vulnerable areas or de-rating	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules		Corrosion more likely due to unrectified paint defects
Damage	High	Could lead to a structural failure collapse or loss of crane.	Evaluate risk and strengthen locally if required.			Unattended minor damage may progress to more serious defects.
Hoist/Luffing: Hook						
Fatigue	High	Could lead to dropped load.	Design information, Crane history/records, Replacement, NDE inspection records, End of life assessment	BS2903		
Damage	High	Could lead to dropped load.	Replacement, NDE inspection records	BS2903		

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Hoist/Luffing: Hook Block Assembly						
Fatigue	High	Sudden failure which could lead to dropped load	Design information, Crane history/records, NDE inspection records, End of life assessment	BS4534		
Corrosion	High	Sudden failure which could lead to dropped load, or seizure which could lead to a load hang-up	Protective Coating, preservation, inspection and maintenance	BS4534	Corrosion and limited use may cause sheaves to seize	
Damage	High	Sudden failure which could lead to dropped load, or seizure which could lead to a load hang-up	Evaluate risk and provide securing/protection if required, inspection and maintenance	BS4534	Possibility of progressive damage storm due lack of early attention	
Water ingress, condensation	High	Water passing seals could lead to corrosion	Type of seal, maintenance, drainage holes/channels	BS4534		
Hoist/Luffing: Sheaves/Pulleys						
Erosion	High	Could lead to sheave jamming, damage to rope, rope jumping the sheave	Inspection, maintenance, repair/replacement	BS4534	Erosion may cause sheaves to ???	
Damage	High	Could lead to sheave jamming, damage to rope, rope jumping the sheave	Inspection, maintenance, repair/replacement	BS4534	Possibility of progressive damage storm due lack of early attention	
Hoist/Luffing: Sheave Pins						
Corrosion	High	Could lead to sudden failure or seizure and sheave jamming resulting in damage to rope	Material selection, Protective coating/sleeves, inspection, maintenance, repair/replacement	BS4534	Possible pitting due to lack of early attention	Pin should be corrosion resistant material wherever possible
Erosion	High	Could lead to sheave jamming resulting in damage to rope	Inspection, maintenance, repair/replacement	BS4534		

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Hoist/Luffing: Rope Compensator						
Fatigue	High	Sudden failure could lead to collapse and dropped load.	Design information, Crane history/records, NDE inspection records, End of life assessment			
Corrosion	High	Sudden failure could lead to collapse and dropped load.	Material selection and preservation, inspection, maintenance, repair/replacement		Late detection of corrosion	
Erosion	High	Sudden failure could lead to collapse and dropped load.	Inspection, maintenance, repair/replacement			
Damage	High	Sudden failure could lead to collapse and dropped load.	Protection, inspection, maintenance, repair/replacement		Progressive storm damage	
Hoist/Luffing: Drums						
Fatigue	High	Sudden failure could lead to collapse and dropped load/jib.	Design information, Crane history/records, NDE inspection records, End of life assessment	BS MA 79 Cl 4.2.2 to 4.2.4		
Erosion	High	Sudden failure could lead to collapse and dropped load/jib.	inspection, maintenance, repair/replacement	BS MA 79 Cl 4.2.2 to 4.2.4		
Damage	High	Sudden failure could lead to collapse and dropped load/jib.	Protection, inspection, maintenance, repair/replacement	BS MA 79 Cl 4.2.2 to 4.2.4		

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Hoist/Luffing: Ropes/Pendants						
Fatigue	High	Sudden failure could lead to collapse and dropped load/jib.	inspection, maintenance, repair/replacement	BS302: Part 3, BS464, BS6570		
Creep	High	Sudden failure could lead to collapse and dropped load/jib.	inspection, maintenance, replacement	BS302: Part 3, BS464, BS6570		
Corrosion	High	Sudden failure could lead to collapse and dropped load/jib.	Rope type (zinc coated), inspection, maintenance, replacement	BS302: Part 3, BS464, BS6570	Corrosion due to loss of protective coating, stagnant water due to lack of use	
Erosion	High	Sudden failure could lead to collapse and dropped load/jib.	Inspection, maintenance, replacement	BS302: Part 3, BS464, BS6570		
Damage	High	Sudden failure could lead to collapse and dropped load/jib.	Crane stowing arrangements, local protection, inspection, maintenance, replacement	BS302: Part 3, BS464, BS6570	Progressive damage	
Hoist/Luffing: Rope Anchors						
Fatigue	High	Sudden failure could lead to collapse and dropped load/jib.	inspection, maintenance, repair/replacement			
Creep	High	Sudden failure could lead to collapse and dropped load/jib.	inspection, maintenance, replacement			
Corrosion	High	Sudden failure could lead to collapse and dropped load/jib.	Design, materials, preservation		Corrosion due to loss of protective coating	
Damage	High	Sudden failure could lead to collapse and dropped load/jib.	Crane stowing arrangements, local protection, inspection, maintenance, replacement.			

