HSE
Health & Safety Executive

A pilot study on the impact of OSD research on installation design

Prepared by **MaTSU**
for the Health and Safety Executive

OFFSHORE TECHNOLOGY REPORT

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A pilot study on the impact of OSD research on installation design

Dick Hodierne, Rachael Spencer and Fiona Davies
MaTSU
154 Harwell
Didcot
Oxfordshire
OX11 0RA

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Summary

To assess the impact and effectiveness of research on HSC/E's wider objectives, an evaluation has been carried out on a group of projects related to particular topside process topics. Design plays a crucial role in safety and, in recent years, HSE have undertaken a considerable number of projects related to design of offshore installations. The study reported here has been undertaken with the overall objectives of assessing the impact on process design that has been achieved by OSD research, and to make recommendations for future impact assessments.

Work has taken place in three key areas:

- the development of a practicable methodology for assessing the impact of the chosen set of projects: this has included a means of describing key stakeholders and pathways for research dissemination / application and development of a number of different 'indicators' for measuring the impact;
- the identification and characterisation of relevant projects;
- the application of the methodology to the chosen projects and a presentation of the findings along with suggestions for future impact assessments.

The impact assessment approach that has been developed has proved useful in assessing the impact of OSD research on installation design. In the first instance the area of explosions has been where most of the effort of this impact assessment study has been focused, but some work has also taken place in the area of process equipment. The visual approach to describing stakeholders, research outputs and dissemination methods aids the understanding of the methodology, whilst allowing for the possibility of a very complex set of relationships. The utilisation of a number of different impact indicators allows various pathways to the end user to be considered. The general approach takes account of, and is applicable to, research in any topic area. The framework can also provide an indication of how to increase the influence of the research and development work.

The findings clearly indicate that the topsides / process research sponsored by OSD has impacted upon the design of offshore oil and gas installations. They also give an indication of the key means of transferring the findings from the research and development work, through the stakeholder hierarchy, to the designers.

As is shown through this study, there is a range of problems associated with evaluation of research impact. (It is for example unlikely that mechanisms have been set up in advance to assist in the impact evaluation process, using the methodologies discussed in this report.) The discussion section of this report highlights issues that will help to streamline and facilitate evaluation of the impact of the research. The recommendations section outlines the potential for future impact assessments and relevant factors in the choice of methodologies.

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1 Introduction & Objectives

The Health & Safety Executive's (HSE) mission is *"To ensure that the risks to people's health and safety from work activities are properly controlled"*. This is achieved through writing and introducing legislation, enforcing legislation through inspection and audits, and conducting research. The imperative for conducting research originates from the duty placed on the Health and Safety Commission (HSC) in the Health and Safety at Work Act (1974) to *"inform, stimulate and guide, operators, owners and others on whom duties of care are placed by promoting the development and dissemination of up-to-date knowledge about hazards and risks"*.

HSE's Mainstream research is commissioned following principles of ROAMEF, whereby a statement of Rationale, Objectives, Appraisal, Monitoring, Evaluation and Feedback of an area of research is set out as an aid to strategic planning. Evaluation is a key activity as it provides a means of testing that research funds are being applied to programmes / projects that are properly prioritised and meet HSE's operational needs. These established systems have been helpful in enabling systematic evaluation arrangements, the most important stemming from the White Paper 'Realising our potential'. Post project evaluation provides an overview of the efficiency of the processes by which the research was commissioned and conducted. It does not however seek to measure the impact of the research on the end user.

Some previous attempts to measure the impact of HSE research in general have centred around gathering information on the distribution of reports. Apart from the issues surrounding the uncertainties of who reads the reports and their relationship to the intended target of the research, the work reported here shows that report distribution is only one factor of the impact process and that a complex nest of pathways exists from the research to the end user involving several intermediate bodies.

Design has been identified as an important stage in the life cycle approach in which a higher safety level can be achieved. With the aim of achieving an informed advancement, an evaluation of how OSD R&D in the area of installation design has impacted the industry, has been requested. Broadly, the research area of interest was all OSD research projects that could have an impact on design of offshore installation topsides. However, it was agreed that the focus would be on process and layout aspects of topsides, which incorporates such topics as fires & fire protection, explosions, gas flares & cold vents, topside plant, mechanical equipment, gas & liquid containment, maintenance, and installation layout.

Due to the assessment methodology adopted for this study, a much more focussed portfolio is required. It was agreed to limit the portfolio still further to the explosions area in the first instance, to be followed by the process equipment area. A number of projects were included in the explosions area that addressed both fire and explosion.

The overall objective of this study has been to determine the impact that this research has had and to make recommendations for future impact assessment. This has been achieved by:

- developing a methodology for assessing the impact of research portfolios (report section 2);
- identifying OSD projects and relevant project information related to process and layout aspects of offshore installation 'topside' design and more specifically, in the explosions and process equipment areas (report section 3);

- applying the methodology to determine the impact that OSD research and development has had on offshore installation design (report sections 4, 5 and 6);
- consolidating the lessons learnt and producing recommendations for future impact assessment (report section 7);
- describing the project findings in a report format suited to dissemination.

2 Potential Impact of Research

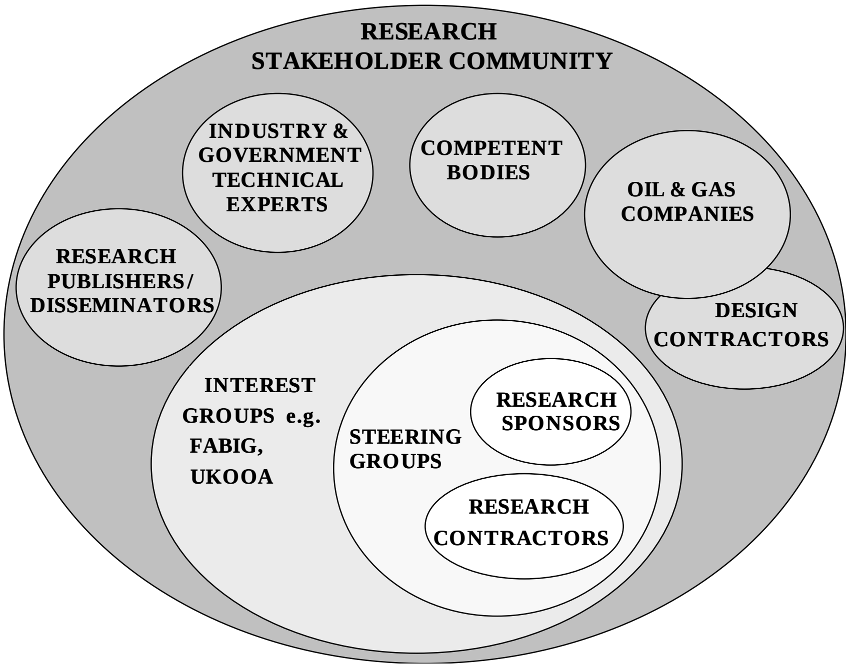
We are concerned with measuring the impact of a research portfolio. This section describes an approach to impact evaluation that can be generally applied, either to a small set of projects or to entire project portfolios.

2.1 THE IMPACT ASSESSMENT FRAMEWORK

The means of measuring impact will be dependent upon the nature of the research carried out, and the research outcomes. In general, it may be expected that there is little hard evidence by which the impact can be measured, and in particular it would be unusual to find one single method by which impact could be measured effectively.

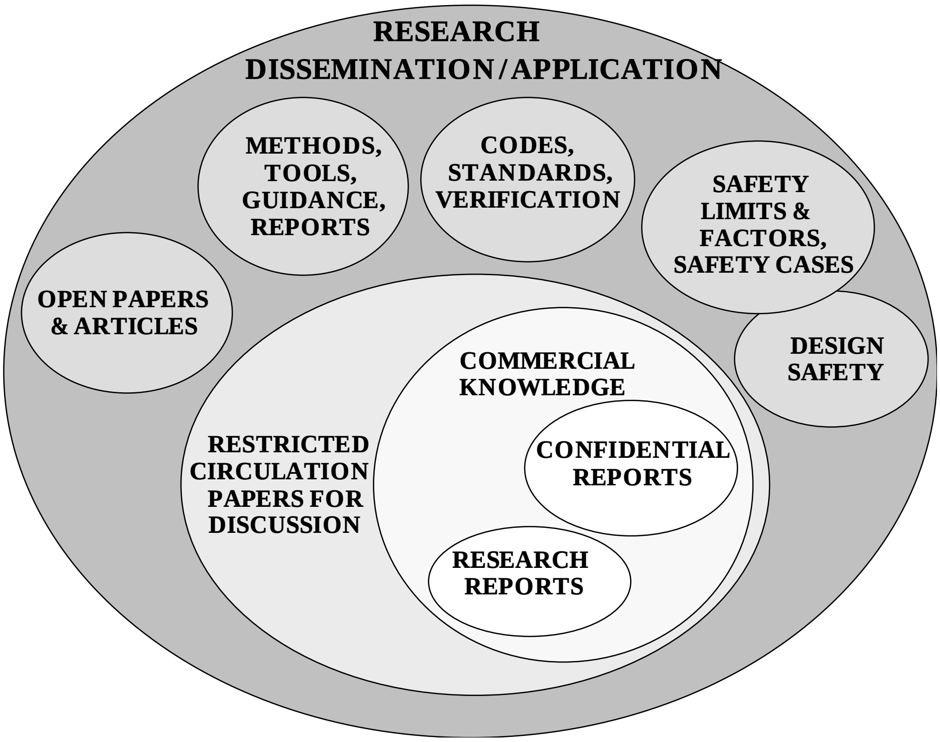
We take as our starting point the research itself and the research stakeholders. The hierarchy and interfacing of the research stakeholder community can best be described by layering, as in Figure 2.1.

Figure 2.1: Research Stakeholder Community



We then consider the possible research outcomes and the means of application/ dissemination of this to the stakeholders; also described by layering, shown in Figure 2.2. This provides an understanding of the framework within which research takes place and results potentially impact upon stakeholders.

Figure 2.2: Research Application/Dissemination Means



To identify possible routes of measuring impact, it is important to understand the flow of information through the hierarchy. The mechanisms by which project results and reports (that may initially be confidential to the research sponsors and the researchers) are transferred to other stakeholders (such as industry groups, other oil and gas companies, competent bodies, or designers) is of interest. The means of dissemination or application of the research results could include e.g. open reports, conference papers, or codes and standards. In addition to the influences of direct dissemination there may be more subtle influences on design culture that may have profound effects in the long term.

The focus of this study is to investigate how the outcomes of research into offshore installation topside design have been transferred to the designers and whether this results in changes in design practice.

2.2 THE IMPACT INDICATORS

A number of indicators that can be used to assess the effectiveness of the impact routes have been identified and are described in Table 2.1.

Table 2.1: Candidate Impact Indicators

Indicator name	***Data required?***	***Reason for inclusion***	***How will the indicator be calculated?***	***How will the indicator be analysed?***	***How does the indicator support HSE mission, vision & services?***
Commercial product	If there is a commercial product, sales statistics on the product	The presence of a commercial product arising from a project shows there is a market for the project findings	Ask firm selling product	Sales to UK sector	Willingness to buy the product indicates project findings have been presented in a way that they can be readily used
Codes and standards	Have the project findings been included in an industry wide (National or International) code of practice or standard?	Compliance with internationally recognised good practice can be demonstrated	Did HSE research have input? - Ask members of standards committees - Ask research contractor(s) who did the work	Either has been included in a number of codes of practice or standards or has not. (Yes/No response)	Improved codes and standards
HSE 'In house' standards	Have the project findings been included in HSE internal assessment guidance documents?	HSE can demonstrate that design assessments are carried out to appropriate guidelines	Examine appropriate documents for references to project findings	Either the findings have been referenced or not	Shows if assessment guidance has kept pace with research
Industry 'In house' standards	Has some numerical data, formula or methodology been incorporated into design manual?	Design practice can be shown to be in-line with current research	Did HSE research have input? Ask design contractors	Has/ has not been included in company design manual	Shows if design practice has kept pace with research.
Numbers of reports requested	How many open research reports have been requested?	Demonstrates degree of interest	Ask HSE Books / HSE Research Strategy Unit (i.e. the report distributors)	Number of requests	Gives an indication of the general interest in the published findings
Who has requested reports	What sort of person/organisation has requested reports	Shows type of organisation/ person interested in the work	Ask HSE Books/ HSE Research Strategy Unit	Number of responses in pre-defined categories	Shows whether project findings are reaching the target audience
Background document	Have the findings been included in an historical review? Is it required or recommended reading for designers?	Demonstrates interest in good practice and not just compliance with codes/ standards	Did HSE research have input? - Ask design contractors - Examine review report(s)	- Contractors will say whether they hold copies - Work will/ will not be referenced	Shows whether the design culture has been influenced
Referenced	The reference list of design code/ guidance document /standard[1]	Demonstrates whether the R&D is considered useful	By examining the reference list	Whether or not the report is referenced	Shows the relative importance of the project results
Citation indices	Which documents have cited HSE reports?	Indicates the influence this work has had on others	Via Information services database searching	Number of citations	Shows whether research is ultimately of interest to the design community
Response to ORF[2] article	How many phone calls or e-mails were there about the article?	Demonstrates degree of interest	Ask the person(s) listed at foot of article	Subjective number of responses[3]	Gives an indication of the relevance or timeliness of the article

[1] Design code / guidance document / standard - The working guidance developed during a project. This may not be a published document.

[2] ORF: "Offshore Research Focus" is a quarterly HSE publication aimed at raising awareness of proposed, current and completed research, in the offshore area.

The candidate impact indicators clearly have different characteristics and it should be appreciated that certain of them can be applied across a wide range of projects e.g. '*Number of reports requested'*, while others may only be practicably applicable to a few projects e.g. *'Commercial product'* (since only a few R&D projects result in a commercial product being produced). In addition, a selection of the indicators can be trialed directly, e.g. *'Numbers of reports requested'*, *'Who has requested reports'*, and *'Citation indices'*. Others are more difficult to measure directly and require contact and discussion with relevant stakeholders.

The following breakdown expands on a selection of the impact indicators to which particular attention was paid during the data collection phase of this study.

2.2.1 Offshore Technology Reports

Offshore Technology (OT) reports are produced to record results from the HSE programme of offshore technology research (and the earlier Department of Energy programme). There are a number of classifications of OT reports:

- The OTH series of reports are high quality, priced reports, printed and sold by HSE Books and also sold through booksellers.
- The OTI series are priced, published reports often used as support information to OTH reports, and these are also printed and sold by HSE Books and sold through booksellers.
- The OTO series contain reports where the anticipated overall sales do not warrant full publication and distribution. Single copies are available free on request from HSE.
- In addition there are reports which are commercially restricted and distributed only within government or as agreed with the contractor (OTN and OTX reports).

In assessing the impact of research reports on stakeholders not directly involved in the research, it is the extent of distribution of the openly available reports that is of interest. HSE Books hold details of the numbers of OTH and OTI reports issued, while the Research Strategy Unit of HSE has been the focal point for requests for the free OTO reports since April 1998 and can provide a listing of OT reports distributed via them since this date. Both centres also hold information on the organisations to which the reports are distributed.

If a discrete set of stakeholders can be identified it would also be possible to obtain information regarding the extent of OT report distribution and the use made of the information contained, by direct surveying of these contacts.

2.2.2 ORF Articles

Offshore Research Focus (ORF) is a quarterly publication produced on behalf of the HSE. It includes:

- calls for expressions of interest;
- brief details of new projects authorised by OSD;
- progress on current research projects;
- results of completed research;
- details of available OT reports.

