



Factoring the human into safety: Translating research into practice

Executive Summary for:

Vol. 1 – Benchmarking (RR 059/2002)

Vol. 2 - Accident Analyses (RR 060/2002)

Vol. 3 - Crew Resource Management (RR 061/2002)

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This is the Executive Summary of the final report for the project 3661 'Factoring the Human into Safety: Translating Research into Practice', sponsored by: Agip UK Ltd; AMEC Process & Energy Ltd.; BP-AMOCO; Coflexip Stena Offshore Ltd; Conoco UK Ltd; Elf Exploration UK PLC; Halliburton Brown & Root; Health and Safety Executive (OSD); Kerr-McGee North Sea Ltd; Salamis SGB Ltd; Transocean Sedco Forex; Shell (UK) Expro; Texaco North Sea (UK) Ltd; Total Fina PLC.

Volume 1 of the report is '**Benchmarking Human and Organisational Factors in Offshore Safety**' (RR 059/2002).

Volume 2 of the report is '**The Development and Evaluation of a Human Factors Accident and Near Miss Reporting Form for the Offshore Industry**' (RR 060/2002).

Volume 3 of the report is '**Crew Resource Management Training for Offshore Operations**'. (RR 061/2002).

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Executive Summary

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The overall aim of the project was to develop practical programmes for the offshore oil and gas industry that can lead to:

- a) A better understanding of human and organisational factors in safety,
- b) Continued improvements in safety management and
- c) An improved 'safety culture' throughout the industry as a whole.

In order to achieve this overall objective, three work packages were proposed which build on previous work (see Mearns, Flin, Fleming and Gordon, 1997).

1. A benchmarking study to identify, analyse and share best practice on human factors safety-related issues.
2. A systematic analysis of trends in human factors causes of offshore accidents. This information can be used to develop training programmes for CRM and for training accident investigators. The information could also be used in the benchmarking study.
3. The development of a Crew Resource Management (CRM) programme designed for training supervisors and offshore teams in human factors issues.

In essence Volume 1 is developing measures of offshore safety from a prospective viewpoint, Volume 2 examines human factors aspects of offshore safety from an retrospective perspective and Volume 3 presents a method for 'closing the loop' between these safety analyses and offshore safety training.

Acknowledgement

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**“Executive Summary”. Volume I
Benchmarking Human and Organisational Factors in Offshore Safety (RR
059/2002)**

Introduction

This document outlines the results from Volume 1 of the Joint Industry/ HSE funded report RR 059/2002, which has investigated the feasibility of benchmarking human and organisational factors in offshore safety. Building on an informal benchmarking exercise carried out during the project ‘Human and organisational factors in offshore safety’ (OTH 97 543), the current study had the following objectives:

- Provide a vehicle and stimulus for the participating companies to pursue improvements in safety
- Create a tool with which to improve efficiency through the use of actionable results
- Establish indicators highlighting the effectiveness of safety measures
- Provide competitive analysis enabling peer group comparisons to be made
- Analyse trends in total safety expenditure, personnel satisfaction with safety and the effectiveness of the SMS
- Develop a balanced scorecard by incorporating business impact measures

These objectives incorporated various aspects of a benchmarking approach. First, a set of indicators was developed to measure the human and organisational factors that can have an impact on offshore safety. This then provided a means by which the participating organisations could compare their relative performance and examine the reasons for the differences in safety performance. The data could then be used to identify and share best practice - a stated aim of the UK oil and gas industry’s Step-Change in Safety Initiative (see www.oil-gas-safety.org.uk).

Sample and Method

The sponsoring organisations allowed access to 13 offshore installations for piloting the methodology. The benchmarking exercise was carried out on an *installation basis* and provided a vehicle both for *internal benchmarking from 1998 to 1999* and *external benchmarking against peers*.

Examination of the previous literature on benchmarking health and safety performance and extensive discussions with members of the project Steering Group Committee led to the development of a set of safety performance indicators. These indicators were selected on the basis of being representative of the human and organisational factors that could have an impact on offshore safety, the data could be provided and shared by the participating companies and had potential for improvement. The indicators included a range of ‘leading indicators’, which can help determine the state of safety before accidents and incidents occur and also a set of ‘lagging indicators’, e.g. RIDDOR (HSE, 1996).

A balanced scorecard model (Kaplan and Norton, 1992) was used to consider safety on the installations from four perspectives:

1. Customer perspective – How does the workforce view safety?
2. Internal Business Process perspective – How is safety being managed on the installation?

3. Financial perspective – What are the costs of safety, both in investment and the costs of accidents?
4. Learning and Growth perspective – What can be done to improve safety in the upstream oil and gas industry?