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Hoist/Luffing: Luff Rams (IF)						
Corrosion	High	Sudden failure could lead to collapse and dropped load/jib.	Design, materials, preservation		Corrosion due to loss of protective coating	
Mechanism: Brake Assemblies						
Corrosion	High	Sudden failure could lead to release of load/jib.	inspection, maintenance, repair/replacement	Service brakes to BS MA 79 Cl. 4.4		
Erosion	High	Sudden failure could lead to release of load/jib.	Inspection, maintenance, repair/replacement	Service brakes to BS MA 79 Cl. 4.4		
Mechanism: Gearboxes		* Dependant on position of brake whether cricial or not				
Fatigue	High	Sudden failure could lead to release of load/jib.	inspection, maintenance, repair/replacement, overspeed protection should apply brakes.	Manufactures Instructions		
Mechanism: Couplings						
Fatigue	High	Sudden failure could lead to release of load/jib.	inspection, maintenance, repair/replacement, overspeed protection should apply brakes.	Manufactures Instructions		
Mechanism: Drive Shafts						
Fatigue	High	Sudden failure could lead to release of load/jib.	inspection, maintenance, repair/replacement, overspeed protection should apply brakes.			
Slew Ring Assembly: Slew Ring						
Fatigue	High	Could lead to slew ring failure and loss of structure above slew ring	Inspection, maintenance, repair/replacement, restraining devices	Manufactures Instructions		
Erosion	High	Could lead to slew ring failure and loss of structure above slew ring	Inspection, maintenance, repair/replacement	Manufactures Instructions		

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Slew Ring Assembly: Slew Ring Bolts						
Fatigue	High	Could lead to bolt failure and loss of structure above slew ring	Inspection, maintenance, repair/replacement, restraining devices	BS3692, BS4464		
Creep	High	Could lead to bolt failure and loss of structure above slew ring	Condition monitoring, inspection, maintenance, repair/replacement, restraining devices	BS3692, BS4464		
Corrosion	High	Could lead to bolt failure and loss of structure above slew ring	Bolt material, preservation, corrosion allowance, inspection, maintenance, repair/replacement, restraining devices.	BS3692, BS4464	Undetected onset of corrosion	
Slew Ring Assembly: Slew Bearing		- Pintle mounted only				
Corrosion	High	Could lead to bearing failure/collapse and seizure of slew drive system.	Seals, lubricant type, restraining devices.	Manufactures Instructions	Undetected onset of corrosion	
Brinelling	High	Could lead to bearing failure/collapse and seizure of slew drive system.	Condition monitoring, inspection, maintenance, repair/replacement, restraining devices.	Manufactures Instructions	Brinelling due to lack of movement	
Damage	High	Could lead to bearing failure/collapse and seizure of slew drive system.	Condition monitoring, inspection, maintenance, repair/replacement, restraining devices.	Manufactures Instructions		
Water ingress, condensation	High	Bearing failure due to corrosion damage.	Seals, lubricant type, restraining devices, drainage channels.	Manufactures Instructions	Undetected ingress of water	

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Slew Ring Assembly: Slew Drive Chain (IF)			- Pintle mounted only			
Corrosion	High	Could lead to drive chain failure and loss of slew drive.	Inspection, maintenance, repair/replacement.	BS 288		
Erosion	High	Could lead to drive chain failure and loss of slew drive.	Inspection, maintenance, repair/replacement.	BS 288		
Damage	High	Could lead to drive chain failure and loss of slew drive.	Inspection, maintenance, repair/replacement.	BS 288		
Slew Ring Assembly: House Roller Assembly			- Pintle mounted only			
Fatigue	High	Could lead to housing failure and loss of structure above slew ring	Inspection, maintenance, repair/replacement, restraining devices	Manufactures Instructions		
Damage	High	Could lead to housing failure and seizure of slew drive system.	Inspection, maintenance, repair/replacement, restraining devices	Manufactures Instructions		
Loose Fittings	High	Could lead to housing failure and loss of structure above slew ring	Inspection, maintenance, repair/replacement, restraining devices	Manufactures Instructions		
Hydraulic: Rams						
Corrosion	High	Damage to seals resulting in loss of control or function	Materials, coatings, protective bellows, inspection, maintenance, repair/replacement.	Manufactures Instructions	Undetected onset of corrosion	
Water ingress, condensation	High	Contamination of oil by condensation	Oil type, seals, maintenance, drainage channels.	Manufactures Instructions	Increased risk of condensation due to infrequent use	