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3 Records of responses to ORF articles are not kept, so this indicator would rely on individual recall. A further confounding factor is that there are often two contact names, one for HSE and one for the research contractor.

ORF is distributed free of charge to individuals within the industry. Recipient categories include:

- Oil & gas companies
- Certification companies
- Contractors/constructors
- Equipment manufacturers and suppliers
- Engineering consultants
- Other consultants
- Financial organisations
- Academic institutions
- Private research establishments
- Government research establishments
- Government offices
- Trade Associations
- Media

Past issues of ORF have included articles relating to projects within the research portfolio. Contact details for further information on the research, are listed at the foot of each article. It is theoretically possible to gauge the extent of interest in relevant articles, through discussion with the named contacts. In practice, this is complicated by the possibility that one or more contacts may be listed (e.g. the HSE Project officer in charge of the research and the main researcher). Further, it is unlikely that any formal record is kept of requests for further information.

As for OT reports, if a discrete set of stakeholders can be identified, it would be possible to obtain information regarding the knowledge of, and interest in, ORF articles by direct surveying of contacts.

2.2.3 Citations

SCISEARCH, published by the Institute for Scientific Information, is a multidisciplinary scientific and technical database containing bibliographic information and cited references from approximately 5,000 of the world's leading scientific, technical, and medical journals.

Bibliographic information, abstracts, author and keywords are generally searchable. Coverage dates back to 1974 and the database contains over 10 million records.

SCISEARCH is an appropriate search database for references, citations and journal articles in any scientific, technical and medical field.

2.2.4 References

An indication of whether the research and development is considered useful can be gauged by the extent to which the research is referenced, for example within individual company / national / international design codes, guidance documents or standards. This can be investigated either by examination of relevant codes/ guidance documents/standards or by surveying of relevant stakeholders to discover the extent to which they reference, or are aware of others referencing, the research.

2.3 IMPACT CHART

To aid visualisation of the overall picture, inter-relationships and interactions chart representation has been used to describe the flow of information via routes and between stakeholders. Figure 2.3 shows the relationships between the initial research, the various intervening bodies, and the targeted end user. This may not be a complete model and all the links have not been validated. However, it is useful for postulating pathways to the end user, in our case the designer. These pathways can then be examined using the various indicators.

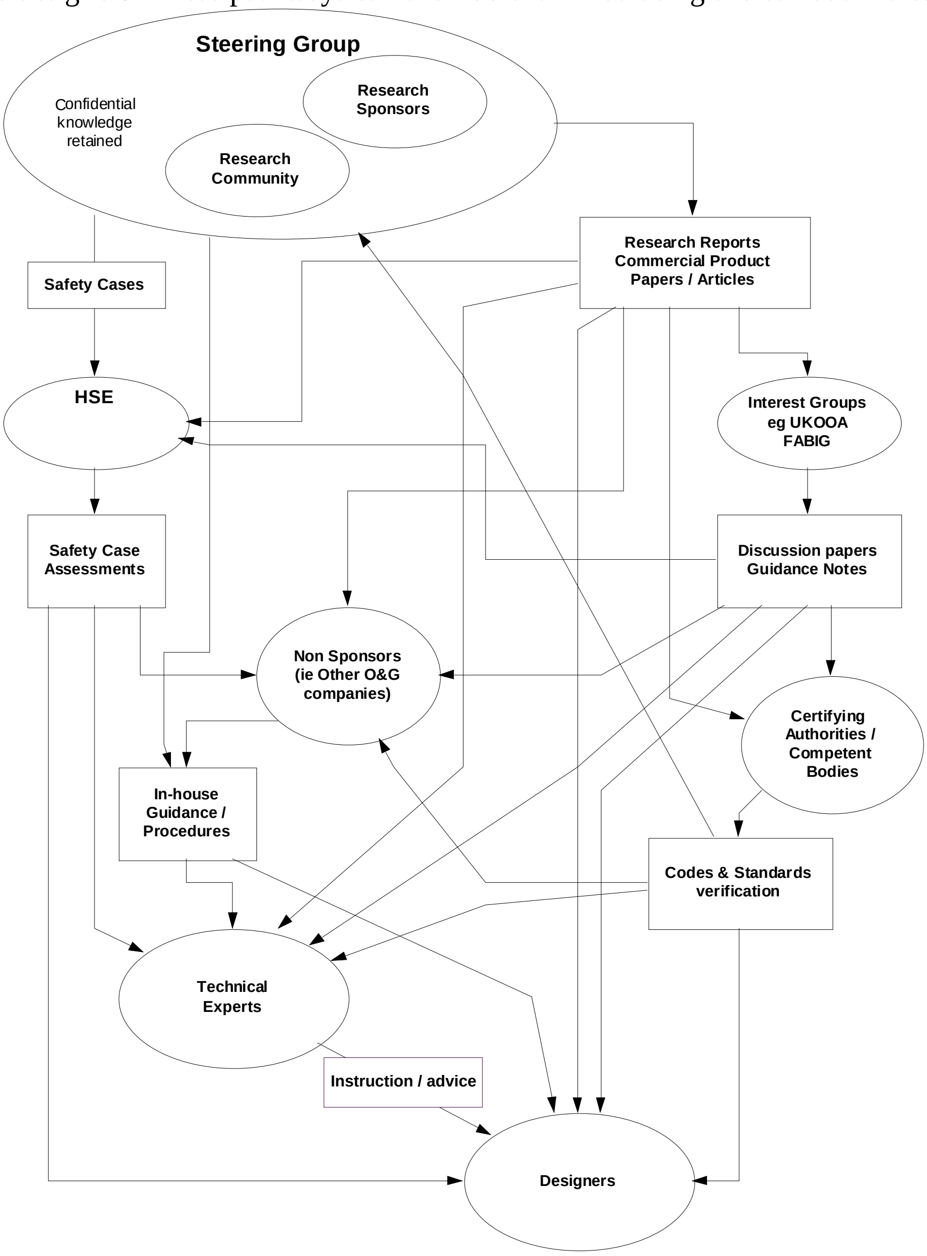


Figure 2.3: Impact Inter-relationships and Interactions Chart

Rounded boxes represent the key stakeholders
Square boxes represent the means of information dissemination

The Impact Flowchart is an attempt to describe in simple terms what can be a very complex set of relationships. The focus has been on the flow of information down to the designers to achieve an impact upon design practice. No indication of the feedback routes, used for example to develop future research, has been given. These are even more complex and less distinct that the means of achieving the impact.

Due to their regulatory presence HSE would be expected to be a stakeholder in any such flowchart related to research in the UK Oil & Gas Industry. For the portfolio under consideration, HSE are also involved as Research Sponsors and they have a presence on the Industry groups, UKOOA and FABIG.

3 The Research Portfolio

To be able to apply the impact assessment framework, we must first define the portfolio of projects of interest and identify research outcomes. The research area of interest was all OSD research projects that could have an impact on process and layout aspects of topsides design. Whilst some indicators have been applied across the whole set of projects it was appreciated that other indicators could only be practicably applied to fewer projects with the resources available. It was agreed that initially the 'explosion' topic would be investigated followed by the 'process equipment' topic. This was because the explosion topic provided a suitable number of projects (54), but the process equipment and layout topics each had only 3 projects. It was considered doubtful that the impact assessment techniques could be fully developed on such small project sets alone. However work on small project sets can complement work on larger project sets and some information was obtained on the process equipment topic area (See section 5.2.5).

3.1 PROJECTS LISTINGS

The HSE Offshore Safety Division has a research database, Herald, which holds details of all completed, current and proposed projects, categorised against a number of fields. The fields can be searched to identify specific projects or groups of projects and include descriptive fields where free text searching can be performed:

- Title
- Background
- Objectives
- Conclusions

and closed fields such as:

- Keywords (relevant keywords are: *design, topside, process, layout)*
- Programme area (relevant programme area is *Topsides Plant and Accommodation*)

In addition, OSD have a database that lists the project reports: The Offshore Technology Report database (OTTER). As an initial attempt to identify relevant portfolio projects, Herald and OTTER fields were searched for 'design', 'topside', 'process' and 'layout'. The listing of projects that this produced was checked for relevance and any irrelevant projects were omitted.

To ensure all relevant projects were identified, this listing was supplemented by examining every OSD (previously DEn) funded project (total of ~3500) in turn to determine by title, background text and objectives, whether it was relevant to the research topics under consideration. In addition a second independent scan of all Offshore Technology reports produced was carried out to identify relevant reports and hence, by association, relevant projects.

Combining the results of the initial searching and the thorough scan produced a directory of 324 projects: Table A1.1, Appendix 1. The full project directory covers the general topside topics of 'layout' and 'process' from the complete range of Department of Energy/ HSE projects. Certain projects, while technically relevant, were intended for HSE internal use only and are excluded from the portfolio. Some projects of very broad scope covering topics such as generalised risk assessment and risk perception are included even though at first appraisal they appear unlikely to greatly influence topside design directly. They are retained in the project directory because they are equally as applicable to topside process and layout as to other topics.

As discussed in section 2, different impact indicators apply in different cases, also some are more easily measurable than others. Certain impact indicators could, by virtue of the low amount of effort involved and because they caused minimal intrusion, be applied to a wide selection of projects. Other indicators are likely to be both effort intensive and to place excessive demands on stakeholder representatives. Consequently a smaller group of projects is needed to test the application of some indicators. For this reason, and with HSE's agreement, a sub-set of 'explosion' projects was identified. These projects were manually selected and are referred to as topic 'E' projects. In total 54 projects are in this subset: listed in Appendix 1, Table A1.2. It was further agreed to apply some of the indicators to the 'process equipment' topic area. There are 3 projects in this subset listed in Appendix 1, Table A1.3

3.2 PROJECT GRADING & RELATIONSHIPS

3.2.1 Factors for consideration

Projects within any topic area are likely to have different degrees of influence, when assessing the overall impact of the topic-related research. To ensure the focus of effort is directed appropriately (eg that sufficient attention is given to the most influential projects), it will be important to understand how projects relate to each other and to the overall portfolio, their size, the applicability of their research findings, etc. A degree of project grading may be necessary. The following considerations should be taken account of before applying impact indicators to the research portfolio:

1)	Position in hierarchy	Many projects don't exist in an isolated context but feed on the results of previous projects and/or feed into future projects. In some instances different contractors are used to work on different aspects of an overall task. In other cases a research string may be deliberately set up as a number of projects, some in series and some in parallel. Often preliminary projects are required to set the scope of major work tasks, to generate industry support, or to define what needs to be done. A starting project in a multi-phase series of projects may be less likely to produce a definitive deliverable that could influence the designer. Conversely, projects may be set-up at the end of the main task to verify the outcomes or to write guidance for example.
2)	Size of project	A small project may encompass less and may therefore be less influential than a larger project.
3)	HSE sole sponsor	The project may have been intended to support HSE internal needs and may therefore be less influential in directly informing industry.
4)	Review/ Validation	Some projects are clearly independent reviews or validations of another project(s). By themselves they may not be influential but may add to or modify the understanding of the other project(s).
5)	Background/ support	Some projects may provide technical support early in the life of a large project or may be helpful in the later analysis of the project findings.

3.2.2 Grading of topic E portfolio

We look in detail at the topic E portfolio, the overall aim of which was to improve understanding of what explosions are, how they occur, what their effects on offshore installations are, and what can be done to mitigate the damage they cause. For this topic, it was not difficult to grade the projects due to the coherent framework that defined the project relationships. For other topics with no overall enabling or controlling project, it is possible that the individual projects may not fill all the spaces in a matrix of research requirements. The topic E projects can be broadly split into six strings, each with its own set of relationships. These are:

- The Blast & Fire Engineering Programme
- The Gas Safety Programme
- Explosion Prediction Methods
- Explosion Suppression by Waterspray
- Explosion Interaction with Obstacles
- Individual Projects

Each of these strings is described. A diagrammatic representation of the sequence of the projects and an indication of how they relate to each other and to other strings is included at the start of each section, with descriptive text thereafter. The existence of relationships between strings means that there may be other equally valid ways of representing the groups of projects.

The Blast & Fire Engineering Programme (Managed by Steel Construction Institute)

P2592: Blast and Fire Engineering for Topsides - Phase I

⇒ P2865: B&F ph2 Planning & Definition

⇒ P3126: Topside Blast & Fire Engineering - Phase II
P3140: Explosion Suppression by Watersprays ---♦
P3219: Review of Struct. Response to Blast Loading Prep.
P3205: Blast Pressure Predictions for Topside Structures ---⊗
P3333: Large Scale Explosion Repeatability
P3425: Additional Full Scale Explosion Tests-Project 3126
P3515: Structural blast response - model evaluation.

⇒ P3522: Large Scale Explosions in a Range of Geometries (Phase IIIa)
P3600: Explosion attenuation by waterspray ---♦

⇒ P3629: Repeatability of Large Scale Explosion Tests

⇒ P3637: Phase IIIb - Preparation of Gas Explosion JIP
P3651: Explosion Modelling-Using Autoreagas ---⊗

⇒ P3119: Review of Interim Guidance on fire and blast
P3399: Phase I - Development of Explosion and Fire Guidance

Key ---♦ See also Explosion Suppression by Waterspray
---⊗ See also Explosion Prediction Methods

In 1989, Project 2592 (Phase I) collated and assessed knowledge from both onshore and offshore industries relating to blast and fire engineering in the areas of:

- blast loading, response and resistance of offshore structures
- fire loading, response and resistance of offshore structures
- representative blast and fire accident scenarios
- legislation, codes of practice and certification requirements in respect of blast and fires.

It produced a series of 26 technical state of the art reports and a set of interim guidance notes. It also identified the need for an experimental programme to improve understanding of the processes involved and allow updated guidance to be written.

As a result, P2865 (Phase II planning and definition) developed a detailed experimental programme and project plan for large scale experimental studies to provide information for the development and validation of computer based fire and explosion models.

P3119 reviewed, with emphasis on structural resistance, the SCI Interim Guidance on blast and fire (produced under P2592), the FABIG Technical Note on Fire Resistant Design and the supporting reports (OTI series) to identify significant areas of uncertainty, areas of omission or weakness and to identify areas requiring further investigation.

Following on from P2592 and P2865, P3126 (Phase II) was set up as a JIP to perform a series of jet fire tests and gas explosions, the latter in a purpose built rig at Spadeadam. The tests covered a limited number of large scale experiments and boundary conditions, to validate the effect of water sprays on gas explosions pressure. The principal conclusions were reported at a dedicated conference in London on 18-19 Feb 1998, the proceedings of which are publicly available via SCI.

So that the results from P3126 could be fully utilised, and a good understanding of the phenomena could be achieved, P3140 was undertaken. The aim was to supply background information on the effect of nozzle type on gas explosion pressure and the effect of reducing droplet size by lowering the surface tension using commercial surface active agents. P3219 reviewed the proposal for work under P3140 to ensure maximum benefit was obtained from the resulting programme of work. P3333 funded one repeat test within P3140 to assure OSD that the conditions/ parameters measured are were repeatable and within accepted error range in a large scale test rig.

P3126 produced limited experimental data from large scale tests, therefore P3205 was undertaken to consolidate the results by simulating gas explosion tests using CFD codes and producing predictions of blast overpressures and flame arrival times for nine pre-determined scenarios.

P3399 reviewed the need for technical guidance for the design and protection of offshore facilities against fire and explosion, and assessed the quality and relevance of the guidance. In addition a detailed JIP proposal for the development of the technical guidance, was prepared.

P3425 supplemented the work of P3126 by carrying out four large scale gas explosion tests, with the aim of reducing the uncertainties in gas explosion models.

