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**Flow of Safety-Related Structural Integrity
Information in the Offshore Industry**

Summary Report

HSE

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Information in the Offshore Industry**

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Glossary

Domain	Term / abbreviation	Meaning
Offshore	Asset	The field or installation as considered from a financial point of view.
Offshore	Duty holder	The operator (or owner in the case of a mobile installation) with the responsibility for the Safety Case [reference SCR].
Aviation	ECCAIRS	European Co-ordination Centre for mandatory Aircraft Incident Reporting Systems
General	Exchange	Used to describe transfer of information between two parties in one direction. One exchange is represented by one record (or one row) in the project database.
Shipping	MSIP	Marine Structural Integrity Program [reference 23].
Offshore	OIM	Offshore Installation Manager
Offshore	Operator	For a fixed installation, the person appointed by a concession owner to execute any function of organising or supervising any operation to be carried out by such installation or, where no such person has been appointed, the concession owner. [reference SCR]
Offshore	SRSI	Safety Related Structural Integrity

1 INTRODUCTION

1.1 Aim of the Study

This report summarises a pilot study of the flow of safety-related structural integrity (SRSI) information in the offshore industry. The study sought to better understand the current flow of SRSI information within the offshore industry, to make comparisons with information flow in other industries, and to model the flow of structural integrity information within the industry. In this way, the study aimed to contribute to improving the effectiveness with which SRSI information for offshore structures is managed.

1.2 Work undertaken

An initial model of information flow was hypothesised based on the lifecycle of an installation. A review of relevant regulations was carried out, including the Safety Case regulations (SCR), Design and Construction regulations (DCR1, DCR2, DCR3) and Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) regulations (PFEER). A literature search was carried out, and a number of papers reviewed relating to the management of SRSI information. These reviews focused the questions for subsequent interviews carried out with representatives from operator and designer organisations, with two HSE inspectors, and for comparison, with two structural specialists in the nuclear industry.

The interviews were summarised and a number of 'exchanges' were extracted from the information. Each exchange related to a transfer of information in one direction between two parties. The source, user, use, description, scope and transmission method was described for each exchange.

1.3 Findings

Analysis of the information from the interviews showed that the hypothesised lifecycle model was insufficient on its own. The hypothesised lifecycle model is sequential, and shows information flow for a particular installation, but does not represent the richness of information available about communication between different groups of people. A second pilot model was developed to show the concurrent flow of information between organisations, and between sub-groups within organisations.

A number of areas are outlined in this summary report to suggest directions for further work in improving the management of safety related structural integrity information in the offshore industry.

2 THE FLOW OF SAFETY-RELATED STRUCTURAL INTEGRITY INFORMATION

2.1 Nature of the communication

The study found details of both formal (for example, via the safety case and design documentation) and informal (for example, via industry groups, or by word of mouth within a company) flows of information. In particular, from both the operator and HSE point of view, relationships between the regulator and the regulated appeared to be good, and publications such as Offshore Research Focus were deemed useful and readily available. The openness of the relationships between operators and HSE seems a positive result of less prescriptive regulation.

The information covered a range of topics related to structural integrity and safety, including inspection, structural models, safety of the offshore installation and regulations.

2.2 How the information flows

The study indicated that there is a lot of information flowing within the operator organisation, and in particular between assets, both within the same operating company, and between assets owned by different companies working in the same area. Communication between specialists within an operating company and the assets was also noted, covering a range of subjects including the structural and mechanical integrity of the installation and more general safety topics.

There was little evidence from the study of structural integrity information being given to the workforce (apart from top-side loading limits contained in operating procedures [8]), and even less feed back from the workforce into the safety case, or to designers. In particular, little feedback from operations to design other than 'when something goes wrong' was mentioned by interviewees.

Interfaces appeared to be strong generally within organisations, and between designers, operators and regulators where they are working together. No evidence was found of a strong interface between designers and the HSE, with no exchanges from designers to the HSE. Another area where additional confidence needs to be gained of the continuity of information is the case of secondary handover, where a new operator takes over an older field from an existing operator.

With one exception all of the exchanges recorded within the HSE were between specialists and general inspectors. The remaining exchange related to the use of the HSE offshore library by general inspectors to find out about regulations and research carried out. The exchanges between the HSE general inspectors and specialists were in both directions, and covered both broad and specialist information.

3 ORGANISATION AND STORAGE OF THE INFORMATION

3.1 Information “Store and Retrieve”

In general, there did not seem to be a centralised method of storing information; information tends to be held by whoever creates the information, and passed on to the user of the information on request, or at a particular point in the lifecycle. For example, operators will ask designers for information they need at a particular stage; designers will search for information on current best practice for a particular project.