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
Electrical: Earthing						
Creep	High	Failure of connection, loss of earthing, loss of circuit protection, increased risk of loss of protection against indirect contact.	Material protection, proper prevention of corrosive interaction, inspection.	BS5467, BS6004, BS6007, BS6141, BS7211.	Increased risk of undetected corrosion damage	
Damage	High	Fire or electric shock risk	Sound earth connection/ cable protection, cable routes. Local operating procedures	BS7430	Undetected storm damage	
Electrical: Lightening Protection						
Damage	High	fire, electric shock or explosion	Design, protection arrangements, inspection. Local operating procedures	BS6651	Undetected storm or mechanical damage	
Control & Instrumentation: PLC's/SLI (IF)						
Damage	High	Loss of control or signal errors	Selection of equipment, location, local protection, vibration isolation	BS5490, BS5435	Undetected storm or vibration damage	
Water ingress, condensation	High	Loss of control or signal errors	Enclosure design/sealing, anti condensation heaters	BS5490, BS5435	Increase risk of condensation in unheated spaces	
General Safety Features: Emergency Stops						
Damage	High	Failure to operate or unintended operation	Hardware type, location, inspection, maintenance.	BS5501, BS7535, BS7671	Undetected damage	
Water ingress, condensation	High	Failure to operate or unintended operation	Hardware type, location, inspection, maintenance.	BS5501, BS7535, BS7671	Increase risk of condensation in unheated spaces	
General Safety Features: Overload Alarm						
Water ingress, condensation	High	Failure to operate leading to structural overload	Hardware type, location, anti condensation heaters, inspection, maintenance.	BS5490, BS5435	Increase risk of condensation in unheated spaces	

Lifetime Limiting Mechanisms	Criticality Category	Effect	Mitigation	Current Design Standards	Likely Shortfall	Comments
General Safety Features: Hoist Limit/Stop						
Damage	High	Failure to stop at end of travel resulting in damage and dropped load	Robust hardware, local protection, component duplication, inspection, maintenance.	BS7535, BSEN 60947-5	Undetected damage	
General Safety Features: Luffing Limit/Stop						
Damage	High	Failure to stop at end of travel resulting in damage and dropped load	Robust hardware, local protection, component duplication, inspection, maintenance.	BS7535, BSEN 60947-5	Undetected damage	
General Safety Features: Slew Limit/Stop						
Damage	High	Failure to stop at end of rotation resulting in damage and dropped load	Robust hardware, local protection, component duplication, inspection, maintenance.	BS7535, BSEN 60947-5	Undetected damage	
General Safety Features: Slack Rope Protector						
Damage	High	Failure to operate or unintended operation	Hardware type, location, inspection, maintenance	Lloyds Chapter 7 (cl 6.5.5)		
General Safety Features: Ladders and Walkways						
Corrosion	High	Collapse leading to injury or fatality	Materials selection, preservation system, inspection, maintenance, repair/replacement		Undetected deterioration	
Damage	High	Collapse leading to injury or fatality	Inspection, maintenance, repair/replacement.			
General Safety Features: Safety Harness						
Ageing, Degradation	High	Failure leading to injury or fatality	Material quality, stowage, inspection, maintenance, repair/replacement.			
General Safety Features: Drivers Escape Gear						
Ageing, Degradation	High	Failure leading to injury or fatality	Material quality, stowage, inspection, maintenance, repair/replacement.			

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Boom
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could lead to a collapse of the boom and/or a dropped load.
Mitigation	Operational Records, NDE, Inspection Records, PD6493 Assessment
Applicable	BS2573: Part 1: 1983: Section 8 and Lloyds Rules.
Likely Shortfalls	Some of the older versions of some codes, e.g BS2573: 1960, did not require a fatigue analysis.
Comments	non ductile behaviour, crane likely to be at the end of its fatigue life.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Boom
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to a collapse of the boom and/or a dropped load.
Mitigation	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating
Applicable	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules
Likely Shortfalls	
Comments	Corrosion more likely due to unrectified paint defects

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Boom
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a collapse of the boom and a dropped load.
Mitigation	Securing arrangements for boom in stowed position
Applicable	BS2573: Part 1: 1983, and Lloyds Rules
Likely Shortfalls	
Comments	Unattended minor damage may progress to more serious defects. Procedures should include ensuring that the boom is securely stowed when out of service

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Boom
Life Limiting Mechanism	Loose fittings
Criticality	High
Effect	Could lead to the boom becoming detached and may lead to a dropped load.
Mitigation	Type of fittings, maintenance, inspection
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Whip Hoist Structure
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could lead to a collapse of the whip hoist jib and/or a dropped load.
Mitigation	Operational Records, NDE, Inspection, PD6493 Assessment
Applicable	BS2573: Part 1: 1983: Section 8 and Lloyds Rules
Likely Shortfalls	Some of the older versions of some codes, e.g BS2573: 1960, did not require a fatigue analysis.
Comments	non ductile behaviour, crane likely to be at the end of its fatigue life