P3515 prepared a dataset from the Spadeadam blast panel tests, carried out under P3126, to allow accurate modelling of the structure and blast loading. It was found that the structural response models produced widely different results for response.

The explosion test results from Phase II (P3126) gave higher over-pressures than predicted by models, and damaged the Spadeadam rig on three occasions. The work was considered to be insufficient to allow useful guidance to be written with confidence. P3522 was a further phase (IIIa) in the work and was undertaken with the following objectives:

- to provide additional explosion data in a range of geometries;
- to provide input to design guidance for reduction of overpressures on new and modified installations;
- to identify appropriate mitigation measures;
- to reduce explosion overpressures on existing installations;
- to provide additional data to validate explosion models.

As part of P3522, P3600 ensured that the deluge system used for large scale experiments in the explosion investigation was well characterised and was representative.

During the test programme performed in P3522, two tests showed significant variation in the internal overpressures. It was concluded that the two tests might produce two different structural responses. P3629 carried out tests to analyse the repeatability of measurements. The repeatability tests showed that a variation in explosion overpressures and flame speeds could be produced from the same test conditions. P3637 prepared a proposal for joint industry sponsorship, to provide information on explosion hazards from realistic releases, and P3651 was set up to investigate the sensitivity of the CFD gas explosion model to predicting the variability in the tests.

The Gas Safety Programme (Christian Michelsen Research)

P2607: Gas Safety Programme 1990-1992
⇒P3144: Gas Safety Programme 1993-1996
⇒P3601: Gas Safety Programme 97-99

P2607 aimed to develop engineering guidelines and numerical tools for the improvement of industrial gas safety. The 90-92 programme delivered some 40 reports (not openly available); a Gas Explosion Handbook; a 3-D numerical explosion simulator - FLACS (Flame Acceleration Simulator); and, a PC-version of FLACS - μFLACS. OSD made use of μFLACS to check various scenarios in Safety Cases.

As a follow-up to P2607, P3144 was a second programme covering the period 1993-1996. The overall objective was to develop knowledge to improve the ability of FLACS to provide relevant and accurate data for preventing or mitigating gas explosions. The knowledge and results of the work have, in addition to being reported, been transferred to the programme participants through FLACS-computer codes. The programme was closely related to several other projects going on simultaneously and in which the researchers were involved.

P3601 follows on from the previous programmes, to develop and improve the FLACS computer code for explosion modelling, and improve general understanding of the release and ignition of flammable gases.

P3348, 'GEEJIP- Gas Explosion Engineering', utilised findings from the Blast & Fire Engineering and Gas Safety Programmes to improve the design methods used to protect against gas explosion.

Explosion Prediction Methods (Has links with the Blast & Fire Engineering Programme and Explosion Interaction with Obstacles)

P2390: Study of Gas Explosions within Modules - Phase I
⇒ P2935: Appraisal of Explosion Prediction Methods
⇒ P3128: Update of OTH-89-312- Explosion Prediction Methods

In 1989 the DEn commissioned a review of the applicability of predictive methods to gas explosions in offshore modules. The project (P2390) investigated practicable counter measures for reducing the consequences of ignition of gas leaks within process modules. The findings were presented in OTH 89 312. P2935 updated the review and suggested where additional information was required and where code comparison or benchmark exercises would be appropriate. P3128 updated OTH 89 312 (P2390) using data produced under P2935. The report summarises and reviews the applicability of explosion models employed for offshore gas explosion hazard assessments. It concluded that although there was a range of validation information for various models, there was not much information comparing different models, and no explosion experiments had been carried out at full scale. The SCI phase II JIP (P3126) - under the Blast and Fire Engineering Programme - was expected to fill this gap.

Explosion Suppression by Waterspray (Has links with the Blast & Fire Engineering Programme)

P2484: The Effects of Water Sprays on Gas Explosions
⇒ P2828: Assessment of a Gas Explosion Suppression System
⇒ P2937: Explosion Suppression by Watersprays
⇒ P3211: Water Sprays Interact. with confined gas Explosion

In 1989, P2484 was set up to investigate methods by which to reduce the consequences of gas explosions in offshore modules, particularly in respect of existing modules where enhanced layout and venting cannot easily be facilitated. In particular the project investigated whether there was a beneficial interaction between deluge water sprays and a combusting gas cloud in the presence of a significant field of obstacles. It suggested that the operation of water deluge systems can, in certain circumstances, mitigate the effects of gas explosions in congested volumes.

P2828 was set up to characterise the droplet size distribution produced by a modified deluge nozzle and to assess the effectiveness of the spray in reducing the overpressures resulting from gas explosions in partially confined, congested volumes.

P2937 demonstrated the potential of mitigating gas explosion overpressure by using water sprays. The mechanism by which this is achieved is understood on a qualitative basis and arises from the action of the explosion flow on the water droplets, which break up into a fine mist. P3211 investigated this further by undertaking non-reactive flow tests to study the acceleration and break up of individual droplets in accelerating gas flows in a shock tube.

Explosion Interaction with Obstacles (Has links with the Blast & Fire Engineering Programme as a sub-string of Explosion Prediction Methods)

P3060: Interaction of Fast Explosions with Obstacles P3357: Obstacle Scale Interaction with Explosion Severity ⇒ P3278: Using PDR in Modelling Confined Explosions

There was felt to be little quantitative data on the interaction of explosion scenarios in an obstacle-congested volume, with individual structures and equipment. Obstacles in the path of a propagating flame can accelerate the propagation, resulting in a more severe explosion.

P3060 investigated the interaction of fast explosion through a series of experiments conducted on a medium scale rig.

P3357 quantified the relationship between the characteristic scale of obstacles and explosion mass burning rate downstream of the obstacles. It included an experimental programme studying the influence of obstacles on turbulent flame acceleration at a larger scale than that studied in P3060. The project produced correlations for predicting turbulent burning velocity, which are central to most models of offshore gas explosions. The findings input into P3278, which developed mathematical equations for describing the flow through a large number of obstacles with the aim of improving overpressure prediction in offshore modules. The project also compared alternative modelling approaches, based on the sensitivity of explosion predictions to uncertainties in the representation of obstacles.

Individual Projects

There are a number of individual projects within the portfolio, these were set up either (a) in support of immediate OSD needs, (b) to take advantage of opportunities as they arose, or (c) to provide information at a required point in time.

(a) To enable inspectors to assess safety cases effectively, projects have been sponsored to provide detailed technical information in the following areas:

- performance of aluminium alloys subject to explosions and/ or fire response (P3083)
- escalation potential of an explosion of hydrocarbon/ air mixture in an HP flare (P3250)
- approach to explosion response, resistance and capacity as presented within safety cases (P3502)
- use of the FLACS code to predict overpressures for real FPSO geometries (P3605)
- well-instrumented explosion experiments so as to obtain data suitable for the validation of overpressure prediction methods (P2749)
- mechanisms of release from pipework, such as flange failure, and subsequent combustion (P3569)

- ignition probability data, with the aim of setting down a structured and valid method for checking ignition probabilities used in offshore installation QRAs (P3209).

A further project was set up to show that a thorough explosion analysis is necessary to make effective MODU improvements and to demonstrate that risks are ALARP (P3400). In addition, immediate support, to review how hydrocarbons may enter or be generated within an electric motor enclosure and how they may become ignited, was required (P2514). This was as a result of two similar explosion incidents.

(b) Taking advantage of opportunities as they have arisen, OSD have joined other industry projects as well as funding work initiated by the industry. For example:

- OSD have joined Industry JIPs as an observer to ensure they were aware of developing techniques that may be employed in future Safety Case submissions. It was also felt that offshore safety could benefit by the incorporation of the work into fire and blast guidance notes (P3426 and P3673).
- One portfolio project undertook further development of the code of a computer model, developed for predicting the effects of fires and explosions on offshore installations, so as to extend its scope, increase accuracy and enable it to handle new scenarios (P2977).
- A further portfolio project assessed the potential of an available explosion suppression system to mitigate the effects of explosions and also identified further developments that would be necessary to provide a practical system for use offshore (P2878).

(c) A number of projects have addressed the need for position papers, immediate guidance, review of other work, etc. Typical projects include:

- Modelling of a series of combustion events, with the report from the work forming an annex of the Department's further report of the technical investigation which was submitted to the public enquiry (P1751)
- a review of methods of suppression/mitigation of gas explosions in offshore modules (P2544)
- a project set up to collate and appraise technical comments received from the industry, as a precursor to the production of revised guidance notes (P2586)
- a review of possible applications of water-based offshore fire protection systems (P2702)
- a procedure to improve initial explosion pressure predictions enabling early modification to the designs (OTH 97 541), was produced for implementation by topside engineering companies and designers (P3350)
- the collation of information on fire and explosion R&D capabilities in the USA and Canada (P3439)
- provision of early indications of requirements to allow HSE to play a key role in the development of FABIG codes/ standards (P3606)
- preparation of a position paper to summarise strengths and weaknesses of analytical techniques available for determining offshore structural response to hydrocarbon explosions (P3625).

3.3 KEY OUTPUTS FROM THE PROJECT GRADING ANALYSIS

In the context of assessing the impact on installation design, the project grading and relationships analysis (section 3.2.1) has been used to highlight those projects that have produced particularly relevant outputs. There are indicators that can practicably be applied only to a few projects or reports due to resource limitations and hence there is a need to know which projects or reports are most relevant. These indicators were those involving project report assessment and the citations indexing. The following can be seen to be key project reports.

Project Number	*Project Report*	*Description*
3399	OTO 97 011: Review of available technical guidance for the design and protection of offshore facilities against explosion and fire	This project report gave a comprehensive review of the need for technical guidance for the design and protection of offshore facilities against fire and explosion and an assessment of the quality and relevance of the available guidance.
2607	Gas Explosion Handbook	The Gas Explosion Handbook summarises the main results and experience of the contractor's research programmes and consultancy activity on gas explosion safety. The handbook was conceived to give a simple presentation of the available information and is intended to be used by process, design and structural engineers, as well as safety engineers.
2390	OTH 89 312: Predictive methods for gas explosions in offshore modules	This 1990 report provided a state of the art review of the modelling approaches and models that could be used for the prediction of overpressures generated in gas explosions in offshore modules. The review was extensive and it included models that were at the early stages of development and some general models with potential for being adapted for offshore explosion assessment.
3128	OTH 94 449: A survey of current predictive methods for explosion hazard assessments in the UK offshore industry	This 1995 report provided an update to OTH 89 312, concentrating on those models known to be available for use in offshore explosion hazard assessments.

4 Methodology

This study has focused on the development of an impact assessment methodology, equally applicable across a variety of research topics. Within the time and budgetary constraints of the project it has been possible to investigate a sub-set of the potential impact indicators that had been developed and selected for use in consultation with HSE. These have been trialled to test their applicability and usefulness, and to develop them further. The aim has also been to allow lessons to be learned regarding their implementation, prior to any wider utilisation of the indicators.

As discussed in Section 2, a number of indicators are applicable across the portfolio and easy to assess for a large number of projects (e.g. distribution of OT reports), while others are more time consuming to apply (e.g. citations indexing and stakeholder surveying). Therefore the distribution of OT reports has been investigated for the whole portfolio, while citations indexing and stakeholder surveying have been performed on projects within the topic E portfolio. Other indicators have not been trialled, either because the resources available did not allow or because they were considered to be less reliable. The applicability of the impact indicators is discussed further in Sections 7 and 8.

4.1 OFFSHORE TECHNOLOGY REPORTS

OT reports that were produced as deliverables for the projects within the directory, and are openly available, are listed in Appendix 1, Table A1.5. The OTH and OTI reports have been made available for sale via HSE Books, while OTO reports have been distributed free of charge upon request, by the HSE Research Strategy Unit (RSU).

HSE Books and RSU were requested to provide details of these OT reports, in particular, details of the number of copies distributed (monthly, annual and total) and the contacts to whom they were distributed.

In addition, MaTSU was able to consult previous monthly management information prepared for OSD dating from 1996 to 1998. These reports include listings of the organisations in receipt of OTO reports. Although no indication is given of which organisations requested which reports, it is considered useful to review the listing to determine the different types of organisations that typically request OTO reports.

4.2 STAKEHOLDER SURVEYING

Surveying of stakeholders can be undertaken to obtain information relating to all the impact indicators. This also allows subtle influences or issues to be aired and understood which may affect the impact of the research and would not necessarily be obvious from a more direct impact measurement such as citations indexing. For these reasons, stakeholder surveying is a very valuable means of data collection and should be included in any thorough and detailed impact assessment. Typical stakeholder categories, and the primary reasons for contacting each group, can be described in general terms:

Research Sponsors:	Views on the research; the benefits that have arisen from their sponsorship; and use made of results e.g. degree of openness/sharing.
Research Contractors:	Level of involvement in the research and the impact of this on other research undertaken.
Industry Groups:	Awareness of the research and via which dissemination channels; utilisation/endorsement of the results; and dissemination to others.
Contractors:	Has the output of the research directly influenced in-house standards / procedures?
Competent Bodies:	Awareness of the research and via which dissemination channels.
Other Oil & Gas Companies (i.e. non sponsors):	Awareness of the research and via which dissemination channels; and use made of results within their company.
Other:	Awareness of the research and surrounding issues / topics.

A selection of questionnaires, telephone interviews and face-to-face interviews can be utilised, dependent on the time and resource available for the impact assessment, and also on the level of information sought.

In this work, a stakeholder study was carried out on topic E, using semi-structured telephone interviews (see Appendix 3)

4.2.1 Stakeholder Identification

Relevant contacts were identified by a number of sources:

HSE Contacts

HSE provided a number of contact names for key individuals within operators and design contractors that had been involved in the research.

The Fire and Blast Information Group (FABIG)

FABIG was founded by the Steel Construction Institute (SCI) to meet the need for up to date information on the loading and response of offshore installations to fire and explosion and with a proposal to transfer fire engineering expertise that had been developed onshore to offshore. The objectives of FABIG[4] are to:

- provide a centre for information relating to the loading, response and protection of offshore structures subjected to fires and explosions
- maintain and support the Interim Guidance Notes for the design and protection of topside structures against explosion and fire, preparing and distributing amendments and new issues as required.
- provide, for the benefit of the Group's members, technical notes giving background to and examples based on the Interim Guidance Notes.
- collate and review fire and explosion research data and inform the Group's members on a regular basis by newsletter as to the latest state of the art.
- arrange such meetings as are deemed beneficial to assist in the exchange of information and thereby the ongoing education of the Group's members.

FABIG has around 60 subscribing members, listed in Appendix 2, Table A2.1. They include Oil and Gas Companies, Consultants, Contractors, Manufacturers, Regulators, Certifying Authorities, Universities and Research Organisations.

Internet Searches

An Internet search for organisations involved in offshore fire and explosion work was used to identify contractors that were felt likely to be involved in topside structural design. A number of Internet links were found to be useful, including:

http://www.energyweb.net	Energy Web International Supply Source Directory
http://www.spe-uk.org	SPE UK
http://www.petroleum.co.uk	Institute of Petroleum
http://www.1stdirectory.com/oil/	The Applegate First Directory
http://www.lr.org	Lloyds Register
http://www.fabig.com	FABIG
http://www.hse.gov.uk/osd/oilr.htm	Research on blast and fire engineering for topside structures offshore

Conference Proceedings

A preliminary review of relevant conference proceedings for offshore fire and explosion work was used to identify contractors that were felt likely to be involved in topside structural design. The proceedings directly referred to were:

Society of Petroleum Engineers, SPE - various conferences 1990 to 1998
Safety on Offshore Installations Conference November 1999

[4] Taken from FABIG web site www.fabig.com 16/2/00

Consolidated List of Contacts

From the above described information sources, a consolidated listing of relevant stakeholder contacts was constructed. The type and description of each organisation, together with an indication of the contacts made within each organisation is shown in the table below. In addition a coding system is employed to retain anonymity of survey participants.