Although there was evidence in the interviews of information being stored and retrieved at the design and operation phases, there was little evidence of a single store of information used consistently, and the mechanisms for obtaining information are often informal. Critically, the availability of information is often dependent on being able to find the right people with the right information. Information transfer between individuals dominates information flow around the ‘loop’. From a systems perspective, this allows the possibility of lost or miscommunicated information, or the use of out of date information.

However, there were indications that such a background store was starting to evolve. In particular, the involvement of operators and designers in the development of regulations, and the application of the same regulations to design, operation and maintenance suggests a background ‘highway’ of shared information.

3.2 Transmission and Storage of Information

The interviews indicated that paper is still more widely used than computer-based¹ means for the transmission and storage of SRSI information. Paper based means include audit reports from the HSE, inspection records and the safety case. Both the literature review and the interviews indicate the increasing use of computers as a means of storage and transmission of information. A structural model of the installation is traditionally held on computer by the designer, and new uses are now being made of computers, both for inspection planning and monitoring, and for communication of broader issues via company Intranets (a closed system Internet). Some operators are now maintaining electronic safety cases for their own use. Two principal advantages of a well designed electronic safety case were highlighted in the interviews. Firstly, information can be accessed more quickly by a larger number of people (possibly with different views of information defined for different users). Secondly, consistency can be maintained when updates are made to the safety case. The interviews have shown that operators and designers appear to be interested, but cautious about the use of computer based support for inspection planning.

Verbal transmission (either by telephone, or at meetings) is also a widely used method of transmission of information for informal communications

¹ In this study, computer-based was defined to include any method making use of a computer for transmission, including electronic mail (e-mail), a database, internet or intranet (in-company internet) systems, and specialised computer applications.

3.3 Transmission & Storage in other industries

The Marine Structural Integrity Program (MSIP) within the shipping industry shows that it might be possible to have a more integrated computer based system for management of information.

In the aviation industry the ECCAIRS project (European Co-ordination Centre for mandatory Aircraft Incident Reporting Systems) illustrates the ability of an industry to share information on incidents. If offshore operators start to collect and store information about incidents, maintenance and inspection histories on computer, in the long term this information could be shared to everyone's benefit, as more data could make inspection planning more reliable. The transition between a 'non-sharing' and a 'sharing' culture is one that would need careful consideration.

3.4 Currency of Information

Defining the currency of the information proved a difficult step. Information about the duration for which information remained valid was not forthcoming in the interviews. Most information appeared to have both short and long term use. It is perhaps a hangover from the previously prescriptive regime that what information needs to be stored for how long is not routinely defined. One implication of this is that there is little certainty of organisational or industry learning from one project lifecycle to the next. Lifecycle coding is starting to be used by one of the interviewees, where a decision is made about the expected lifetime of the information at the time the information is documented, and the documents marked accordingly. The aim is to ensure that information from earlier phases of the lifecycle is available when required at later stages. On its own, lifecycle coding is not enough to ensure that where information becomes unexpectedly out-of-date, it is properly superseded, but it suggests that the problem of currency is beginning to be recognised within the industry.

To further the work in this area, improved data on the expected lifetime of information would need to be gathered. A closer look at parallel systems identified in the aviation and marine industries could provide guidance on the pitfalls and benefits of such systems, with an assessment made of their applicability within the offshore industry. Lifecycle coding and any other methods being used to manage the currency of documents could also be investigated.

4 TECHNICAL CONCLUSIONS

4.1 Research information and HSE Inspection

Research information is frequently managed at a higher level of an organisation, and so its source is not linked to any one stage of an installation lifecycle. However, the use of research information appears to be greatest during the design and operation phases, and increasingly for de-commissioning.

HSE Inspection and assessment of the Safety Case were also seen as key influences during the design and operation phases.

4.2 Defining 'Safety Critical Elements'

Interviewees could be divided into two groups in terms of their method of identifying and selecting safety critical elements:

1. Risk based approach: assessing the likelihood of failure of an element, and the consequence of each of those failures to produce a measurement of risk, and setting all elements over a certain threshold as safety critical.
2. Consequence based approach: working backwards from selected major hazards, in order to assess which element's failure will lead to such a hazard.

Supplementary to the risk or consequence based approaches, those parts of the structure which were most likely to suffer damage were prioritised for attention in some circumstances. The consequence based approach is the closest to the definition provided in the Design and Construction regulations [DCR1].