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Whip Hoist Structure
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to a collapse of the whip hoist jib and/or a dropped load.
Mitigation	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating
Applicable	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules
Likely Shortfalls	
Comments	Corrosion more likely due to unrectified paint defects

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Whip Hoist Structure
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a collapse of the whip hoist jib and a dropped load.
Mitigation	Securing arrangements for boom in stowed position
Applicable	BS2573: Part 1: 1983, and Lloyds Rules
Likely Shortfalls	
Comments	Unattended minor damage may progress to more serious defects. Procedures should include ensuring that the whip hoist is securely stowed when out of service

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Whip Hoist Structure
Life Limiting Mechanism	Loose fittings
Criticality	High
Effect	Could lead to the whip hoist jib becoming detached and may lead to a dropped load.
Mitigation	Type of fittings, maintenance, inspection
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Boom Bearing
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a collapse of the boom and a dropped load.
Mitigation	Evaluate risk and strengthen/de-rate if required.
Applicable	BS2573: Part 2: 1980, and Lloyds Rules
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Apex/A-Frame
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could possibly lead to a collapse of the apex and/or a dropped load/boom.
Mitigation	Operational Records, NDE, Inspection, PD6493 Assessment
Applicable	BS2573: Part 1: 1983: Section 8 and Lloyds Rules
Likely Shortfalls	Some of the older versions of some codes, e.g BS2573: 1960, did not require a fatigue analysis.
Comments	non ductile behaviour, crane likely to be at the end of its fatigue life

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Apex/A-Frame
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to a collapse of the apex and/or a dropped load/boom.
Mitigation	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating
Applicable	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules
Likely Shortfalls	
Comments	Corrosion more likely due to unrectified paint defects

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Apex/A-Frame
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a collapse of the apex and a dropped load/boom.
Mitigation	Evaluate risk and strengthen apex if required.
Applicable	BS2573: Part 1: 1983, and Lloyds Rules
Likely Shortfalls	
Comments	Unattended minor damage may progress to more serious defects.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Apex/A-Frame
Life Limiting Mechanism	Loose fittings
Criticality	High
Effect	Could lead to components on the apex/A-frame becoming detached and may lead to a dropped load.
Mitigation	Type of fittings, maintenance, inspection
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Superstructure
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could lead to a structural failure collapse and/or loss of crane.
Mitigation	Operational Records, NDE, Inspection, PD6493 Assessment
Applicable	BS2573: Part 1: 1983: Section 8 and Lloyds Rules
Likely Shortfalls	Some of the older versions of some codes, e.g BS2573: 1960, did not require a fatigue analysis.
Comments	non ductile behaviour, crane likely to be at the end of its fatigue life

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Superstructure
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to a structural failure collapse and loss of crane.
Mitigation	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating
Applicable	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules
Likely Shortfalls	
Comments	Corrosion more likely due to unrectified paint defects

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Superstructure
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a structural failure collapse or loss of crane.
Mitigation	Evaluate risk and strengthen locally if required.
Applicable	
Likely Shortfalls	
Comments	Unattended minor damage may progress to more serious defects.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Substructure
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could lead to a structural failure collapse and/or loss of crane.
Mitigation	Operational Records, NDE, Inspection, PD6493 Assessment
Applicable	BS2573: Part 1: 1983: Section 8 and Lloyds Rules
Likely Shortfalls	Some of the older versions of some codes, e.g BS2573: 1960, did not require a fatigue analysis.
Comments	non ductile behaviour, crane likely to be at the end of its fatigue life

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Substructure
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to a structural failure collapse and loss of crane.
Mitigation	Protective Coating, Corrosion Allowance, Strengthening of vulnerable areas or de-rating
Applicable	BS2573: Part 1: 1983: Section 4.2 and Lloyds Rules
Likely Shortfalls	
Comments	Corrosion more likely due to unrectified paint defects

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Substructure
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a structural failure collapse or loss of crane.
Mitigation	Evaluate risk and strengthen locally if required.
Applicable	
Likely Shortfalls	
Comments	Unattended minor damage may progress to more serious defects.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Baseplate Connections
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in a connection could lead to a loss of the crane.
Mitigation	Operational Records, NDE, Inspection, PD6493 Assessment
Applicable	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules
Likely Shortfalls	Some of the older versions of some codes, e.g BS2573: 1960, did not require a fatigue analysis.
Comments	non ductile behaviour, crane likely to be at the end of its fatigue life