Type of Organisation	***Organisation Code & Description***	***Contacts made within organisation***
Association	UKOOA representative	UKOOA Committee members (various of the Operator contacts below)
Operators	Operator A (OA): One of the sponsoring organisations for some of the research	OA1 - Researcher OA2 - Researcher OA3 - Health and Safety Manager
	Operator B (OB):	OB1 - Researcher OB2 - Researcher
	Operator C (OC): One of the sponsoring organisations for some of the research	OC1 - Health and Safety Manager
	Operator D (OD): One of the contractors involved in the research	OD1 - Researcher
Design Contractors	Design Contractor A (CA): a large multi-disciplinary organisation concerned with oil and gas.	CA1 - Structural Engineer CA2 - Structural Engineer
	Design Contractor B (CB):	CB1 - Design Engineer CB2 - Health and Safety Manager
	Design Contractor C (CC): conceptual design and front end engineering design for both onshore and offshore oil and gas developments.	CC1 - Front End design
Specialist Design Consultants	Consultant A (ConA): main area of business safety case assessments	ConA1 - Hazards Assessment for Safety Cases
	Consultant B (ConB): consultancy and software sales	ConB1 - Specialised Analysis
Other	Other 1 (Other1): Science & Engineering consultancy	Other1 - Project Manager

4.2.2 Stakeholder Contact

A cross section of stakeholders were contacted by telephone and requested to answer a number of interview questions. A prompt question list was developed to provide a consistent framework for the interviews (an example is included at Appendix 3). The question list refers to generic issues and the questions were asked in a non topic-specific manner. The interviewees were however chosen around topic E and they often did refer to explosion topics to illustrate their responses.

The different groups of stakeholders were contacted to extract the following information:

Research Sponsors:	Contacted to obtain their views on the research; the benefits that have arisen from their sponsorship; use made of results e.g. degree of openness / sharing.
Research Contractors:	Level of involvement in research, impact on other research undertaken in the explosions area.
Industry Groups:	Their awareness of the research and via which dissemination channels, utilisation / endorsement of the results, dissemination to others
Design Contractors:	Contacted to discover whether or not some numerical data, formula or methodology has been incorporated into their in-house design standard as a direct result of the research.
Competent Bodies:	Awareness of the research and via which dissemination channels.
Other Oil & Gas Companies:	Awareness of the research and via which dissemination channels. Use made of results within their company. Key relationships between operators and other bodies
Other:	Other information relevant to assessing the impact of the research on offshore installation design.

4.3 CITATIONS

A selection of reports, from particularly relevant projects within the portfolio, has been identified through the project grading exercise described in Section 3.2. These reports are:

Project Number	***Research Contractor***	***Authors***	***Report Number and Title***
3399	Steel Construction Institute		OTO 97011: Review of available technical guidance for the design and protection of offshore facilities against explosion and fire
2607	Christian Michelsen Research AS	Dag Bjerketvedt, Jan Roar Bakke, Kees van Wingerden	Gas Explosion Handbook
2390	British Gas plc	British Gas plc, Research & Development Division	OTH 89312: Predictive methods for gas explosions in offshore modules
3128	National Nuclear Corporation	D J Gardner and G Hulme	OTH 94449: A survey of current predictive methods for explosion hazard assessments in the UK offshore industry

Each was selected for searching in the SCISEARCH Database with the aim of examining the extent of referencing of each.

5 Findings

The findings from the implementation of each impact indicator are presented and discussed, in turn.

5.1 OT REPORT DISTRIBUTION

HSE Books distribute only the priced publications (OTH and OTI reports). The reports, and the total numbers that were distributed (for the years 1996-1999 for a random selection), are shown in Table A4.1, Appendix 4.

RSU mainly distribute OTO reports but have also been found to distribute a small number of OTH and OTI reports. The reports, and the total numbers that were distributed (since April 1998), are shown in Table A4.2, Appendix 4.

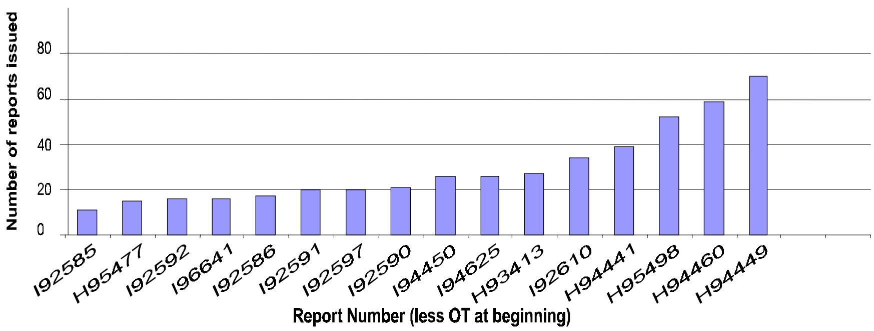
Due to the different nature of reports and their distribution from different sources, it is sensible to consider OTH and OTI reports separately from the OTO reports. The quantities of OTH and OTI reports distributed by RSU have been found to be small and are not considered in the analysis.

Although HSE hold data on whom each report is distributed to, they are unable to make this information available for the study. Therefore it is not possible to analyse recipients of the OT reports produced as part of the portfolio of research. However, it has been possible to obtain information on the different types of organisation in receipt of OTO reports more generally.

5.1.1 OTI and OTH reports

Data was obtained for the years 1996-1999 for a random selection[5] of the OTI and OTH reports. Data were provided on the number of reports issued per month over the 4-year period. The total number of distributed reports is shown in Figure 5.1 below.

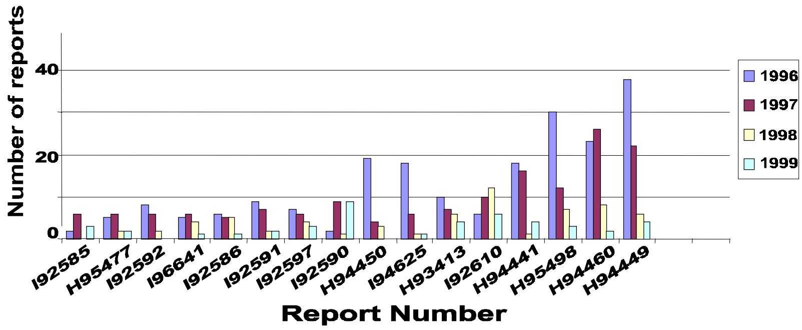
Figure 5.1:



[5] It was not possible for HSE Books to provide details on all reports, as requested, due to time constraints

Figure 5.2 shows the distribution of reports on an annual basis.

Figure 5.2:



It is clear that there is considerable variation in the number of copies of each report that have been issued, from a low of 11 up to a high of 116. On an annual basis, the number of copies of a report that are issued tends to decrease with increasing years. This is not unexpected, as it is likely that publicity about the availability of the reports would be highest when the report is first released.

Reports that were issued as bulk orders (e.g. 100 copies of OTH 94 458 in 1996) should be treated with caution. It is likely these were issued to the project participants or at a conference/event and it is not possible to judge how many have been distributed to the contacts that HSE would wish to influence.

It is possible that a series of reports, produced under the same project, have been distributed to single contacts within organisations. For example, OTH 94 450 and OTI 96 641 are both from Project 2763; 26 and 16 reports have been distributed respectively, which may well be to 26 distinct contacts instead of the maximum of 42. Similarly, P2535 has yielded a series of OTI reports (OTI 92585 - OTI 92610) which may have been issued as a series.

It is important to note that although a report may have been 'issued' it does not necessarily mean that it has been sold. It may have been issued for HSE internal use or as stock for possible sale through a bookshop.

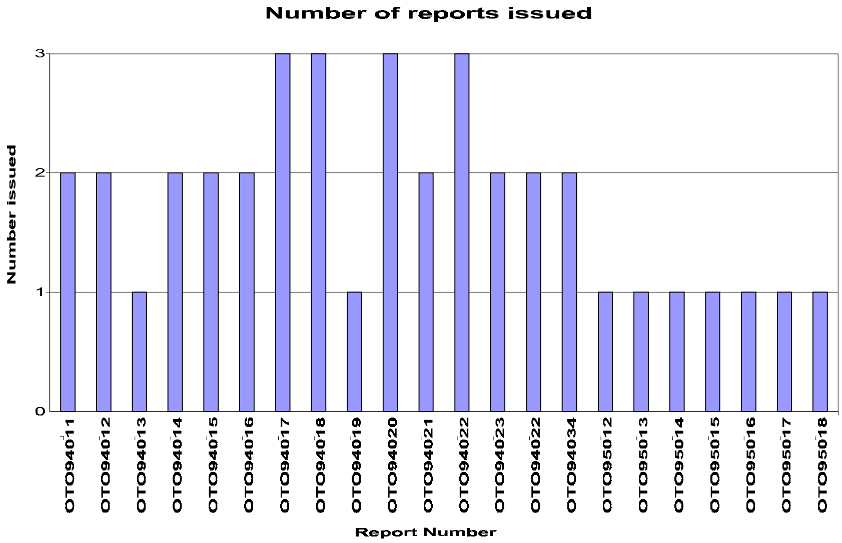
OTH 94449: 'A survey of current predictive methods for explosion hazard assessments in the UK offshore industry', was identified as a particularly relevant report by the filtering and relationships exercise. It is of interest to note that this is one of the more widely distributed reports, with a total of 70 copies distributed over the four-year period (38, 22, 6 and 4 by successive years).

5.1.2 OTO Reports

Numbers of reports distributed

Of the 83 different OTO reports that have been issued by RSU, only 10 have had more than 2 copies distributed since April 1998. Figure 5.3 shows the numbers of topic E reports distributed.

Figure 5.3:



By their nature, OTO reports are not expected to warrant full publication and distribution so it is unsurprising that there is considerably lower uptake of the OTO reports than described for the OTH and OTI reports. Further, the publicity of the availability of OTO reports has been dependent on e.g. the HSE Project Officer, and there may have been considerable variation in methods employed.

The figures only cover the limited period, April 1998 - December 1999. A number of reports were first issued as far back as 1993, so we would not necessarily expect there to have been many requests in 1998 and 1999. For this reason it is not appropriate to investigate any annual trends, or to place too much emphasis on the distribution analysis. However points that can be noted from the distribution figures are:

- P3182 produced the series of reports, OTO 95 012 - OTO 95 018. One copy of each was issued in August 1998. It is likely that the series of reports went to one interested party.
- P3057 produced the series of reports OTO 94 011 - OTO 94 024. Between 1 and 3 copies of each have been issued. The following table shows the distribution of the reports by month.

	Aug 98	*Nov 98*	*Dec 98*	*Jan 99*	*Oct 99*
OTO 94 011	✓				✓
OTO 94 012	✓				✓
OTO 94 013	✓				
OTO 94 014	✓				✓
OTO 94 015	✓				✓
OTO 94 016	✓				✓
OTO 94 017	✓	✓			✓
OTO 94 018	✓		✓		✓
OTO 94 019					✓
OTO 94 020	✓			✓	✓
OTO 94 021	✓				✓
OTO 94 022	✓			✓	✓
OTO 94 023	✓				✓
OTO 94 024	✓				✓

It would appear reasonable to assume that two (2) organisations have each requested a selection of the series, one in August 1998 and the other in October 1999.

Organisations in Receipt of Reports

In the period April 1996 - March 1997, approximately 200 different organisations were in receipt of OTO reports. The following breakdown gives an indication of the different categories of recipient organisations, as well as the numbers of organisations that fall within each category.

5<>10: Universities/Colleges/Research Establishments
Booksellers/Libraries
Medical Centres/Hospitals
Institutions/Associations/Agencies
Aviation Industry
Nuclear Industry
Offshore Engineering, Fabrication & Project Management Consultancies
Drilling Contractors
Named Individuals

20<>30: Operating Companies

30<>40: Offshore Manufacturers, Suppliers & Service Contractors

~70: Other - which include a very wide range of companies from a variety of industry sectors e.g. Pharmaceuticals, Chemicals, Food and Glass, as well as Insurance companies, local councils, water companies, etc.

The distribution is not restricted to the UK, with a spread of requests from across the world e.g. Australia, Belgium, Botswana, Canada, Netherlands, Norway, Sweden and the USA.

In the period April 1997 - February 1998, approximately 100 different organisations were in receipt of OTO reports. The following breakdown gives an indication of the different categories of recipient organisations, as well as the numbers of organisations that fall within each category.

0<>5: Medical Centres/Hospitals
Drilling Contractors

5<>10: Universities/Colleges/Research Establishments
Booksellers/Libraries
Institutions/Associations/Agencies

Offshore Engineering, Fabrication & Project Management Consultancies

10<>15: Named Individuals
Offshore Manufacturers, Suppliers & Service Contractors
Operating Companies

~ 20: Other - which include companies from other industry sectors e.g. Chemicals, as well as safety consultants and engineering firms.

The distribution is again not restricted to the UK, with a spread of requests from across the world e.g. Australia, Canada, France, Norway and the USA.

Of particular interest is the number and nature of organisations that are directly involved in installation design, i.e. the Operating companies, design consultants and design engineers. For both periods there is good representation of operating companies in receipt of reports, including sponsors and non-sponsors of the topic E portfolio. For the 1996/97 period three (3) offshore engineering, fabrication and project management companies, and four (4) offshore manufacturers, suppliers and service contractors, that received reports, are involved in design engineering or design consultancy. For the 1997/98 period, design engineering or design consultancy organisations in receipt of OTO reports are restricted to five (5) large offshore engineering, fabrication and project management companies. No small design consultants received OTO reports in this period.

5.2 STAKEHOLDER SURVEYING

An anonymised summary of the discussions with each stakeholder is included below. For simplicity, reference throughout is made to 'he' regardless of whether the contact was male or female. The interviews were semi-structured, following an aide memoir (see Appendix 3). The questions related to OSD funded research and design in general, but the interviewees were selected on the basis of their association with topic E projects. As a consequence the information obtained often made reference to topic E subjects.

5.2.1 Operators

OA1 was well aware of work done relating to jet fires, pool fires, passive fire protection (PFP) and explosion. OT reports are referenced in Operator A's documents and OA1 had also published articles related to the explosion projects. OA1 provided an indication of the scientific journals that may reference the research. Overall OA1 is of the view that the research has not only had an impact on design but also on safety awareness and on whether designs meet ALARP (As Low As Reasonably Practicable) requirements.

OA2 had also published conference papers and journal articles relating to the explosion projects. He was familiar with ORF but did not need to contact HSE or fellow researchers via ORF. He felt that the research had been very influential but that there was more to learn.

OA3 does not anticipate much direct reference to research projects in design guidance. He thinks that 90% of guidance is capturing current good practice, by talking to operators and taking account of ISO standards. He noted that UKOOA has a role in the decision making process. New developments are fed back into codes once they have become accepted good practice. Operator A's company guidance is not currently being updated, as there are very few new installations.

OB1 said that he was certain that OT reports would be referenced extensively in the Interim Guidance Notes, which were currently being updated. The data was certainly being used and when the update was completed the OT numbers would be referenced.

OB2 said that OT reports were not explicitly referenced in in-house guidance, although the philosophy and background are referred to. Specifications to designers were very basic i.e. just giving the over pressure values. OB2 had published many papers and tended to refer to engineering journals rather than scientific ones. He was very familiar with ORF but due to his close relationship with HSE and other researchers did not need to use it as a point of contact. Other colleagues served on ISO and UKOOA committees.