The methodology for measuring the workforce's perspective on safety had already been developed in two previous projects (OTH 97 543 and OTH 94 454). These projects involved carrying out 'safety climate' surveys of offshore installations in which respondents outlined on five- to seven-point rating scales, their perception of risk; safety behaviour, attitudes to safety; satisfaction with safety measures and satisfaction with communication about health and safety and their job. By using statistical criteria such as the predictive validity of various scales with respect to self-reported accidents, the Offshore Safety Questionnaire (OSQ) was considerably shortened for the purposes of the current benchmarking exercise. The OSQ 98 consisted of 65 items arranged in five sections and the OSQ 99 consisted of 79 items arranged in seven sections.

HSG 65 (HSE 1997) was used as a model for development of the internal business process perspective. Safety performance indicators used in other health and safety benchmarking programmes were incorporated to cover six main areas;

1. Health and safety policy
2. Organising for health and safety
3. Management Commitment
4. Workforce Involvement
5. Health surveillance and promotion
6. Health and safety auditing

In addition, the participating installations were required to provide details of their management structure, including the position of safety professionals within the hierarchy and their accident and incident statistics including RIDDOR data (HSE, 1996), near-misses, visits to the rig medic and number of cards/ reports from behavioural modification programmes. Any relevant documentation to support the questions asked in the Safety Management Questionnaire (SMQ) was also requested. All information had to be provided with respect to the year June 31st 1997 to June 31st 1998 (for the 1998 benchmarking survey) and June 31st 1998 to June 31st 1999 (for the 1999 benchmarking survey).

With respect to the financial perspective, it became apparent in the early stages of the project that the installations involved would not be able to provide an indication of their safety investment (since this budget was tied up in operational costs to the organisation). However, some organisations did record loss-costing data and a questionnaire was developed with the assistance of AUPEC to collect this information. For a variety of reasons, only three installations were able to provide loss-costings and thus insufficient data was provided to establish any firm conclusions.

The learning and growth perspective was expected to emerge from the best practice identified in other perspectives of the balanced scorecard.

Results

For the 1998 safety climate survey, 682 questionnaires from 13 installations were available for analysis and for 1999, 806 questionnaires from 13 installations were analysed. Analyses included a) Principal Components Analysis (PCA), to determine the underlying structure of the attitudes and perceptions held by the workforce; b) Analysis of Variance (ANOVA) and post-hoc Tukey tests to distinguish where differences lay between the results for the various installations; c) Discriminant Function Analysis (DFA) to determine which scales led to classification of accident and non-accident respondents and d) Structural Equation Modelling (SEM) to confirm theoretical models regarding the underlying structure and content of safety climate.

The PCA indicated that the 1998 OSQ consisted of four factors that covered attitudes to safety; 'perceived management commitment to safety'; 'propensity to report accidents and incidents'; 'perceived supervisor competence' and 'rules and safety implementation'. Two factors emerged that covered aspects of safety behaviour: 'general safety behaviour' and 'safety behaviour under incentives/pressure'. Additional scales were 'involvement in health and safety', 'communication about health and safety', 'satisfaction with safety activities' and 'health and safety policy awareness'.

The ANOVA indicated significant differences between the installations with regard to their scores on the respective scales. Details of each installation's individual performance and a comparison of its performance against the other installations were fed-back to the participating companies on the understanding that this information would be disseminated to the installation. *A case study of how an installation's relative performance can be assessed is outlined in the report.*

Stepwise DFA indicated that *perceived management commitment to safety*, *willingness to report accidents* and *perceived supervisor competence* predicted self-reported accidents for respondents in all job roles and also those in a subset that excluded catering, administration, services and medical roles. In all cases bar one, higher scores on the scales were associated with lesser likelihood of accident. The exception was perceived supervisor competence where more favourable ratings of the supervisor were associated with *greater likelihood of accident*. A possible explanation for this result is that in those teams where the supervisor was perceived to be less competent, individuals took more *personal responsibility* for safety. In addition, individuals *experiencing an accident* showed significantly *less favourable* scores on all OSQ scores except for supervisor competence. In 1999 the three most powerful predictors of self-reported accidents were *general safety behaviour*, *involvement in health and safety* and *work pressure*. All three predictors were in the expected direction: low rates of unsafe acts, high work pressure and low rates of involvement were associated with higher accident likelihood.

The SEM for both 1998 and 1999 indicated that the theoretical model was largely confirmed with the division of safety climate into three levels - *informational exchange*, *central affective level* and *manifest level*. High levels of perceived involvement, communication and policy awareness (informational exchange) act to improve perceived management commitment (central affective level) which in turn suppresses self-reported unsafe behaviour (manifest level). In a similar manner, high

levels of communication about health and safety improve perception of management commitment by acting through perceived supervisor competence.