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Baseplate Connections
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to a structural failure collapse and loss of crane.
Mitigation	Protective Coating, inspection/replacement , Strengthening of vulnerable areas or de-rating
Applicable	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules
Likely Shortfalls	
Comments	Corrosion more likely due to unrectified paint defects

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Baseplate Connections
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a structural failure collapse or loss of crane.
Mitigation	Evaluate risk and strengthen locally if required.
Applicable	
Likely Shortfalls	
Comments	Unattended minor damage may progress to more serious defects.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Pedestal/Pintle
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could lead to a structural failure collapse and/or loss of crane.
Mitigation	Operational Records, NDE, Inspection, PD6493 Assessment
Applicable	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules
Likely Shortfalls	Some of the older versions of some codes, e.g BS2573: 1960, did not require a fatigue analysis.
Comments	non ductile behaviour, crane likely to be at the end of its fatigue life

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Pedestal/Pintle
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to a structural failure collapse and loss of crane.
Mitigation	Protective Coating, inspection/replacement , Strengthening of vulnerable areas or de-rating
Applicable	BS2573: Part 1: 1983: Section 8.7 and Lloyds Rules
Likely Shortfalls	
Comments	Corrosion more likely due to unrectified paint defects

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Structure: Pedestal/Pintle
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to a structural failure collapse or loss of crane.
Mitigation	Evaluate risk and strengthen locally if required.
Applicable	
Likely Shortfalls	
Comments	Unattended minor damage may progress to more serious defects.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Hook
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure will lead to a dropped load.
Mitigation	Design information, Crane history/records, Replacement, NDE inspection records, End of life assessment
Applicable	BS2903
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Hook
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to dropped load.
Mitigation	Replacement, NDE inspection records
Applicable	BS2903
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Hook Block Assembly
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could lead to a sudden failure, which in turn could lead to dropped load.
Mitigation	Design information, Crane history/records, NDE inspection records, End of life assessment
Applicable	BS4534
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Hook Block Assembly
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Sudden failure could lead to dropped load, or seizure which could lead to a load hang-up
Mitigation	Protective Coating, preservation, inspection and maintenance
Applicable	BS4534
Likely Shortfalls	Corrosion and limited use may cause sheaves to seize
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Hook Block Assembly
Life Limiting Mechanism	Damage
Criticality	High
Effect	Sudden failure could lead to dropped load, or seizure which could lead to a load hang-up
Mitigation	Evaluate risk and provide securing/protection if required, inspection and maintenance
Applicable	BS4534
Likely Shortfalls	Possibility of progressive damage storm due lack of early attention
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Hook Block Assembly
Life Limiting Mechanism	Water ingress, condensation
Criticality	High
Effect	Water passing seals could lead to corrosion
Mitigation	Type of seal, maintenance, drainage holes/channels
Applicable	BS4534
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Sheaves/Pulleys
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Could lead to sheave jamming, damage to rope, rope jumping the sheave
Mitigation	Inspection, maintenance, repair/replacement
Applicable	BS4534
Likely Shortfalls	Erosion may cause sheaves to ???
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Sheaves/Pulleys
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to sheave jamming, damage to rope, rope jumping the sheave
Mitigation	Inspection, maintenance, repair/replacement
Applicable	BS4534
Likely Shortfalls	Possibility of progressive damage storm due lack of early attention
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Sheave Pins
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Corrosion could lead to sudden failure or seizure and sheave jamming resulting in damage to rope
Mitigation	Material selection, Protective coating/sleeves, inspection, maintenance, repair/replacement
Applicable	BS4534
Likely Shortfalls	Possible pitting due to lack of early attention
Comments	Pin should be corrosion resistant material wherever possible

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Sheave Pins
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Could lead to sheave jamming resulting in damage to rope
Mitigation	Inspection, maintenance, repair/replacement
Applicable	BS4534
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Rope Compensator
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue could lead to a sudden failure or collapse resulting in a dropped load.
Mitigation	Design information, Crane history/records, NDE inspection records, End of life assessment