OC1 was well aware of the OT reports both through participation in various Joint Industry Projects (JIPs) and via ORF. He had obtained reports from HSE. OT reports are referenced in operator C's procedures. Some methodology, formulae or numerical values arising from the work was used in the procedures, probably as a result of involvement with the research. HSE research was referred to in internal documents. OC1 is on the ORF circulation list but did not use ORF as a means of contact because they have direct contact with HSE and researchers through their participation in the projects. He was involved with HSE and UKOOA standards committees and meetings. Operator C provides reports and JIP results to contractors and offers guidance but does not prescribe use of specific numbers or formulae.

OD1 would make occasional reference to OT reports but more reference was made directly to the tools developed by the projects. He had published a conference paper related to projects within the portfolio. He was familiar with ORF but made contact with HSE and researchers at JIP meetings. OD1 participated in UKOOA committees and has made presentations to FABIG.

5.2.2 Design Contractors

CA1 had access to OT reports and they were referenced in company procedures. Some methodology, formulae or numerical values which have arisen from HSE sponsored research was referenced or used in in-house codes. CA1 has published papers that refer to HSE or JIP projects or reports. He is familiar with ORF but had not contacted HSE or a researcher mentioned in ORF. He would use the research findings in participating in the evolution of new design culture. CA1 felt that the lack of business was currently the biggest influence on offshore design.

CA2 was currently working on a major UK project and was aware of a range of fire and explosion studies and HSE OT reports. The results of HSE work would be used in the project. No single person within the company was responsible for updating the design procedures, especially as there was not much new work taking place and this would be a task undertaken at direct cost to the business. Procedures were updated on an ad-hoc basis. It is usual for contractor A to work to the clients design guides. Personnel numbers were being reduced and most effort was being expended on proposals for new work.

CB1 indicated that company B's main area of business was in the offshore energy sector. He had access to most OT reports and contact with HSE at a scientific level (e.g. with regard to blast pressure analysis but not concerning the calculation of over pressure). Contractor B was not a prime user of R&D directly, making use of FABIG information on practical aspects. In-house codes were updated in an ad-hoc manner. CB1 was not directly aware of project findings being included in an in-house code, he received load definitions and time history specifications from another part of his organisation. He was not familiar with ORF, but felt that the findings of the research would be used in the near future rather than far future. CB1's concerns were that various people from the clients onwards were imposing higher overpressures, leading to an uneconomic design.

CB2 had access to OT reports that were directly quoted in design guidance. Specialist design houses were used in deciding which methodology to follow. He felt that there was still some debate as to which models to believe. Reference was made to results but these were not necessarily used explicitly. CB2 had not published any papers referring to HSE sponsored projects, but was familiar with ORF and had contacted HSE or a researcher mentioned in ORF. He would use research project findings directly and felt that there was a strong requirement for the revised fire and explosion guidance notes.

CC1 had access to a number of relevant OT reports. The documents produced for the customers directly refer to OT reports, and the methodologies, formulae or numerical values used by contractor C came from OT reports. He had published papers that inferred HSE sponsored work. CC1 was familiar with ORF and had contacted HSE or a researcher mentioned in ORF. Research project findings would be used directly if they were available in the public domain. The biggest factor in design currently was how to deliver safety in an economic fashion. He felt that the research results were well known by the industry, which is now waiting for the re-issue of guidance.

5.2.3 Specialist Design Consultants

ConA1 knew of OT reports via industry contacts and had a number of them. OT reports are often referenced directly in reports for clients. HSE project data is referenced in the project reports but he was not aware of any project finding being included in codes of practice. ConA1 was not familiar with ORF but had contacted HSE or researchers about particular projects as a result of industry contacts. Research findings would be used directly rather than waiting for design culture to evolve.

ConB1 has access to a number of OT reports and they are directly referenced in company procedures. Data from HSE reports was used but project findings were not included in codes of practice. ConB1 had published papers that refer to HSE or JIP research. He was familiar with ORF and had contacted HSE or a researcher mentioned in ORF.

5.2.4 Other

The project manager for Other1 indicated that the UKOOA project to reissue design Guidance Notes was delayed due to budgetary problems but was expected to re-start in 2000.

5.2.5 Process Equipment - Separation processes

Contact was made with a senior researcher involved in R&D on separation systems. He stated that the R&D activities were steered towards the solution of real life problems by the active participation of the offshore operators. Equipment that had been developed in the labs was now either being used offshore or else was being further developed in conjunction with commercial process equipment suppliers. Predictions of equipment performance compared well with measurements on offshore separators using the new technology. There were other areas in which commercial applications were likely to come in time.

There was not time available to conduct interviews with stakeholders in a similar fashion to that carried out for topic E and so it is not possible for example to determine how well known the research was outside of the sponsor companies.

5.3 CITATIONS

Authors names are needed for searching by SciSearch, which meant that Report OTO 97 011 had to be excluded. The following shows the search terms used and the results of the search.

Report	***Author***	***Organisation***	***Findings***
OTH89312	British Gas plc	British Gas plc	No citations
OTH94449	D J Gardner, G Hulme	NNC ltd	No citations
The Gas Explosion Handbook	Dag Bjerketvedt, Jan Roar Bakke, Kees van Wingerden	Christian Michelsen Research AS	One citation (see below)

<u>Title:</u> Application of ALARP to the Design of the BP Andrew Platform against Smoke and Gas Ingress and Gas Explosion
<u>Authors:</u> Tam V (*); Moros T; Webb S; Allinson J; Lee R; Bilimoria E
<u>Companies:</u> BP Explorat Co Ltd (*), Chertsey Rd, Sunbury, TW16 7LL, Middx, England
Brown & Root, London, England
<u>Source:</u> Journal of Loss Prevention in the Process Industries, (SEP 1996) Vol. 9, No. 5, pp. 317-322. ISSN: 0950-4230.

6 Conclusions

In this section we present specific conclusions relating to the impact of OSD research on installation design, as well as more general conclusions relating to the adopted approach to impact assessment; the definition of a research portfolio; and the trialed impact indicators.

6.1 IMPACT OF OSD RESEARCH ON INSTALLATION DESIGN

The original intention had been to investigate the impact of OSD research on installation design in the widest sense, however there are many hundreds of projects that could be included in such a portfolio. Even with a focus on process and layout aspects of topside design, some 324 relevant projects were identified. It has not been possible to apply any impact indicators in detail to this large portfolio and it is not therefore appropriate to draw any conclusions regarding the impact of OSD research on installation design in this wide sense. However, the portfolio of explosions projects provides a manageable subset, to which impact indicators can be applied more effectively and from which conclusions can be drawn relating to the impact on design in the area of explosions.

The process equipment and layout topics had too few projects to adequately be used in the development of impact assessment methodologies. Whilst some useful information would be obtained, certain impact indicators may not be useable eg because there are no open reports. In addition the conclusions that can be drawn from a few reports are unlikely to be as sound as those from a few tens of reports. There were however indications that process equipment technologies developed during the HSE sponsored projects were being commercialised and would at some point be generally available to the offshore industry.

The findings clearly indicate that the research sponsored by OSD has impacted upon the design of offshore oil and gas installations, with respect to explosions. They also give an indication of the key means of transferring the findings from the research and development work, through the stakeholder hierarchy, to the designers.

The key channels for the dissemination of research findings and utilisation of the results are found to be participation in the projects and participation in relevant committees such as FABIG. The interview findings show the importance of the strong relationships between the research community and Industry groups and between Industry groups and technical experts within design organisations. In particular it was found that:

- Operators get to know about R&D through active participation in JIPs and industry groups and committees such as FABIG and UKOOA.
- Contractors get to know about R&D through contact with and by working for operators. They also participate in FABIG.
- The Interim Guidance Notes produced by FABIG for the design and protection of topside structures against explosion and fire are highly regarded.
- Large organisations usually have a 'Health and Safety' engineer and/or 'Chief Engineer' who is familiar with relevant R&D and who is in charge of producing guidance in a form more suited to the designer. As he often sets the standards for the designers he is a key individual in the stakeholder hierarchy.

- Smaller organisations generally have more specialised roles and may have individuals undertaking design studies who are familiar with the R&D, often through their industry contacts rather than by direct involvement.
- Whilst designers may express an interest in research, they often work to derived standards without knowledge of how these are derived.
- The majority of contractor and operator representatives interviewed considered that the research findings would be used directly or would be involved in the evolution of a revised design culture.

Report distribution is found to be weak as a direct route to impacting the designer. They are more likely to be influenced by contact with other stakeholders. In addition, the time period for which information on report distribution was available restricted the usefulness of any analyses of extent of distribution of relevant reports. Neither was it possible to investigate who had received specific reports. However, we do know that operators, design consultants and design engineers are included in the listing of organisations in receipt of OTO reports. Direct surveying of relevant stakeholders would allow this useful information to be collated in a more comprehensive study.

Citations indexing did not reveal much referencing of portfolio output reports (particularly OT reports). However it is believed this is a function of the indexing rather than a good indication of the impact. Citation indexing is much used within the research community largely involving research-orientated journals. Citation indexing is less used in engineering journals as the original research reports are unlikely to be directly referenced. Hence discussion with relevant stakeholder contacts indicated that they were aware of the work and referenced it in e.g. in-house standards. In addition, operator and contractor contacts indicated that they often disseminate R&D via conferences, describing in summary form practical applications for the work in a manner that is more attractive to the design community than the project reports.

The majority of interviewees are familiar with Offshore Research Focus (ORF) but not many see it as a way of contacting HSE or researchers for further information often because they have more direct means of contact, (for example via project steering groups or via FABIG). Designers are less likely to be familiar with ORF than operator contacts.

6.2 IMPACT ASSESSMENT APPROACH

The impact assessment approach that has been developed has so far proved useful in assessing the impact of OSD research on installation explosion design. The methodology has not been tested in other topic areas but the techniques are non-specific and should be equally applicable to other topic areas. Whilst the detailed application of some of the indicators is partly dependent on the organisations and management structures involved in each topic area, the indicators are generally applicable. Subsequent assessments will benefit from the work to trial this approach.

The visual approach to describing stakeholders, research outputs and dissemination methods ensures that the concept is understandable, while allowing for the possibility of a very complex set of relationships. The utilisation of a number of different impact indicators allows the approach to take account of, and be applicable to, research portfolios in any topic area; the most relevant impact indicators can be selected accordingly. Understanding the possible pathways from the research to the targeted end user(s) helps focus the impact assessment but also allows any findings that are not intuitive to be explained and incorporated. In the current study the task was to examine the impact on designers and these could be identified as a fairly distinct end user. For other tasks a wide ranging target audience, comprised of several different groupings, may be identified eg if one were to examine the impact of R&D on the working practices of occupants of offshore installations.

The framework not only allows the impact to be assessed but also, perhaps more importantly, can provide an indication of how to increase the influence of the research and development work.

6.3 DEFINITION OF RESEARCH PORTFOLIO

The impact assessment approach relies on a clearly defined and understood portfolio of projects and the appropriate selection of indicators. It is therefore important to select an appropriate portfolio, in terms of number and nature of projects, for the time and budget available for the impact assessment. Someone with a good understanding of the work that has taken place in the area of interest will most easily select an appropriate portfolio of projects. This is obviously specific to the retrospective definition of a portfolio. For maximum applicability of these techniques, consideration of the evaluation of individual projects/portfolios should be made when the projects are first set up.

Once the portfolio has been defined, it is essential to obtain an understanding of the specific focus of each project; the research work it has encompassed; the outcomes; resulting products; available reports; extent of dissemination; etc. It is also considered essential to perform a filtering and relationships exercise to determine how the projects relate to each other, and consequently which are of most relevance. This will allow the focus of effort to be appropriately targeted and the application of impact indicators to be undertaken effectively.

6.4 IMPACT INDICATORS

The indicators that have been trialled are discussed here. The remaining indicators, listed in Table 2.1, have not been trialled, either because of time constraints or because the indicator was considered to be of limited reliability. It is important that the pathways between the research and the end user are carefully considered. As there are clearly multiple pathways then a combination of carefully chosen indicators should be used. Resource constraints may preclude the indicators thought most likely to provide the most useful information being used in each study. The most appropriate indicator may provide less information but provide it in a more timely or less costly manner. Also certain indicators may compliment each other.

So that the most appropriate indicators be used for any study, a number of factors need to be taken into account, including:

Time available;
Budget;
Policy constraints;
Legal factors - eg Data Protection Act

6.4.1 OT Report Distribution

OT report distribution numbers are easy to assess and analyse. However, there are a number of considerations that affect the conclusions that can be drawn from the OT report distribution data. Primarily:

- It is not possible to obtain a complete record of all issued reports. HSE Books can provide details of OTH and OTI reports distributed since 1996 and the Research Strategy Unit can provide details of OTO reports distributed since April 1998. For projects that generated OT reports before these dates, there may have been significant distribution of reports that it is not possible to assess.
- It is not possible to obtain information regarding the individuals/organisations to which specific reports have been distributed. Therefore, no qualification of the results in this respect is possible.
- To draw conclusions about the merits of the distribution levels it is essential to analyse the target audience, i.e. the number and nature of organisations that it is desirable to have received copies of the reports.
- The extent of proactive publicising of the results of the work can have a significant effect on the distribution of reports.
- Consider also whom the report was written for. Some reports have been written primarily for HSE [6]internal use or for specific industry groups. In addition much of the published work by virtue of subject matter was best suited to the academic community.

In addition, a major problem with the OT report route is the time delay between completion of the work and publication of the study report(s). Conference papers are a far more timely means of disseminating findings (especially interim results) and generating discussion, and often present the work in a manner better suited to the end user. Also, if an industry group such as FABIG is well attended and proactive, it is likely that early project results can be most effectively disseminated here, e.g. through the Technical Guidance Notes.

6.4.2 Citations

Citation indices can be expected to show links between similar groups of people, for example 'scientists' writing for 'scientific' journals would be expected to read and make reference to articles written by 'scientists' in 'scientific' journals. That the OT reports identified from the portfolio were not found to be referenced may indicate that:

- researchers do not read or make reference to OT reports;
- the function of and means of obtaining OT reports is not understood;
- project results are more likely to be found by reference to conference papers and journal articles, by searching on researcher names and the names of sponsor's representatives.

Therefore, for the explosion portfolio, citations indexing is not as powerful an impact indicator as might initially be expected. It is possible that this could reflect the nature of the contractors for much of the work. The more applied, industrial contractors are felt to be less likely to be concerned with publicising the results of their work, e.g. in conference papers, while academic researchers place great emphasis on dissemination of their work. A further factor is that industry groups such as FABIG publish their own summary reports, and these reports may be more likely to be referenced than OT reports.

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[6] The HSE is obliged to make research reports available whenever possible

6.4.3 Stakeholder Surveying

The approach to contacting stakeholders will depend upon the time and budget available and the required depth of any survey. However, it does provide an opportunity to collate much information on a number of different impact indicators and it allows subtle views/ influences to be seen and understood. It also allows the possibility of opening up additional avenues of investigation that may not otherwise have been identified. For these reasons it should be considered an essential part of any impact survey.

As some of the indicators such as 'Industry In house standards' ideally require an on-site visit to each of a number of operators or contractors, there may be practical limitations on how these indicators are used. However if the opportunity for a visit is taken, there may be a number of generic issues that a trained observer could obtain information on apart from the specific issues. These generic issues may include:

- Background information on organisational structure;
- How technical guidance is communicated;
- Nature of relationship with major operators;
- Nature of information services and availability of reference material
- Attitude toward training

For design issues, a good time to perform an impact assessment would be whilst a lot of UK offshore design work is taking place. At other times it can be difficult to locate designers who are familiar with UK offshore practice. This is because the designers may be working to codes and standards specific to a country other than the UK, and they may actually be abroad or involved in other industry sectors.

