A Guide To Quantitative Risk Assessment for Offshore Installations

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Every reasonable effort has been made to ensure that this Guide is based on the best knowledge available up to the time of finalising the text. However, no responsibility of any kind for any injury, delay, loss or damage, whatsoever, resulting from the use of the Guide can be accepted by CMPT, the sponsors or others involved in its publication.

Publication 99/100a

ISBN I 870553 365

FOREWORD

The need for guidance on risk assessment was identified as an industry requirement as a result of regulations, initially promulgated in the UK and Norway, requiring quantitative risk assessments of new and existing installations as part of their safety case. At that time, no standard reference works existed, most expertise was held by individual operators and consultants and little reached the public domain.

The project leading to this Guide was initiated by MTD Ltd, and is now published by The Centre for Marine and Petroleum Technology (CMPT), in order to assist engineers involved in commissioning, performing and evaluating risk assessments specifically for the offshore industry.

The Guide was prepared under contract by Mr J R Spouge of DNV Technica (now part of Det Norske Veritas) as the primary contractor, with significant input from AEA Technology and Dovre Safetec. It was sponsored by 8 organisations (four oil operators and four regulatory bodies) and was managed for MTD, and latterly CMPT, by Mr R W Barrett.

Project Sponsors

Amoco (U.K.) Exploration Company
Chevron UK Ltd
Exxon Production Research Company
The Health and Safety Executive
Minerals Management Service (USA)
Mobil Technology Company
National Energy Board (Canada)
Norwegian Petroleum Directorate

Steering Group

A Steering Group comprising representatives of participants, MTD Ltd and CMPT, and the Technical Services Contractors provided the forum for both verbal and written discussion of the content of the Guide during its preparation. During the period of the project, the following individuals served on the Steering Group which was chaired by Mr W D Howells (Chevron UK Ltd) and Mr R W Barrett:

T Al-Hassan	Health and Safety Executive
RW Barrett	Centre for Marine and Petroleum Technology
DJ Bridge	Health and Safety Executive
FM Davies	Marine Technology Support Unit
K Gulati	Mobil Technology Company
S Harding	Exxon Production Research Company
WD Howells	Chevron UK Ltd
KL Nilsson	Norwegian Petroleum Directorate
ME Rodgers	Exxon Production Research Company
RJ Smith	National Energy Board (Canada)
JK Smith	Amoco (U.K.) Exploration Company
CE Smith	Minerals Management Service (USA)
JR Spouge	DNV Technica
A Wang	Exxon Production Research Company

Technical Services Contractors

The preparation of this Guide was undertaken by the following organisations and the individuals who worked on its various elements are listed below:

AEA Technology	KG Kinsella CG Morgan
DNV Technica	DJ Bridge JR Spouge EJ Smith
Dovre Safetec Ltd	S Haugen L Paterson F Vollen
Electrowatt Engineering Services UK Ltd	S Hall AJ Skudder
Four Elements Ltd	S Harris B Morgan

Acknowledgement

A further acknowledgement is due to the Health and Safety Executive's Offshore Safety Division who made additional contributions to the project. In particular we wish to acknowledge the input made by S Schofield, I Brearley, and T Norman during the latter stages of the project.

The principal author, JR Spouge, also wishes to acknowledge present and former colleagues, too numerous to list individually, whose assistance has been drawn upon extensively during the preparation of the Guide.

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1. INTRODUCTION TO THE GUIDE

1.1 General Introduction to Offshore QRA

Offshore production of oil and gas involves some of the most ambitious engineering projects of the modern world, and is a prime source of revenue for many companies and countries. It also involves risks of major accidents, which have been demonstrated by disasters such as the explosion and fire on the UK production platform *Piper Alpha*, the capsizes of the Norwegian accommodation platform *Alexander Kielland* and the Canadian semi-submersible drilling rig *Ocean Ranger*, and the sinking of the Norwegian gravity base structure *Sleipner A.*

Major accidents represent the ultimate, most disastrous way in which an offshore engineering project can go wrong. Accidents cause death, suffering, pollution of the environment and disruption of business. Being so dramatic, they attract attention from the news media and linger in the public memory, causing concern about safety offshore. Are offshore platforms safe enough? Can major accidents be prevented? How should the offshore industry achieve an appropriate balance between the interests of safety and the economics of oil and gas production?