Applicable

Likely Shortfalls

Comments

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Rope Compensator
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Severe corrosion could lead to sudden failure resulting in collapse and dropped load.
Mitigation	Material selection and preservation, inspection, maintenance, repair/replacement
Applicable	
Likely Shortfalls	Late detection of corrosion
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Rope Compensator
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Severe erosion could lead to sudden failure resulting in collapse and dropped load.
Mitigation	Inspection, maintenance, repair/replacement
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Rope Compensator
Life Limiting Mechanism	Damage
Criticality	High
Effect	Damage could lead to sudden failure resulting in collapse and dropped load.
Mitigation	Protection, inspection, maintenance, repair/replacement
Applicable	
Likely Shortfalls	Progressive storm damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Drums
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Fatigue failure in parent metal, weld or connection could result in a sudden failure leading to collapse and dropped load/jib.
Mitigation	Design information, Crane history/records, NDE inspection records, End of life assessment
Applicable	BS MA 79 Cl 4.2.2 to 4.2.4
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Drums
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Severe erosion could lead to collapse and/or dropped load/jib.
Mitigation	inspection, maintenance, repair/replacement
Applicable	BS MA 79 Cl 4.2.2 to 4.2.4
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Drums
Life Limiting Mechanism	Damage
Criticality	High
Effect	Damage causing a sudden failure could lead to collapse and dropped load/jib.
Mitigation	Protection, inspection, maintenance, repair/replacement
Applicable	BS MA 79 Cl 4.2.2 to 4.2.4
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Ropes/Pendants
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Sudden fatigue failure will lead to a loss of the ropes and result in a dropped load/jib.
Mitigation	inspection, maintenance, replacement
Applicable	BS302: Part 3, BS464, BS6570
Likely Shortfalls	There should be no shorfalls as ropes are likely to be supplied to an up to date standard since they are usually replaced at regular intervals (every few years).
Comments	Fatigue in ropes is well understood, and is generally covered under normal maintenance procedures. Hence, fatigue should not be dependant on the age of the crane.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Ropes/Pendants
Life Limiting Mechanism	Creep
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	inspection, maintenance, replacement
Applicable	BS302: Part 3, BS464, BS6570
Likely Shortfalls	There should be no shorfalls as ropes are likely to be supplied to an up to date standard since they are usually replaced at regular intervals (every few years).
Comments	Creep in ropes is well understood, and is generally covered under normal maintenance procedures. Hence, creep should not be dependant on the age of the crane.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Ropes/Pendants
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	Rope type (zinc coated), inspection, maintenance, replacement
Applicable	BS302: Part 3, BS464, BS6570
Likely Shortfalls	Corrosion due to loss of protective coating, stagnant water due to lack of use.
Comments	Corrosion in ropes is well understood, and is generally covered under normal maintenance procedures. Hence, corrosion should not be dependant on the age of the crane.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Ropes/Pendants
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	Inspection, maintenance, replacement
Applicable	BS302: Part 3, BS464, BS6570
Likely Shortfalls	There should be no shorfalls as ropes are likely to be supplied to an up to date standard since they are usually replaced at regular intervals (every few years).
Comments	Erosion in ropes is well understood, and is generally covered under normal maintenance procedures. Hence, erosion should not be dependant on the age of the crane.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Ropes/Pendants
Life Limiting Mechanism	Damage
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	Crane stowing arrangements, local protection, inspection, maintenance, replacement
Applicable	BS302: Part 3, BS464, BS6570
Likely Shortfalls	Progressive damage
Comments	

Design Element	Hoist/Luffing: Rope Anchors
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Sudden failure will lead to a loss of the rope and lead to a dropped load/jib.
Mitigation	inspection, maintenance, repair/replacement
Applicable	
Likely Shortfalls	There should be no shorfalls as rope anchors are likely to be supplied to an up to date standard since they are usually replaced at regular intervals (every few years as the ropes are replaced).
Comments	Fatigue in rope anchors is well understood, and is generally covered under normal maintenance procedures. Hence, fatigue should not be dependant on the age of the crane.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Rope Anchors
Life Limiting Mechanism	Creep
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	inspection, maintenance, replacement
Applicable	
Likely Shortfalls	There should be no shorfalls as rope anchors are likely to be supplied to an up to date standard since they are usually replaced at regular intervals (every few years as the ropes are replaced).
Comments	Creep in rope anchors is well understood, and is generally covered under normal maintenance procedures. Hence, fatigue should not be dependant on the age of the crane.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Rope Anchors
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	Design, materials, preservation
Applicable	
Likely Shortfalls	Corrosion due to loss of protective coating
Comments	Corrosion in rope anchors is well understood, and is generally covered under normal maintenance procedures. Hence, fatigue should not be dependant on the age of the crane.