7 Evaluation of Future Research-Discussion

As has been shown, there is a range of problems associated with evaluation of the impact of research. Actual impact can only be measured at the time of the impact occurring or retrospectively some time after the initial impact is expected to have taken place. If a need to measure impact is identified after a particular project, programme or portfolio of research has been carried out; it is less likely that mechanisms were set up in advance to assist in the evaluation process.

This section of the report highlights issues to consider and address ahead of research being carried out, which will help to streamline and facilitate evaluation of the impact of the research. Although the current pilot study has focused on the impact of OSD research on installation topside process design, many of the same issues apply when evaluating the impact of research in general.

Consideration of these issues here does not imply that they have not received attention in the past. Rather, this is a pulling together of a set of inter-related issues and seeking to address them all in a systematic manner.

- ***Portfolio, programme or project?*** Across the range of HSE research topic areas, there are research portfolios (e.g. Jet Fires, Shiftwork), programmes of projects (e.g. linked projects underway in parallel or being carried out in a phased series), and individual projects (e.g. set up to address more immediate and perhaps unpredicted needs). It is suggested that consideration of measuring the impact of the research should be addressed at the highest level first (portfolio) and then at the progressively lower levels so that a co-ordinated approach can be adopted.

- ***Sphere of influence?*** There are a number of questions to address here. How broad or narrow is the desired 'sphere of influence' for a particular research portfolio? That is, which individuals and organisations is the research aimed at influencing directly and in what way? Similarly, which individuals and organisations is it intended that the research should influence but by a more indirect route? What are the desired influences here? [The impact flow chart (see Section 2.3) should help in determining the desired sphere of influence when considering research in the topic E area.]

- ***Influence mechanisms?*** Once it is known which individuals and organisations the research is intended to influence and the nature of impact desired, attention can turn to selecting the most appropriate influence mechanisms for the case being considered. There are several aspects to the influence mechanism: it is directional so, what individuals / organisations are at the start of an influence vector? what individuals/organisations are at the end of that influence vector?; what methods will act most effectively as influence carriers in this case? (It is rare for there to be only one appropriate method. The chances of obtaining the influence required are likely to be enhanced by adopting more than one method.)

- ***'Through life' influence and impact?*** In the past, the focus may have been on influence and impact of the final deliverables from research. These deliverables could be OT reports published some time after research completion. Increasingly, 'through life' influence and impact are receiving the attention they deserve. That is, the importance of keeping a range of stakeholders informed on an ongoing basis from project inception - perhaps via launch publicity - onwards has been acknowledged. The flow of information and potential influence is not purely one-way from the research project outwards. The stakeholders may have contributions to make that will affect the way in which a project progresses. Examples include providing comments on interim reports and piloting draft versions of new methodologies.

- ***Measuring impact?*** A range of ways to measure research impact was examined earlier. Most measures have associated problems. For example, information may be sought on numbers of OT reports distributed and the recipients. But is receipt of an OT report actually a useful indicator that its contents will have an impact on the receiving organisation? Even if this is felt to be an indicator of some value, the Data Protection Act does not allow details of those who have requested copies of reports to be revealed. The impact measurement process does have some inherent problems. However, most can be addressed or avoided by determining how impact is to be measured <u>before</u> the research commences and ensuring that the necessary systems are in place to allow the impact measurement to take place when required. For example, recording a category for the report requester (operator, contractors, researcher, etc) would remove the need to give out detailed personal data while still providing useful information for analysis purposes. It is desirable to keep impact measures as simple as possible, while at the same time not compromising their potential effectiveness. It is also important to consider <u>when</u> different types of impacts might be expected to take place. Results of measurement that takes place too early may underestimate the overall scale and nature of the impact. Conversely, measurement that takes place some time after the initial impact may mean that detail is lost (e.g. information having been forgotten, individuals having moved on etc) or cannot be disentangled from the impacts of more recent research.

- ***Refining the impact evaluation process?*** It has been mentioned that the impact evaluation process should be as simple as possible. It is also true that retaining a core set of measures for repeated use is of value in terms of repeatability, allowing comparison between research programmes and lessening the drain on resources. At the same time, this should not be at the risk of overlooking potentially important routes of influence that are only associated with particular research. There will also be lessons to learn from the early application of any evaluation process that can be used to modify and improve its later use.

- ***Other considerations?*** The process of getting a research concept from the laboratory into a fully developed product / methodology takes many years. In the time from conception to end use, many things may have changed including:
  - Economic factors:
  - Regulatory issues;
  - Evolution of competitive technology;
  - New assessment tools;

  - Fluid employment market - it is no longer possible always to retain knowledge and experience in individuals within organisations.

  To successfully take account of these factors requires flexibility, resilience and a strong belief in the outcome. The involvement of a committed industry body is a bonus in obtaining continuity, though the aims of government and industry do not always coincide at all times through the life of a project string (ie set of projects with a common theme, following a common set of objectives).

- ***Direct involvement?*** The HSE is sometimes directly involved in projects that produce design standards as project deliverables. Although there have been no such projects in the process and layout areas, there are examples in the pipelines area (Project 3185 - specification for unbonded flexible pipe & Project 3500 - JIP - Deepwater Pipeline Design Criteria). It is clear that projects that directly aim to produce design standards are more likely to impact directly on the designer and it is likely that the impact may be easier to assess.

8 Recommendations

The techniques described in this report have been trialled for particular sets of projects and particular end users, namely for topside process design projects and for designers. Whilst we believe the methodology to be widely applicable, this has yet to be demonstrated in practice. Further work on a different topic area and different end user may reveal features of the techniques that have not been prominent in the work reported here. A further study on a different topic area, may yield a more thoroughly tested methodology that could more easily be applied to new studies.

The impact assessment techniques may need to be slightly adjusted for different topic areas and / or end users, taking account of the particular stakeholder relationships that apply. Applied carefully, impact indicators are useful and can be adapted to resource constraints (whilst more information can be obtained from site visits for example, useful information can still be obtained from interviews).

In the long term, information from design safety cases may indicate the degree of uptake of technology which started off as research projects and has become accepted as the state of the art. Clearly some technology has a more apparent effect (perhaps giving rise to a standard or a revised design parameter), whilst other technology has a more subtle effect. It is recommended that, when the opportunities arise, participation takes place in projects that aim to produce standards. The most effective of these are projects involving a mix of academic, operator and manufacturer representation, as the various different view points are expressed and can be more readily appreciated, leading to deliverables in which all parties have a commitment. After an appropriate time for the deliverables to be assimilated, it would be useful to carry out an impact assessment.

Appendices

CONTENTS

Appendix 1
Project Portfolio

Table A1.1: Project Directory

Project No.	*Title*
70	Riser Tensioner Equipment
101	Ultrasonic Flowmeter
104	Measurement of Water in Crude Oil
119	Inst. Requirements to Predict Safety + Performance
143	Airflow over Production Platforms
160	CIRIA Newsletter and Digested Reports
181	Directory of Current Research
212	Research on Continuous Sampling Device
253	NEL/IP Meter - Prover Research Project
288	Electrochemical Crack Detection
306	Safety Guidelines for Offshore Installations
323	Tests at BP Kent Refinery on Auto Sampling Device
353	Planning of Safety Provisions Offshore
472	Jetting System for Flow Measurement
476	Offshore Crane Research
544	Heat Transfer from Flare Stacks
555	Meter Prover Phase 3
556	Reversed Phase Water in Oil Sampling Tests
557	Checklist for Offshore Gas Liquefaction Plants
599	Management of Reliability and Safety Study
600	Risk Analysis of North Sea Operations
617	Feasibility Study of Scanning Ionising Radiation
665	Guidance on Firefighting Equipment
666	Study of Fire Damage to Offshore Platforms
667	Guidelines for Offshore Flare Systems
704	Heavy Gas Dispersion Trials
709	Magnetic Particle Inspection
715	Emergency Shut Down Systems
722	Fire Safety from Hydrocarbon Fires
723	Data Base on Reliability of Offshore Plant
742	Vibration Performance of BP Forties 'B' Platform
743	Automatic Sampling Techniques for Crude Oil
774	Preventative Maintenance for Offshore Crane Safety
781	Monitoring of Offshore Crane Slewing Rings
791	Fire Damage to Offshore Steel Installations
809	Noise + Vibration Control: Guidance for Designers
858	Large Scale Simulations of Offshore Operations
868	Assessment of Non-Pool Fire Types
890	Hydrocarbon Fire Tests Flux Levels (Experimental)
936	Evaluation of Dispersion Models
987	Magnetic Particle Insp Techniques - Welded Joints
998	Diesel Engines in Potentially Flammable Atmosphere
1012	Risk Overview Study of Offshore Activities
1098	Updating Draft Guidance Notes Fire Fighting Equip
1751	Simulation Of Gas Explosions Within Modules
2007	An Overview of Risk on the UKCS
2025	Offshore Control Engineering Systems - Review

Project No.	***Title***
2026	Preparation of Camera Ready Copy of Fire Report
2030	Improvement of Offshore Deluge Valve System
2034	Magnetic Particle Inspection-Offshore Requirements
2084	Achilles Club
2137	Study of Novel Floating Production Vessel Designs
2152	Development of Offshore Fire Fighting Equipment
2156	Incendivity of Sparking in Large Elec. Machines.
2175	Smoke Movements in Escape Routes
2188	Film/Video on Safe Use of Cranes in O/S Industry
2189	Film/Video: Ionising Radiation in the O/S Industry
2192	Compact Prover Evaluation
2272	Tech Support to PED5-Structural Fire Protection WG
2288	Drafting of Mechanical Guidance Notes
2303	Revision of Fire Fighting Equipment Guidance Notes
2318	Review of Test Options for Hydraulic Fluids
2333	Slug Flow in Flexible Riser Systems
2336	Performance Prediction of Medium Velocity Sprayers
2366	4th Edition of Guidance Notes-Phase 3
2377	Ad Hoc Advice on Fire Protection
2383	Hot Bolting Project
2385	Examination/Testing of Explosion Proof Enclosures
2389	Comparative Safety on Accommodation Location
2390	Study of Gas Explosions within Modules - Phase 1
2395	Offshore Facilities Data Base
2401	Heating & Ventilation Guidance Notes
2409	Erosion in Multi-Phase Flow
2411	Pre study for Monitoring of Floating Production Sys
2420	Risk Assessment of Piper Alpha Prior to Accident
2436	Condensate in Reciprocating Compressors
2437	Fire Performance Testing of Composite Materials
2440	App of Formal Safety Assessments to O/S Facilities
2443	Editing of Guidance for Electrical Equip. Offshore
2450	Risk Assessment of Montrose Alpha
2459	The Prediction of Natural Ventilation Efficiency
2465	Seal Life Prediction for High Duty Application
2484	The Effects of Water Sprays on Gas Explosions
2485	4th Edition of Guidance Notes - Amendments
2504	Gas Hydrate Formation/Transportation in Pipelines
2514	Explosions In Gas Compressor Elec. Motor Drives
2527	Design of Blast Resistant Structures for O/S Ind.
2529	CRC Artwork of the O/S Flare Systems Support Doc.
2534	Advice on Armadillo Quarters Fire Resistance
2535	Jet Fire Testing of Passive Protection Coating
2544	Advice on Explosion Supression/Mitigation
2553	Measurement of Energy Released at Discharge Sites
2557	Prep of Guidance Notes on Formal Safety Assessment
2568	Inspection of Claymore Platform
2586	Consultative Doc. on Protection Against Fire/Exp.
2592	Blast and Fire Engineering for Topsides - Phase 1
2596	Spatial Risk Analysis of Platform Deck Layouts

Project No.	***Title***
2607	Gas Safety Programme 1990-1992
2608	Prep. of Guidance Notes on GRP Piping for Offshore
2623	Guidelines for Ass. of Corrosion in Process Plant
2625	Escalation of Offshore Incidents
2639	G.N.S 45: Gas and Liquid Containment
2646	Insulating Coatings for High Temperature Pipelines
2650	Large Scale Performance Tests of FRP
2654	Two Phase Flow in Risers
2663	Report on Life-Cycle Management Course
2668	A Treatment of Water Offshore - Phase 2
2670	Risk Analysis of Hewitt 48/29 Complex
2690	Guidance on Corrosion & Erosion Monitoring Control
2702	Application Review of Water Spray Technologies
2709	4th edition of Guidance Notes- Revision
2733	Study of Temporary Safe Refuges
2748	MPE Programme 1991-1992
2749	Partially Confined Vapour Cloud Explosions - 500m3
2760	Type 316 Compression Fittings for Sour Service
2763	Oil Well Fires Kuwait - Data Collection
2768	Polymeric Composites : Practical Design Codes
2775	Instrumentation of GRP Fire Tests
2776	Feasibility Study of Emergency Dumping
2790	Smoke Migration on Offshore Facilities
2793	Integration of Design Techniques
2814	Critical Assessment of Liter. Gas Hydrate Formation
2818	Separation Process Intensification
2822	Maintenance Related Incidents in Topside Systems
2828	Assessment of a Gas Explosion Suppression System
2849	Design and Instrum. of Primary Separation Systems
2850	Development of a Valve Testing Procedure
2861	Offshore Crane Drop Load Study
2865	B&F ph2 Planning & Definition
2873	Shock Analysis of Offshore Structures
2875	Compression Ignition Testing of Hydraulic Fluids
2876	Fire & Blast Information Group
2878	PHWES Explosion Suppression System
2895	Quality Assurance of HAZOP
2900	Gas Detector Siting Criterion
2901	Jet Fire Test Data Review
2922	Blowdown Models Validation Using Grain Isle data
2923	Neural Network Pattern Recognition
2924	Valve User Consortium
2927	Riser PFP Standard
2931	Overview of Levels of Risk in UK Offshore Industry
2935	Appraisal of Explosion Prediction Methods
2937	Explosion Suppression by Watersprays
2945	Comparison of Packages for Vessel Blowdown
2948	Emergency Dumping of Large Oil Inventories
2950	Review of HC Fire Test

Project No.	***Title***
2951	Hydrate Formation in Transfer Lines
2952	Assessing the Vulnerability of ESDV to Severe Acc.
2954	Offshore Safety Assessment
2955	Fire Loading on Vessels & Pipework
2960	safety Classification & Vulnerability of Systems
2963	Collapse study of MSF in jet fire scenarios
2976	Review of F&G Detection Systems, BG Morecambe Bay
2977	FIREX Model Development
2979	Validation of Tunnel Fire Models
2980	Fire Protection of Buxton Tunnel
2992	Fire/Waterspray Interactions
2994	Feasibility of Walkdown Procedures for Topside
2996	Accidents and Incidents Report
3002	TSR Firewall Study
3010	Jet Noise Effects During Accidents
3013	Hot Bolting in the Offshore Industry
3014	ESD Valve Vulnerability
3015	TSR Breathability Study
3040	Harwell Offshore Inspection Service (HOIS)
3055	Application of IT to Safety Training
3056	Information needs for new arrivals
3057	Medium Scale Compartment Fire Tests
3060	Interaction of Fast Explosions with Obstacles
3069	Inspection techniques for heat exchanger tubing
3081	Review of Aluminium Use Offshore
3083	Information on Aluminium in Fires & Explosions
3095	Toxic Emissions from Firewalls
3099	Hydrate Kinetics Project (JIP)
3115	Rev of data for the collapse of structures in fire
3119	Review of Interim Guidance on fire and blast
3121	Dispersion Model Verification Tests
3125	Risk perception and safety in the oil industry
3126	Topside Blast & Fire Engineering - Phase II
3128	Update of OTH-89-312- Explosion Prediction Methods
3130	Future trends in safety R&D in offshore industry
3132	Corrosion Performance of Intumescent PFP systems
3138	Compression Ignition Hazards of Hydraulic Fluids
3139	Survey of Fire and Gas Dampers Offshore
3140	Explosion Suppression by Watersprays
3144	Gas Safety Programme 1993-1996
3148	QRA Guide of Offshore Platforms
3151	Update of UKCS Risk Overview Study
3152	Proposal to Validate the Proposed Jet Fire Test
3153	Proving Trials for Interim Jet Fire Test Procedure
3170	Experimental Sea Fires - SINTEF Svalbard, Norway
3182	Compartment Jet Fire with Deluge
3183	Smoke and Gas Dispersion Assessment
3195	Prelim Datacomms System Study
3201	Offshore Medical Evacuations - 1987 - 1992 Data
3205	Blast Pressure Predictions for Topside Structures