Quantitative risk assessment (QRA) is a technique that can be used to help achieve this balance. In the UK and Norway, the use of risk assessment is a legislative requirement for all new and existing installations, and several other countries are implementing similar regulations. As a result, QRA is now being used world-wide by designers, operators, and consultants in the offshore industry.

QRA is a relatively new technique. It cuts across traditional divisions of engineers such as civil, mechanical, chemical, aeronautical - it applies to all of them and belongs to none. Most of the textbooks on it relate to the fields of chemical and nuclear engineering, and there are no standard reference works on how to perform an offshore risk assessment. Most information and expertise is held by individual operators and consultants, and very little has reached the public domain. The UK and Norwegian regulations state what is required from a risk assessment, but do not say exactly how to do it.

As a result, the pool of expertise in risk assessment is very small. Many workers in the field are only recently acquainted with it. Few have experience in more than one or two applications. Risk assessment remains to a large extent a do-it-yourself activity.

In order to fill this gap, the Centre for Marine and Petroleum Technology (CMPT) has organised a multi-sponsor project to prepare a guide to offshore QRA. The sponsors include offshore operators and regulatory authorities in the UK, Norway, USA and Canada. DNV Technica has been the main contractor for the work.

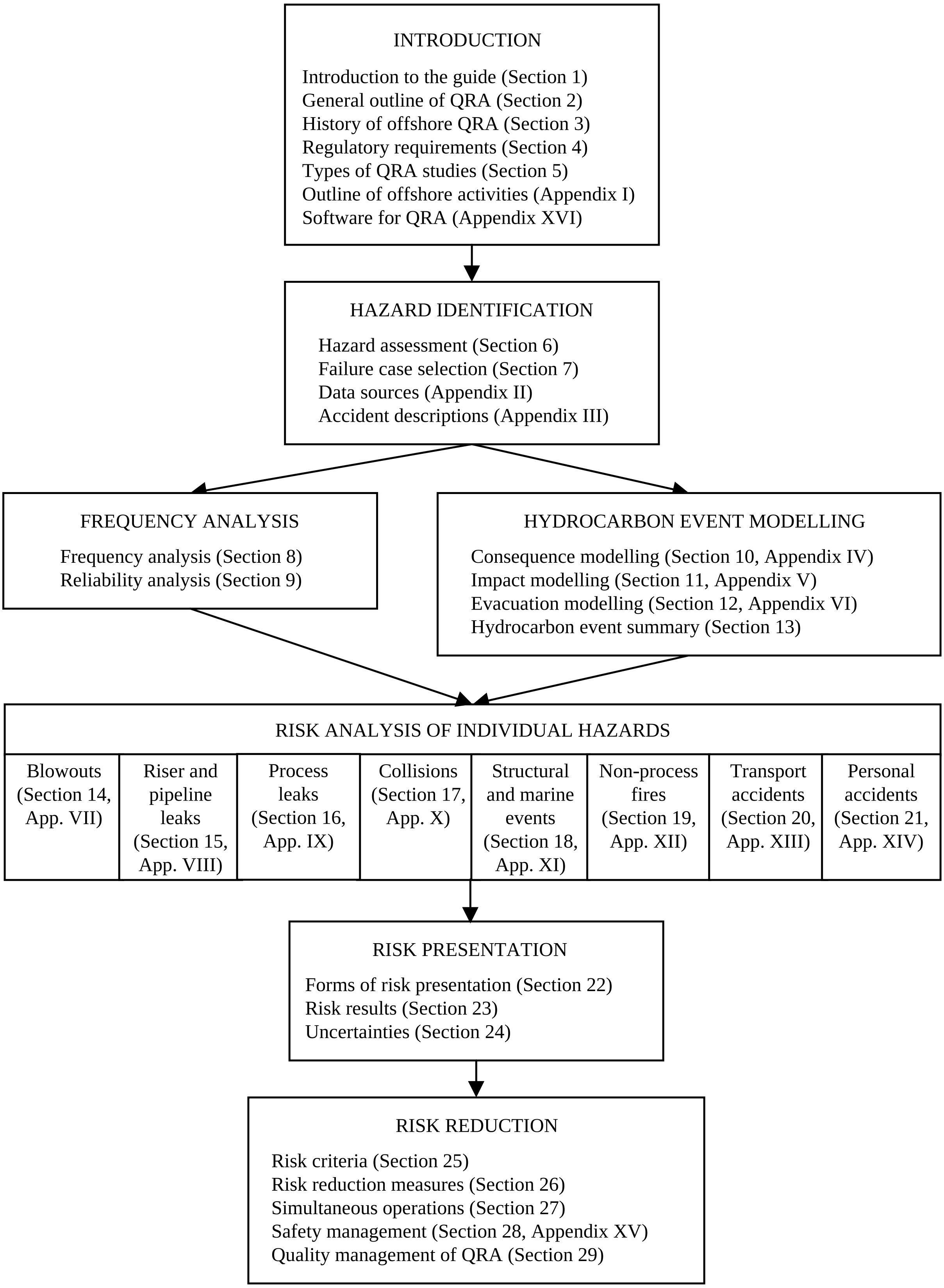
1.2 Objectives of the Guide

The intention of the guide is to provide an introduction to QRA specifically for the offshore industry. It aims to introduce all the major aspects of the subject and to describe good modern practice in offshore QRA. It includes a selection of data and relatively simple analytical techniques that may be used in performing QRAs, and gives references to more sophisticated databases and computational methods. It also presents some example risk results. It is intended to serve partly as a training manual and partly as a reference book, and should be useful for engineers involved in commissioning, performing and evaluating risk assessments.

1.3 Structure of the Guide

Figure 1.1 illustrates the arrangement of material in the guide.

Figure 1.1 Structure Of The Guide



Part I of the guide describes the subject as a whole and gives general guidance and example results. It follows the broad structure of a QRA study, divided into the following main areas:

1. Background material (Sections 1-5)
2. Hazard identification (Sections 6-7)
3. Frequency analysis (Sections 8-9)
4. General modelling of hydrocarbon releases (Sections 10-13)
5. Risk analysis of individual hazards (Sections 14-21)
6. Presentation of risks (Sections 22-24)