One difference resulting from this difference in approach was that in some cases the whole structure may be identified as a safety critical element, whilst in other cases, individual components (for example, a particular spur or joint) would be defined as SCE. In between these two extremes, combinations of components or systems could also be defined as a SCE, for example, fire protection provided by fire and gas detectors, blast walls, extinguishers.

4.3 Safety Case review

4.3.1 *Lack of a system for updating Safety Cases*

The regulations on frequency of review and revision are interpreted in different ways. There was little evidence of consistent checking of the effect of new findings about structures on existing Safety Cases or designs, or for a proven mechanism for ensuring appropriate technical revisions and updates to the Safety Case.

4.3.2 *Possibility of the use of IT to support Safety Case revision*

Where a Safety Case is held as a normal (linear) text document, updates involve a great deal of work to check the effect of one change on the rest of the document. Revised documents need to be printed, copied and distributed. If instead Safety Case information were held as meaningful data, part of the process of update could be automated, with changes propagated through the data. There may be practical difficulties in reviewing such a database, and information technology may not solve the organisational problems of Safety Case revision. However, there are clearly possibilities to be examined.

5 NUCLEAR INDUSTRY

5.1 Transmission and Storage of Information in the Nuclear Industry

Paper is still the dominant form for transmission and storage of safety related structural integrity information within the nuclear industry. Paper is used for safety cases, data manuals, procedures, inspection methods and drawings. Drawings are also held in CAD (computer aided design) systems, which provides the users with additional benefits. Materials data is held on a computer database, and enables easier access. Electronic forms of information are becoming increasingly important, and at least one of the interviewees would favour a move to an electronic safety case. Verbal communication was also shown to be important within the nuclear industry for informal flow of SI information.

5.2 Flow of Information in the Nuclear Industry

More exchanges of information were identified to and from the operations phase than any other phase, with the operator as the key source and user of information. The nuclear industry invests much time and effort in on-going inspection and test programmes, and a significant part of the information flow relates to these.

The nuclear industry appear to be more self contained, making more use of information from within the industry than from outside. Possible reasons for this include the greater levels of integrity assurance required in the nuclear industry, the specialist nature of information related to nuclear hazards, and the longer history of having to deal with critical review both from the regulator and the public.

The results from the nuclear industry indicated a stricter regulatory regime and higher consequence hazards, with less variation in inspection regimes, and an investment in continuous monitoring of the structural integrity.

6 OVERALL CONCLUSIONS

6.1 Literature on 'Information Flow'

Whilst there is much literature about particular technical aspects of structural integrity, it is difficult to find sources of information about the *flow* of information. Some papers which sound promising, by including words such as 'management' in the title, offer only narrow solutions to the problem of information management, including structural reliability theory and linear elastic fracture mechanics. These papers also illustrate the difficulty of finding appropriate data on SRSI information flow - the titles mention structural integrity, but do not make clear the aspects of structural integrity which are covered in the paper.

The most useful papers were those which described a program or system for encouraging the storage and access of information.

6.2 Conclusions of the Literature Review

There is evidence of systems for the flow of Safety-Related Structural Integrity Information in the offshore industry and in other industries. In particular, computer based systems are being developed to manage structural integrity information within the aircraft, shipping and pipeline industries (references [1], [2], [4], [7]).

No specific evidence was found of studies carried out to investigate the flow of Safety-Related Structural Integrity Information. The focus of structural integrity systems is on storing and making information available to those who need it, rather than actively studying or encouraging a flow of information.

No references were found which identified particularly poor management of SRSI information within an industry, although a number of papers present incidents in range of industries which suggest poor flow of information generally. For example, Herald of Free Enterprise [3], Flixborough [3], [6], Alexander Keilland [6], oil tankers Amoco Cadiz and Kurdistan [6], Hinkley Point 'A' power station [5], Quebec bridge [9].

6.3 Modelling Information Flow

6.3.1 *Evolution of a model of information flow*

At the start of the study, an initial model was developed to form the hypothesis for the study. This model assumed a standard lifecycle, with information stored and retrieved at each stage, and activities at each stage of the life-cycle needed to maintain integrity. For example, the design must make the correct assumptions, and use appropriate design codes which take account of the materials being used, the method of construction and the environment in which an installation will operate. Fabrication and construction must follow any assumptions made in the design, and be carried out correctly with no short cuts. During operation, maintenance and inspection is required to ensure that integrity is maintained, and that corrective action is taken when needed. The lifecycle has external inputs and outputs. Inputs include regulatory influence and research, and outputs include the safety case.