Project No.	***Title***
3206	Quantitative Corrosion Risk Analysis
3208	Deluge Ignition Hazard-Static Discharge
3209	Validation of Ignition Frequency for F&E
3211	Water Sprays Interact. with confined gas Explosion
3218	Review of PFP Test Data in Jet Fires
3219	Review of Struct. Response to Blast Loading Prep.
3221	Simulation of Jet Fire Events
3233	Scrapbook of Selected Articles from ORF
3237	The repeatability of IJFT at Different Labs.
3240	Drop Size Distribution Generated by BG Nozzle
3242	Use of GRP
3249	Reliability of NDT methods for topside inspection
3250	Incident- Explosion Consequences Modelling
3258	Review of the use of Titanium and Copper alloys
3262	Comparative Comp Ign Testing Hydraulic Fluids CUL
3274	Sizing of Two Phase Pressure Relief Valve
3276	Phase II - Design and Inst. of Primary Separation Sys
3278	Using PDR in Modelling Confined Explosions
3286	Flow Testing and Pumpability of Gas Hydrates
3293	Pilot Study - The Use of Performance Standard
3322	Quantities of Heavy Hydrates in Subsea Lines
3323	Tools for Improving the Inherent Safety
3327	Preparing Project 3095 Reports for Publication
3333	Large Scale Explosion Repeatability
3334	Determination of PFP Coat-Back Requirements
3336	Fire Mitigation- Effectiveness of Water Deluge
3337	Overpressure Protection of S & T Heat Exchangers
3340	Christchurch Bay Tower Data Archive
3342	Walkdowns - Blast Induced Vibration Study
3348	GEEJIP- Gas Explosion Engineering
3350	Generating Layout Inform. for Explosion Analysis
3351	Review Failures of Duplex Piping Systems
3355	Evaluation of Passive Fire Protection Coating
3356	Test of the Impact of Fire on TR Wall
3357	Obstacle Scale Interaction with Explosion Severity
3362	Instrument. for Structural Response to Explosion
3367	Use of FRP Offshore Phase III
3368	Editing of Document on plant and equipment safety
3373	Sensit. study on structural aspects of fire & blast
3376	Review of Offshore Programmable Electronic Systems
3379	To Witness Jet Fire Tests
3380	FLAIM- Joint Industry Programme
3381	Jet Fire Testing of Tubular Sections
3383	Review of SINTEF Experiments
3391	Prepare Test Samples And Test Large Pipe Section
3398	Review of SINTEF Experiment Reports-Project 3126
3399	Phase I - Development of Explosion and Fire Guidance
3400	Explosion Overpressure in MODU
3404	I-BEAMS; Large Scale Jet Fire Testing

Project No.	*Title*
3412	Test Sample of TR Wall Construction
3425	Additional Full Scale Explosion Tests-Project 3126
3426	Explosion Risks Management
3434	Dynamics of Emergency Valve Operations
3438	JIP- Ignition Modelling
3439	Survey of Fire and Explosion Research in America
3454	4th Edition Review
3466	Reliability Centred Maintenance
3472	Blast Wall Design Review
3473	Decommissioned Living Quarters
3474	Abandonment Safety Cases - Review of issues
3480	EER HAZOP Development with Industry
3482	Mechanical- Use and Operation of Mobile Cranes
3484	Approaches to Hazard Identification- Scoping Study
3485	Mechanical- Trends and Causes of Incidents
3494	EME Loading & Response Protocol
3499	Feasibility Study- Selecting Topsides Options
3502	Explosion Response Safety Case Review
3504	Fire on the sea - phase 3
3507	Structural assessment of explosion test rig
3515	Structural blast response - model evaluation.
3519	Avoidance of Vibration Fatigue in Piping
3522	Large Scale Explosions in a Range of Geometries
3523	Use of FRP Offshore - Final Phase
3525	Strengthening of British Gas Spadeadam test rig
3536	RACH (Reli. ass. for containment of Haz. mats. off)
3539	Uncertainties in Offshore QRA
3540	Analysis of Equipment Population Data
3542	Heat Exchanger Tube Rupture Project
3544	Promoting compliance with safety rules offshore
3550	Spadeadam Deluge Systems Analysis
3555	Effectiveness of water & foam systems - Phase 2
3558	Gas Build-up from High Pressure Gas Releases
3569	An Investigation of the Potential for Explosion DE
3574	CFD Calculation of Impinging Gas Jet Flames
3582	Construction of TR wall samples for fire testing
3584	Safety Integrity Levels for Safeguarding Systems
3587	Velocity Measurement Techniques in Explosion Tests
3588	Simulation of Phase 3A explosion tests
3591	Topsides Options Presentation
3598	Phase 2: QRA Uncertainties
3600	Explosion attenuation by waterspray
3601	Gas Safety Programme 97-99
3604	Validation techniques for explosion models
3605	FLACS simulations to determine hazard potential
3606	Explosion Loading on Offshore Equipment
3607	Offshore QRA Guide presentation
3625	Review of Analysis of Explosion Response
3628	LOLER Technical Guidance
3629	Repeatability of Large Scale Explosion Tests

Project No.	***Title***
3633	Jet Fire of Gas and Oil Testing of PFP
3636	Assessment of Aging on the Performance of PFP
3637	PHASE IIIB-Preparation of Gas Explosion JIP
3641	Assessment of New Earthing Proposals
3643	Production Choke Valve Trials (JIP)
3651	Explosion Modelling-Using Autoreagas
3653	Documentation of Active Fire Suppression Systems
3660	Blast Failure Models for Corrugated Fire Walls
3662	Ambient noise reduction in ships & offshore struct
3672	Live Crude Jet Fires
3673	Experimental/analytical study of blast panels
3677	Review of Process Equipment Performance on FPSOs
5716	Pipework Failures Associated with Gas Compressor
6051	Sand Erosion of Process Equipment
6096	Aging Platforms
6113	Near Field Noise Measurements of the Piping System
6195	Databases- Review of Who has got What
6203	Particle Size Distribution of Mist Carry Over
6206	Heat Exchanger Tube Rupture
6244	Blowdown System
6302	Topsides options feasibility study
9222	JIP FRP Design guideline and standardisation - DnV
9232	Achilles expert system for materials performance

Table A1.2: Explosion Project Sub-Directory

Project No.	***Title***	***Contractor***
1751	Simulation Of Gas Explosions Within Modules	Christian Michelsen Research
2390	Study of Gas Explosions within Modules - Phase 1	British Gas Plc
2484	The Effects of Water Sprays on Gas Explosions	Christian Michelsen Research
2514	Explosions In Gas Compressor Elec. Motor Drives	ERA Technology Ltd
2527	Design of Blast Resistant Structures for O/S Ind.	Wimpey
2544	Advice on Explosion Supression/Mitigation	MOT Ewbank Preece Ltd
2586	Consultative Doc. on Protection Against Fire/Exp.	MOT Ewbank Preece Ltd
2592	Blast and Fire Engineering for Topsides - Phase 1	Steel Construction Institute
2607	Gas Safety Programme 1990-1992	Christian Michelsen Research
2702	Application Review of Water Spray Technologies	Offshore Design Engineering Ltd
2749	Partially Confined Vapour Cloud Explosions - 500m3	Shell UK Exploration & Production
2828	Assessment of a Gas Explosion Suppression System	Chubb Fire Security Ltd
2865	B&F ph2 Planning & Definition	Steel Construction Institute
2878	PHWES Explosion Suppression System	Steel Construction Institute
2935	Appraisal of Explosion Prediction Methods	National Nuclear Corporation
2937	Explosion Suppression by Watersprays	University College Wales
2977	FIREX Model Development	Sintef
3060	Interaction of Fast Explosions with Obstacles	University of Leeds
3083	Information on Aluminium in Fires & Explosions	Steel Construction Institute
3119	Review of Interim Guidance on fire and blast	Visser Consultancy Ltd
3126	Topside Blast & Fire Engineering - Phase II	Steel Construction Institute
3128	Update of OTH-89-312- Explosion Prediction Methods	National Nuclear Corporation
3140	Explosion Suppression by Watersprays	British Gas Plc
3144	Gas Safety Programme 1993-1996	Christian Michelsen Research
3205	Blast Pressure Predictions for Topside Structures	TNO Defence Research
3209	Validation of Ignition Frequency for F&E	AEA Petroleum Services
3211	Water Sprays Interact. with confined gas Explosion	University College Wales
3219	Review of Struct. Response to Blast Loading Prep.	Visser Consultancy Ltd
3250	Incident- Explosion Consequences Modelling	Combustion Dynamics Ltd.
3278	Using PDR in Modelling Confined Explosions	University of Cambridge
3333	Large Scale Explosion Repeatability	British Gas Plc
3348	GEEJIP- Gas Explosion Engineering	Offshore Design AS
3350	Generating Layout Inform. for Explosion Analysis	Natabelle Technology Ltd
3357	Obstacle Scale Interaction With Explosion Severity	University of Leeds
3399	Phase I - Development of Explosion and Fire Guidance	Steel Construction Institute
3400	Explosion Overpressure In MODU	Christian Michelsen Research
3425	Additional Full Scale Explosion Tests-Project 3126	British Gas Plc
3426	Explosion Risks Management	Risk Management Institute
3439	Survey of Fire and Explosion Research in America	Southwest Research Institute
3494	EME Loading & Response Protocol	Steel Construction Institute
3502	Explosion Response Safety Case Review	SLP Engineering Ltd
3515	Structural blast response - model evaluation.	Steel Construction Institute
3522	Large Scale Explosions in a Range of Geometries	British Gas Plc
3569	An Investigation of the Potential for Explosion De	University of Wales
3588	Simulation of Phase 3A explosion tests	Christian Michelsen Research
3600	Explosion attenuation by waterspray	Wormald Ansul (UK) Ltd
3601	Gas Safety Programme 97-99	Christian Michelsen Research
3605	FLACS simulations to determine hazard potential	Christian Michelsen Research
3606	Explosion Loading on Offshore Equipment	Natabelle Technology Ltd
3625	Review of Analysis of Explosion Response	CR Engineering Analysis & Computing Ltd
3629	Repeatability of Large Scale Explosion Tests	British Gas Plc
3637	Phase IIIb - Preparation Of Gas Explosion JIP	British Gas Plc
3651	Explosion Modelling-Using Autoreagas	Century Dynamics Ltd
3673	Experimental/analytical study of blast panels	University of Liverpool

Table A1.3: Process Equipment Project Sub-Directory

Project No.	*Title*	*Contractor*
2818	Separation Process Intensification	Caltec
2849	Design and Instrum. of Primary Separation Systems	Marinetech (UMIST)
3276	Phase II Design and Inst. of Primary Separation Sys	Marinetech (UMIST)

Table A1.4: Layout Project Sub-Directory

Project No.	*Title*	*Contractor*
2389	Comparative Safety on Accommodation Location	Offshore Certification Bureau
2596	Spatial Risk Analysis of Platform Deck Layouts	University College London
2793	Integration of Design Techniques	University College London

Table A1.5: Open Portfolio Project Reports

Project No.	*Report Number*	*Report Title*
666	H89301	Fire Damage to Offshore Steel and Concrete Platforms
667	H89305 O83032 O83042	Background Document to the Guidance Notes on Gas Flares and Cold Vents Design of Offshore Flaring System Flaring System - Guidance Notes
715	O84016	Emergency Shutdown Systems - Guidance Notes.
774	O83003	The Development of Preventative Maintenance for Offshore Crane Safety
791	H89301 O83017	Fire Damage to Offshore Steel and Concrete Platforms Assessment of Fire Damage to Steel Installations
809	O85004 O85005	Noise and Vibration Control Offshore Volume 1 Guidance for Project Management - UR25 Volume 1 Noise and Vibration Control Offshore Volume 2 Guidance on Design - UR25 Volume 2
868	O85014	Offshore Hydrogen Fires. A Review of Available Information - Pt.1. Main Report & Conclusions. Pt.2. Information Reviewed
890	O87012	Measurements during a 'Hydrocarbon' Fire Resistance Test of a Specially Instrumented Block Wall
998	O87021	Standards for Diesel Engines on Offshore Oil and Gas Rigs - Parts 1, 2 and 3.
2025	O86001	Review of Standards and Codes Applicable to Control Engineering Systems on Offshore Installations
2026	H86229	Review of the Department of Energy's Offshore Fire Research Programme
2030	O86002	Development of a Deluge Valve and Control Assembly
2034	H87275	Metallurgical Conditions Affecting the Reliability of MPI Offshore
2152	O87015 O87016 O87017 O88003	Development of a Hydrant Pressure Reducer Development of a Self-Regulating Control Device for Deluge Nozzles Development of a Wide Rangeability Pressure Balanced Foam Proportioner Development of a Self Dumping Filter
2175	O87013	An Experimental Assessment of the Smoke Threat to Escape Corridors in Offshore Accommodation Modules
2333	O93027	Severe Slugging in Flexible Risers
2390	H89312	Predictive Methods for Gas Explosions in Offshore Modules
2443	H90321	Offshore Installations: Guidance on the Safe Installation, Operation and Maintenance of Electrical Equipment
2465	O92002	An Overview of the MERL/BHRG International Seal Life Prediction Project
2484	H90316	Experimental Investigation Effect of Water Sprays on Gas Explosions
2514	H90332	Explosions in Gas Compressor Electric Motor Drives : A Study of Possible Causes and Remedial Measures
2535	O90012	SOFIPP - Shell Offshore Flame Impingement Protection Programme
2592	I92585 I92586 I92587 I92588 I92589 I92590 I92591 I92592 I92593 I92594 I92595 I92596 I92597 I92598 I92599	Generic Foundation Data to be used in the Assessment of Blast and Fire Scenarios Typical Structural Details for Primary, Secondary and Supporting Structures/ Components Representative Range of Blast and Fire Scenarios The Prediction of Single and Two-Phase Release Rates Legislation, Codes of Practice and Certification Requirements Experimental Facilities Suitable for use in Studies of Fire and Explosion Hazards in Offshore Structures The use of Alternative Materials in the Design and Construction of Blast and Fire Resistant Structures Gas/Vapour Build-Up on Offshore Structures Confined Vented Explosions Explosions in Highly Congested Volumes The Prediction of the Pressure Loading on Structures Resulting from an Explosion Possible Ways of Mitigating Explosions on Offshore Structures Oil and Gas Fires: Characteristics and Impact Behaviour of Oil and Gas Fires in the Presence of Confinement and Obstacles Current Fire Research: Experimental, Theoretical and Predictive Modelling Resources The Effects of Simplification of the Explosion Pressure-Time History