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Rope Anchors
Life Limiting Mechanism	Damage
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	Crane stowing arrangements, local protection, inspection, maintenance, replacement.
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hoist/Luffing: Luff Rams (IF)
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Sudden failure could lead to collapse and dropped load/jib.
Mitigation	Design, materials, preservation
Applicable	
Likely Shortfalls	Corrosion due to loss of protective coating
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Mechanism: Brake Assemblies
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Sudden failure could lead to release of load/jib.
Mitigation	inspection, maintenance, repair/replacement
Applicable	Service brakes to BS MA 79 Cl. 4.4
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Mechanism: Brake Assemblies
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Sudden failure could lead to release of load/jib.
Mitigation	Inspection, maintenance, repair/replacement
Applicable	Service brakes to BS MA 79 Cl. 4.4
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Mechanism: Gearboxes
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Sudden failure could lead to release of load/jib.
Mitigation	inspection, maintenance, repair/replacement, overspeed protection should apply brakes.
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Mechanism: Couplings
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Sudden failure could lead to release of load/jib.
Mitigation	inspection, maintenance, repair/replacement, overspeed protection should apply brakes.
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Mechanism: Drive Shafts
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Sudden failure could lead to release of load/jib.
Mitigation	inspection, maintenance, repair/replacement, overspeed protection should apply brakes.
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Ring
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Could lead to slew ring and loss of structure above slew ring
Mitigation	Inspection, maintenance, repair/replacement, restraining devices
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Ring
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Could lead to slew ring failure and loss of structure above slew ring
Mitigation	Inspection, maintenance, repair/replacement
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Ring Bolts
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Could lead to bolt failure and loss of structure above slew ring
Mitigation	Inspection, maintenance, repair/replacement, restraining devices
Applicable	BS3692, BS4464
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Ring Bolts
Life Limiting Mechanism	Creep
Criticality	High
Effect	Could lead to bolt failure and loss of structure above slew ring
Mitigation	Condition monitoring, inspection, maintenance, repair/replacement, restraining devices
Applicable	BS3692, BS4464
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Ring Bolts
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Could lead to bolt failure and loss of structure above slew ring
Mitigation	Bolt material, preservation, corrosion allowance, inspection, maintenance, repair/replacement, restraining devices.
Applicable	BS3692, BS4464
Likely Shortfalls	Undetected onset of corrosion
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Bearing
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Could lead to bearing failure/collapse and seizure of slew drive system.
Mitigation	Seals, lubricant type, restraining devices.
Applicable	Manufactures Instructions
Likely Shortfalls	Undetected onset of corrosion
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Bearing
Life Limiting Mechanism	Brinelling
Criticality	High
Effect	Could lead to bearing failure/collapse and seizure of slew drive system.
Mitigation	Condition monitoring, inspection, maintenance, repair/replacement, restraining devices.
Applicable	Manufactures Instructions
Likely Shortfalls	Brinelling due to lack of movement
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Bearing
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to bearing failure/collapse and seizure of slew drive system.
Mitigation	Condition monitoring, inspection, maintenance, repair/replacement, restraining devices.
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Bearing
Life Limiting Mechanism	Water ingress, condensation
Criticality	High
Effect	Bearing failure due to corrosion damage.
Mitigation	Seals, lubricant type, restraining devices, drainage channels.
Applicable	Manufactures Instructions
Likely Shortfalls	Undetected ingress of water
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Drive Chain (IF)
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Could lead to drive chain failure and loss of slew drive.
Mitigation	Inspection, maintenance, repair/replacement.
Applicable	BS 288
Likely Shortfalls	
Comments	