7. Risk reduction (Sections 25-29)

Part II of the guide includes 16 appendices containing more detailed information that may be useful when conducting an offshore QRA:

- Appendix I gives an introduction to offshore activities suitable for analysts with no prior knowledge of the industry.

- Appendix II outlines the main sources of data on offshore risks.

- Appendix III describes a selection of major offshore accidents.

- Appendices IV, V and VI give details on hydrocarbon release modelling issues covered in Sections 10-13 of Part I.

- Appendices VII to XIV give data on the individual hazards covered in Sections 14-21 of Part I.

- Appendix XV gives a more detailed discussion of safety management systems, which is summarised in Section 28 of Part I.

- Appendix XVI consists of a directory of computer software currently available for offshore QRA.

The information in Part II is necessarily only a small sample, and should if possible be supplemented with more relevant or more up-to-date data.

1.4 Nature of the Guidance

The guide does not attempt to specify a single approach to QRA. As far as possible, it presents a range of approaches from which readers can choose the ones appropriate to their study. Where specific guidance is given, it represents a view on reasonable approaches to QRA, balancing the need for accuracy against the need for economy, or else a judgement of what is typically done. The guidance should not be considered as mandatory, or as recommended by DNV Technica except where stated.

1.5 Referencing

References are given at the end of Part I and at the end of each Appendix.

As far as possible, this guide is based on public-domain sources, and all the references are either openly published or are expected to be published in the near future. In a few cases it references documents that are confidential but widely circulated within the offshore industry.

In many cases there are no public-domain sources for the data needed in a QRA, and therefore Part II of the guide draws extensively on sources that are confidential and cannot be acknowledged in full.

1.6 Definition of Terms

Terms such as ‘hazard’, ‘risk’ and ‘risk assessment’ have been given many different meanings. The definitions which are used in this guide are based on an authoritative multi-disciplinary review by the Royal Society (1983 and 1992), as extended for the chemical process industry (I.Chem.E 1992) and for quality assurance and reliability by ISO (1986) and its national implementations (e.g. BSI 1991). There is by no means universal agreement on the definitions given, but these are reasonably well used and are becoming standard by virtue of being adopted by the above sources.

Definitions of terms used are given at appropriate points in the guide. Definitions of the most commonly used terms and abbreviations are provided in a glossary at the end of Part I.