The lifecycle model can be regarded as largely sequential, that is, information flowing through different stages of the lifecycle. To represent the flow of information between parties within a lifecycle stage, a concurrent model was developed.

The hypothesised model included the idea of a 'storage and retrieval' loop around the lifecycle. However, information flow seems to be more reactive and specific. Interviewees were more aware of information which is provided by one party to another at a particular phase, than of information which remains in the system for a long time.

6.3.2 *Validation of the SRSI information Flow Model*

The model produced by this study is based on a small selection of offshore industry representatives. To develop and validate the model, additional data needs to be collected. In particular, information regarding fabrication and construction, and information from operational staff could be collected. The lack of information concerning communication to or from the workforce could be improved by widening the selection of interviewees to include an OIM and members of the workforce. To improve the understanding of inspection part of the lifecycle, representatives from inspection and diving teams could be included in the study.

7 REFERENCES

7.1 Databases

The following databases were searched as part of the literature survey:

- LISA: Library & Information Science Abstracts. Reed Reference Library
- Information Science Abstracts. Document Abstracts Inc.
- APILIT: American Petroleum Institute
- NTIS. National Technical Information Service
- TULSA (Petroleum Abstracts). University of Tulsa
- Ei Compendex. Engineering Information Inc.
- METADEX. Cambridge Scientific Abstracts.

7.2 Project Reports

RMC R97-47(S)/J1927 (1997). Flow of Safety-Related Structural Integrity Information in the Offshore Industry

RMC R97-47(S)/J1927 Project Report A (1997). Interviews and example questions

RMC R97-47(S)/J1927 Project Report B (1997). Summary of SRSII Flow Model

RMC R97-47(S)/J1927 Project Report C (1997). Full details of SRSII Flow Model

7.3 References for Summary Report

7.3.1 Regulations

- DCR 1: A guide to the installation verification and miscellaneous aspects of amendments by the Offshore Installations and Wells (Design and Construction, etc) Regulations 1996 to the Offshore Installations (Safety Case) Regulations, 1992. L83. HSE Books.
- DCR2: A guide to the well aspects of the Offshore Installations and Wells (Design and Construction etc) Regulations 1996. L84. HSE Books.
- DCR3: A guide to the integrity, workplace environment and miscellaneous aspects of the Offshore Installations and Wells (Design and Construction etc) Regulations 1996. L85. HSE Books.
- PFEER: Prevention of fire and explosion and emergency response on offshore installations. Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) regulations 1995. HSE Books.
- SCR: A guide to the Offshore Installations (Safety Case) Regulations 1992. HMSO.
- MAR: A guide to the Offshore installations and pipeline works (Management and Administration) regulations, 1995

7.3.2 Other references

- [1] Bea, RG (1993) 'Marine Structural Integrity Programs.' In the Society of Naval Architects and Marine Engineers and The Ship Structure committee, Ship Structures Symposium '93, Nov 16-17, 1993.
- [2] Conference proceedings of the 1995 USAF Structural Integrity Program Conference. Airframe Structural Integrity Program (ASIP). Volume 1. Wright Lab, August 1996.
- [3] Curtis, LM (1993). 'Interface Issues in Safety in Disaster Prevention and Management', vol. 2, no. 4, 1993 pp 60-64
- [4] Dry, MJ, Schulte-Strathaus, R & Bea, RG. (1996) 'Ship Structure Integrity Information System (SSIIS) phase 2'. California University, Berkeley, Dept. of Naval Architecture & Offshore Engineering.
- [5] Flewitt, P.E.J. (1995) 'Structural Integrity Assessment of High Integrity Structures and Components: User Experience'. In *Mechanical Behaviour of Materials* (ed. Bakker, A.) Delft University Press, Delft, Netherlands.
- [6] Milne, I. (1994) 'Importance of the management of Structural Integrity.' In *Engineering Failure Analysis* vol. 1, no 3. pp171-181. 1994
- [7] Nessim, MA & Stephens, MJ. (1995) 'Optimization of pipeline integrity maintenance based on quantitative risk analysis'. At Pipeline Reliability Conference, Houston Texas, USA, Sept. 12-14 1995.
- [8] Sharpe, G (1996) 'Structural integrity assurance: BPX's approach' (BP Exploration).
- [9] Symons, CB (1995) 'Structural Reliability - Can analysis replace test?' ESREL '95, pp 331, Safety and Reliability Society.