Design Element	Slew Ring Assembly: Slew Drive Chain (IF)
Life Limiting Mechanism	Erosion
Criticality	High
Effect	Could lead to drive chain failure and loss of slew drive.
Mitigation	Inspection, maintenance, repair/replacement.
Applicable	BS 288
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: Slew Drive Chain (IF)
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to drive chain failure and loss of slew drive.
Mitigation	Inspection, maintenance, repair/replacement.
Applicable	BS 288
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: House Roller Assembly
Life Limiting Mechanism	Fatigue
Criticality	High
Effect	Could lead to housing failure and loss of structure above slew ring
Mitigation	Inspection, maintenance, repair/replacement, restraining devices
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: House Roller Assembly
Life Limiting Mechanism	Damage
Criticality	High
Effect	Could lead to housing failure and seizure of slew drive system.
Mitigation	Inspection, maintenance, repair/replacement, restraining devices
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Slew Ring Assembly: House Roller Assembly
Life Limiting Mechanism	Loose fittings
Criticality	High
Effect	Could lead to housing failure and loss of structure above slew ring
Mitigation	Inspection, maintenance, repair/replacement, restraining devices
Applicable	Manufactures Instructions
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hydraulic: Rams
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Damage to seals resulting in loss of control or function
Mitigation	Materials, coatings, protective bellows, inspection, maintenance, repair/replacement.
Applicable	Manufactures Instructions
Likely Shortfalls	Undetected onset of corrosion
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Hydraulic: Rams
Life Limiting Mechanism	Water ingress, condensation
Criticality	High
Effect	Contamination of oil by condensation
Mitigation	Oil type, seals, maintenance, drainage channels.
Applicable	Manufactures Instructions
Likely Shortfalls	Increased risk of condensation due to infrequent use
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Electrical: Earthing
Life Limiting Mechanism	Creep
Criticality	High
Effect	Failure of connection, loss of earthing, loss of circuit protection, increased risk of loss of protection against indirect contact.
Mitigation	Material protection, proper prevention of corrosive interaction, inspection.
Applicable	BS5467, BS6004, BS6007, BS6141, BS7211.
Likely Shortfalls	Increased risk of undetected corrosion damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Electrical: Earthing
Life Limiting Mechanism	Damage
Criticality	High
Effect	Fire or electric shock risk
Mitigation	Sound earth connection/ cable protection, cable routes. Local operating procedures
Applicable	BS7430
Likely Shortfalls	Undetected storm damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Electrical: Lightening Protection
Life Limiting Mechanism	Damage
Criticality	High
Effect	fire, electric shock or explosion
Mitigation	Design, protection arrangements, inspection. Local operating procedures
Applicable	BS6651
Likely Shortfalls	Undetected storm or mechanical damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Control & Instrumentation: PLC's/SLI (IF)
Life Limiting Mechanism	Damage
Criticality	High
Effect	Loss of control or signal errors
Mitigation	Selection of equipment, location, local protection, vibration isolation
Applicable	BS5490, BS5435
Likely Shortfalls	Undetected storm or vibration damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	Control & Instrumentation: PLC's/SLI (IF)
Life Limiting Mechanism	Water ingress, condensation
Criticality	High
Effect	Loss of control or signal errors
Mitigation	Enclosure design/sealing, anti condensation heaters
Applicable	BS5490, BS5435
Likely Shortfalls	Increase risk of condensation in unheated spaces
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Emergency Stops
Life Limiting Mechanism	Damage
Criticality	High
Effect	Failure to operate or unintended operation
Mitigation	Hardware type, location, inspection, maintenance.
Applicable	BS5501, BS7535, BS7671
Likely Shortfalls	Undetected damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Emergency Stops
Life Limiting Mechanism	Water ingress, condensation
Criticality	High
Effect	Failure to operate or unintended operation
Mitigation	Hardware type, location, inspection, maintenance.
Applicable	BS5501, BS7535, BS7671
Likely Shortfalls	Increase risk of condensation in unheated spaces
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Overload Alarm
Life Limiting Mechanism	Water ingress, condensation
Criticality	High
Effect	Failure to operate leading to structural overload
Mitigation	Hardware type, location, anti condensation heaters, inspection, maintenance.
Applicable	BS5490, BS5435
Likely Shortfalls	Increase risk of condensation in unheated spaces
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Hoist Limit/Stop
Life Limiting Mechanism	Damage
Criticality	High
Effect	Failure to stop at end of travel resulting in damage and dropped load
Mitigation	Robust hardware, local protection, component duplication, inspection, maintenance.
Applicable	BS7535, BSEN 60947-5
Likely Shortfalls	Undetected damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Luffing Limit/Stop
Life Limiting Mechanism	Damage
Criticality	High
Effect	Failure to stop at end of travel resulting in damage and dropped load
Mitigation	Robust hardware, local protection, component duplication, inspection, maintenance.
Applicable	BS7535, BSEN 60947-5
Likely Shortfalls	Undetected damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Slew Limit/Stop
Life Limiting Mechanism	Damage
Criticality	High
Effect	Failure to stop at end of rotation resulting in damage and dropped load
Mitigation	Robust hardware, local protection, component duplication, inspection, maintenance.
Applicable	BS7535, BSEN 60947-5
Likely Shortfalls	Undetected damage
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Slack Rope Protector
Life Limiting Mechanism	Damage
Criticality	High
Effect	Failure to operate or unintended operation
Mitigation	Hardware type, location, inspection, maintenance
Applicable	Lloyds Chapter 7 (cl 6.5.5)
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Ladders and Walkways
Life Limiting Mechanism	Corrosion
Criticality	High
Effect	Collapse leading to injury or fatality
Mitigation	Materials selection, preservation system, inspection, maintenance, repair/replacement
Applicable	
Likely Shortfalls	Undetected deterioration
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Ladders and Walkways
Life Limiting Mechanism	Damage
Criticality	High
Effect	Collapse leading to injury or fatality
Mitigation	Inspection, maintenance, repair/replacement.
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Safety Harness
Life Limiting Mechanism	Ageing, Degradation
Criticality	High
Effect	Failure leading to injury or fatality
Mitigation	Material quality, stowage, inspection, maintenance, repair/replacement.
Applicable	
Likely Shortfalls	
Comments	

Beyond Design Lifetime Criteria Aspects for Offshore Platforms

Design Element	General Safety Features: Drivers Escape Gear
Life Limiting Mechanism	Ageing, Degradation
Criticality	High
Effect	Failure leading to injury or fatality
Mitigation	Material quality, stowage, inspection, maintenance, repair/replacement.
Applicable	
Likely Shortfalls	
Comments	

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