Project No.	***Report Number***	***Report Title***
2592 Contd.	I92600	Explicit Analytical Methods for Determining Structural Response
	I92601	Computerised Analysis Tools for Assessing the Response of Structures Subjected to Blast Loading
	I92602	The Effects of High Strain Rates on Material Properties
	I92603	Analysis of Projectiles
	I92604	Experimental Data Relating to the Performance of Steel Components at Elevated Temperatures
	I92605	Methodologies and Available Tools for the Design/Analysis of Steel Components at Elevated Temperatures
	I92606	Passive Fire Protection: Performance Requirements and Test Methods
	I92607	Availability and Properties of Passive and Active Fire Protection Systems
	I92608	Existing Fire Design Criteria for Secondary, Support and System Steelwork
	I92609	Fire/Blast Performance of Explosion/Fire Damaged Structural and Containment Steelwork
	I92610	Thermal Response of Vessels and Pipework Exposed to Fire
2663	O91001	Piper Alpha - Lessons for life cycle safety management
2702	O92014	Applications review of waterspray technologies - summary report
2748	O93027	Severe Slugging in Flexible Risers
2749	O96004	Explosion Assessment in Confined Vented Geometries. Solvex Large-Scale Explosion Tests and Scope Model Development. Project Report
2763	H94450	Kuwait Scientific Mission - Volume l Mission Overview - July 1992
	H94451	Kuwait Scientific Mission - Volume 2 Technical Report - July 1992
	I96641	Kuwait Scientific Mission - Volume 2 Technical Report July 1992
2793	O94706	Integration of Design Techniques (IDT) 1991-1993 Previously OTN 93 209
2814	H93413	A critical review of hydrate formation phenomena
2822	I95626	Maintenance Related Incidents in Topsides Systems
2828	O92016	Feasibility study of practical gas explosion/supression system for offshore installations
2873	H94430	Blast and Shock Induced Vibrations in Offshore Jacket Installations
2878	H93406	Assessment of Pressure Hot Water Explosion Suppression System
2895	I93617	Quality Assurance of HAZOP
	O96002	Quality Assurance of HAZOP
2900	O93002	Offshore Gas Detector Siting Criterion Investigation of Detector Spacing
2922	H94441	Isle of Grain Pipeline Depressurisation Tests
2927	O95039	Riser PFP Standard
2937	H94463	An Investigation of Factors of Relevance During Explosion Suppression by Water Sprays
2948	H94444	Emergency Dumping of Large Hydrocarbon Oil Inventories
2951	O96708	Hydrates in Subsea Transfer Lines, Hydrate Inhibition Effects of Salinity of Produced Water
2952	I93616	Assessing the Vulnerability of Emergency Shutdown Valves to Severe Accident Conditions
2954	O93019	Offshore safety assessment systems, scenarios and generic calculation methods - An appraisal study for the HSE
2994	H93415	Development of Walkdown Procedures and Pilot Study for the Assessment of Topsides Equipment Subject to Blast Induced Vibrations
3002	O97003	Temporary Refuge Materials Database
3010	H94455	Jet Noise Effects During Accidents
3014	H94460	Topside Emergency Shutdown Valve (ESV) Survivability
3015	H94459	Breathability of the Atmosphere in a Temporary Refuge on an Offshore Platform under External Fire Attack
	H97534	Breathability of the Atmosphere in a Temporary Refuge under External Fire Attack.
3040	H95494	Safety-Related Aspects of Topside Inspection for Internal Corrosion
	H95495	Safety-Related Aspects of In-Service Inspection of Valves
	H96503	Safety Related Aspects of Inspection of Anchor Chains
3055	H94439	The Application of Information Technology to Safety Training
3057	O94011	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-8
	O94012	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-9
.	O94013	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-10

Project No.	***Report Number***	***Report Title***
3057 Contd	O94014	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-11
	O94015	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-12
	O94016	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-13
	O94017	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-14
	O94018	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-19
	O94019	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-20
	O94020	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-22
	O94021	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-23
	O94022	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-24
	O94023	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-25
	O94024	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-27
3060	I94625	Interaction of Fast Explosions with an Obstacles
3083	O94034	Performance of Aluminium Alloys Subjected to Explosions and/or Fire
3095	O97004	Offshore Installations: Assessment of Toxic Product Release Rates from Surfaces of Firewalls under External Fire Conditions - Volume 1 Main Report
	O97005	Offshore Installations: Assessment of Toxic Product Release Rates from Surfaces of Firewalls under External Fire Conditions - Volume 2 - Appendices
	O97006	Offshore Installations: Assessment of Toxic Product Release Rates from Surfaces of Firewalls under External Fire Conditions - Volume 3 - Time Temperature Curves.
	O97007	Offshore Installations: Assessment of Toxic Product Release Rates from Surfaces of Firewalls under External Fire Conditions - Volume - 4 Toxic Product Yields with Time (Tables & Figures.)
	O97008	Offshore Installations: Assessment of Toxic Product Release Rates from Surfaces of Firewalls under External Fire Conditions - Volume 5 - Materials Data
3115	O95021	The Response of Steel Structures on Land to Fire and its Relevance to Offshore Practice - A Review of Existing Information
3125	H94454	Risk Perception and Safety in the Offshore Oil Industry
3128	H94449	A Survey of Current Predictive Methods for Explosion Hazard Assessments in the UK Offshore Industry
3151	H94458	Update of the UKCS Risk Overview
3182	O95012	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-15 with Deluge
	O95013	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-16 with Deluge
	O95014	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-17 with Deluge
	O95015	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-18 with Deluge
	O95016	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-19 with Deluge
	O95017	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-26 with Deluge
	O95018	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-27 with Deluge
3183	H95498	Evaluation Study of Models Used in Predicting Smoke and Gas Ingress on Offshore Structures
	O95033	Model Evaluation Report on the BP Dilution Curves
	O95034	Model Evaluation Report on DISPGAS
	O95035	Model Evaluation Report on PHOENICS
	O95036	Model Evaluation Report on the BMT No. 7 Wind Tunnel

Project No.	***Report Number***	***Report Title***
3201	H94461	Study of Medical Evacuations from Offshore Installations. Five Year Report 1987-1992
3208	O95026	Electrostatic Hazards Associated with Water Deluge and Explosion Suppression Systems Offshore
3221	O95028	Enhancement of SwRI's 0.3 kg/s Laboratory-Scale Alternate Geometry Jet Fire Program
3233	O94032	Offshore Research Focus Reprints Emergency Evacuation and Rescue and Fire and Blast
3237	H95477	Assessment of the Uniformity of the Interim Jet Fire Test Procedure
3258	O96952	Review of In-Service Experience of Copper Alloys for Applications Offshore
3262	O96038	Fire Resistance Tests for Offshore Motion Compensator Fluids
3274	H95475 O96713	Two-Phase Pressure Relief Sizing: An Assessment Study Two Phase Pressure Relief Sizing - An Assessment Study
3286	O96047	Control of Natural Gas Hydrates: Measurement and Modelling of The Rate of Decomposition of a Hydrate Plug
3323	H96521	Improving Inherent Safety
3355	O97010	Feasibility of Providing a Test Facility for the Accelerated Weathering of PFP Jet Fire Test Specimens
3373	O97043	
3381	O96048	Characterization of the Laboratory-Scale Jet Fire Around 203-MM Inside Diameter Tubular Geometries
3391	O96054	Validation of the Jet Fire Resistance Test Procedure - Large Scale Jet Fire Tests on Fire Protected Tubular Members
3399	O97011 O97014	Review of available technical guidance for the design and protection of offshore facilities against explosion and fire Review of Available Technical Guidance for the Design and Protection of Offshore Facilities against Explosion and Fire
3400	H97537	Explosion Load Calculations in a Shale Shaker Area
3404	O96055 O96056	Validation of the Jet Fire Resistance Test Procedure - Large Scale Jet Fire Tests on Fire Protected I-Section Beams Validation of the Jet Fire Resistance Test Procedure - Additional Measurement
3434	O97017 O97018	Emergency Shut-Down Valve Study - Industry Operating Experiences and Views: The Way Forward Emergency Shut-Down Valve Study - Industry Operating Experiences & Views; The Way Forward
3439	O97020	Survey of Fire and Explosion Research and Engineering Organizations in the United States and Canada
3454	O96041	Offshore Lifting and Handling Appliances
3480	O97027	A Trial of a HAZOP Approach to EER Assessments

Appendix 2
FABIG Member Organisations

Table A2.1: FABIG Member Organisations

Member Name	***Member Type***
Agip (UK) Ltd	Oil/Gas Company
AMEC Services Ltd	Consultant/Contractor
Amerada Hess Ltd	Oil/Gas Company
Amey Vectra Ltd	Consultant/Contractor
Australian Marine & Offshore Group	Oil/Gas Company
BG plc	Oil/Gas Company
BP Amoco	Oil/Gas Company
Brown & Root Energy Services	Consultant/Contractor
Cape Durasteel	Manufacturer
Century Dynamics Ltd	Software/Consulting
Chevron UK Ltd	Oil/Gas Company
Christian Michelsen Research	Research Organisation
COWI	Consultant/Contractor
CREA Consultants Ltd	Consultant/Contractor
Den Norske Stats Oljeselskap AS	Oil/Gas Company
Department of Minerals and Energy	Regulator
Det Norske Veritas AS (Nordic Division)	Certifying Authority
Det Norske Veritas Classification AS	Certifying Authority
Det Norske Veritas Industry Ltd	Consultant/Contractor
Dovre Safetec AS	Consultant/Contractor
Elf Aquitaine	Oil/Gas Company
Elf Exploration UK plc	Oil/Gas Company
Elf Petroleum Norge AS	Oil/Gas Company
Enterprise Oil plc	Oil/Gas Company
EQE International Ltd	Consultant/Contractor
Exxon Production Research Co	Oil/Gas Company
Fire Research Station	Research Organisation
Gaz de France	Oil/Gas Company
GexCon A/S	Consultant
Granherne Ltd	Consultant/Contractor
Health & Safety Executive	Regulator
Heriot - Watt University	University
Imperial College	University
Kvaerner Oil & Gas	Oil/Gas Company
Lloyd's Register of Shipping	Certifying Authority
Maersk Olie og Gas AS	Oil/Gas Company
Marathon Oil UK Ltd	Oil/Gas Company
Mech Tool Engineering	Manufacturer
Mobil North Sea Limited	Oil/Gas Company
Mobil Research & Development Corp.	Oil/Gas Research
Nederlandse Aardolie Maatschappij	Regulator
Norsk Hydro	Oil/Gas Company
Norwegian Petroleum Directorate	Regulator
Odebrecht Oil & Gas Services Ltd	Consultant/Contractor
Offshore Design AS	Consultant/Contractor
Offshore Environmental Services	Consultant/Contractor
RAMBØLL	Consultant/Contractor
Salamis (Marine & Technology) Ltd	Consultant/Contractor
Shell (UK) Exploration & Production	Oil/Gas Company
Shell Global Solutions	Software/Consulting
SINTEF Energy	Research Organisation
Total Oil plc	Oil/Gas Company
Total SA	Oil/Gas Company
University of Kingston	University
University of Leeds	University
University of Liverpool	University
University of Manchester	University
Van Dam bv	Manufacturer
Woodside Offshore Petroleum Pty Ltd	Oil/Gas Company
WS Atkins Consultants Ltd	Consultant/Contractor

Appendix 3
Interview Prompt Question List

RECORD OF CONTACT		On:
Individual:	Company:	

I am working on a project for the Health and Safety Executive Offshore Safety Division to investigate the impact of their R&D on design. This includes work totally financed by HSE and also joint industry projects in which HSE had a share.

We are mainly concerned with explosion R&D and how it may have influenced your design procedures or your views on best practice. We would like you to answer these specific questions:

1) What is your main area of business?	1)
2) Have you got, or do you have, access to reports in the HSE OT series?	2)
3) Do you directly refer to research reports in your procedures?	3)
4) Are you aware of any methodology, formulae or numerical values that you use that came from a HSE research report?	4)
5) Are you aware of any project findings being included in a code of practice, in-house code or industry wide code?	5)
6) Have you published any papers that refer to HSE or JIP research projects or reports?	6)
7) Are you familiar with Offshore Research Focus?	7)
8) Have you ever contacted HSE or a researcher mentioned in Offshore Research Focus to find out more about a particular project?	8)
9) Would you use research project findings directly or would you wait until the design culture evolves to take account of new findings?	9)
10) In your opinion, what factors influence offshore design?	10)
11) Do you take part in any cross industry standards committees?	11)

Appendix 4
OT Report Distribution Figures

Table A4.1: Quantities of OT reports sold by HSE Books

Report No.	*Report Title*	*No of reports*
OTH93413	A critical review of hydrate formation phenomena	27
OTH94441	Isle of Grain Pipeline Depressurisation Tests	39
OTH94449	A Survey of Current Predictive Methods for Explosion Hazard Assessments in the UK Offshore Industry	70
OTH94450	Kuwait Scientific Mission - Volume l Mission Overview - July 1992	26
OTH94460	Topside Emergency Shutdown Valve (ESV) Survivability	59
OTH95477	Assessment of the Uniformity of the Interim Jet Fire Test Procedure	15
OTH95498	Evaluation Study of Models Used in Predicting Smoke and Gas Ingress on Offshore Structures	52
OTI92585	Generic Foundation Data to be used in the Assessment of Blast and Fire Scenarios Typical Structural Details for Primary, Secondary and Supporting Structures/ Components	11
OTI92586	Representative Range of Blast and Fire Scenarios	17
OTI92590	The use of Alternative Materials in the Design and Construction of Blast and Fire Resistant Structures	21
OTI92591	Gas/Vapour Build-Up on Offshore Structures	20
OTI92592	Confined Vented Explosions	16
OTI92597	Behaviour of Oil and Gas Fires in the Presence of Confinement and Obstacles	20
OTI92610	Thermal Response of Vessels and Pipework Exposed to Fire	34
OTI94625	Interaction of Fast Explosions with an Obstacles	26
OTI96641	Kuwait Scientific Mission - Volume 2 Technical Report July 1992	16

Table A4.2: Quantities of OT reports issued by RSU

Report Number	*Report Title*	*No of reports*
OTH 94449	A Survey of Current Predictive Methods for Explosion Hazard Assessments in the UK Offshore Industry	1
OTH 96521	Improving Inherent Safety	1
OTI 92602	The Effects of High Strain Rates on Material Properties	1
OTI 92605	Methodologies and Available Tools for the Design/Analysis of Steel Components at Elevated Temperatures	1
OTI 96641	Kuwait Scientific Mission - Volume 2 Technical Report July 1992	1
OTO 92014	Applications review of waterspray technologies - summary report	2
OTO 92016	Feasibility study of practical gas explosion/supression system for offshore installations	2
OTO 93002	Offshore Gas Detector Siting Criterion Investigation of Detector Spacing	4
OTO 94011	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-8	2
OTO 94012	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-9	2
OTO 94013	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-10	1
OTO 94014	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-11	2
OTO 94015	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-12	2
OTO 94016	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-13	2
OTO 94017	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-14	3
OTO 94018	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-19	3
OTO 94019	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-20	1
OTO 94020	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-22	3
OTO 94021	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-23	2
OTO 94022	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-24	3
OTO 94023	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-25	2
OTO 94024	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-27	2
OTO 94034	Performance of Aluminium Alloys Subjected to Explosions and / or Fire	2
OTO 95012	Large Scale Compartment Fires: Experimental Details and Data obtained in Test COMP-15 with Deluge	1
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