In 1999, all participating installations received a report on the state of their safety climate and comparisons of the installation performance against others. The items and scales were slightly different from year to year due to ongoing developments in questionnaire design, however some of the items remained the same. A similar factor structure emerged and once again there were significant differences between installations on the scale scores. Nine installations provided data across both years and only these installations (with a pooled sample size of 521 in 1998 and 624 in 1999) were used to gauge changes across the one-year period on set of common items. The two samples were closely matched with regard to key demographic variables such as supervisory status, accident rate and tenure. Scales on which items could be compared were satisfaction with safety activities, perceived management commitment to health and safety, perceived supervisor competence, willingness to report accidents, general safety behaviour and safety behaviour under incentives/social pressure. In general, performance on all these scales improved from 1998 to 1999 with certain installations showing statistically significant improvements across the two years. *A case study of one installation showed how the benchmarking methodology could be used to compare its performance from 1998 to 1999.*

The Safety Management Questionnaire (SMQ) provided a great deal of data in a qualitative form that complemented quantitative data based on frequencies, percentages and yes/no responses. A coding scheme was developed in order to combine these data sets into scores on each section. However, to satisfy more stringent criteria for objectivity, the more quantitative data was also analysed separately. In all, ten questionnaires were returned from the participating installations for analysis in both 1998 and 1999.

Analysis of data from the both the 1998 and 1999 SMQ took the form of rank correlations between four outcome measures (LTI>3 days, RIDDOR data, Near misses and Dangerous Occurrences) and the six sections of the SMQ. Negative correlations were predicted and found (in other words high scores on the SMQ were associated with lower accident and incident rates), but all significant negative correlations involving sub-scale scores were confined to two areas of management strategy: health promotion and surveillance and health and safety auditing. It is *proposed* that the benefits of health promotions and occupational health programmes *may* be realised through at least one of two processes:

1. Investment by the company in these areas fosters perceptions of company commitment and builds worker loyalty in areas such as safety behaviour
2. Health plans and health programmes improve worker health directly and 'immunise' against work-related injury

Other studies have indicated the importance of health and safety auditing as the first line of defence in preventing injury and it is considered that auditing is a key requirement in any effective safety management system. These findings lead to the following recommendations for safety management:

1. Ambitious H & S auditing goals and their achievement should be emphasised
2. Health surveillance and promotion of the workforce should also be emphasised, extending to worker well being outside the workplace

3. There is limited evidence to suggest that senior onshore personnel making regular offshore visits to discuss safety and communicate with the workforce may improve safety performance.

CONCLUSIONS

- ◆ The benchmarking exercise largely achieved its goals. Benchmarking safety climate was especially successful in highlighting to participatory installations the areas that require intervention.
- ◆ Scores on certain scales within the safety climate questionnaire predicted self-reported accident involvement in a direction concordant with theory. Furthermore, structural equation modelling provided a model of the safety climate process that can form a heuristic in guiding the development of intervention strategies for improving safety climate within the organisation.
- ◆ The process of benchmarking installations provided a wide variation of scores in each of the areas of safety management, and these scores predicted the proportion of respondents reporting an accident within installations.

RECOMMENDATIONS

- ◆ Collaborations between companies in similar sectors of industry for the purpose of benchmarking safety management strategy and safety climate should be encouraged in the drive toward securing safer work environments. The potential gains for each participating installation outweigh the losses of sharing information.
- ◆ Well-defined strategies must be developed for improving safety climate. These strategies are applied once the benchmarking exercise is completed. Benchmarking at regular (e.g. yearly) intervals could provide a means of assessing intervention strategies within and between installations.
- ◆ Outcome measures of safety performance need to be developed further: self-report accidents are relatively rare. A composite measure should be used in future to validate safety climate surveys.
- ◆ In subsequent research the assessment of safety management strategies should be complemented by on-site assessments and semi-structured interviews.
- ◆ Case studies of organisations and their day-to-day approaches to managing safety could provide realistic examples from which to infer safety management philosophy and efficiency. Ultimately, it is at this level that safety management philosophy becomes manifest: the preaching and the practising converge.

“Executive Summary”. Volume 2

Development and Evaluation of a Human Factors Accident and Near Miss Reporting Form for the Offshore Industry (RR 060/2002).

This volume forms the second part of the Project 3661: “Factoring the Human into Safety: Translating Research into Practice”.

The ultimate purpose of this work-package was to improve accident analysis in order to learn from previous incidents and consequently reduce the likelihood of similar incidents recurring. The specific aim was to develop an incident reporting form that would be used to gather ‘human factors’ data from individuals involved in incidents on offshore installations, collect data using this form, and evaluate the form using these data. An accident reporting system was developed based on previous models of accident causation (e.g. Reason, 1990, Wickens & Flach, 1982) with a potential to deliver greater accuracy of human factors incident data.

Chapter One describes seven accident reporting systems, indicating large differences in their structure and content. However, one consistency between those systems is that they are all based on Reason’s accident causation model. The evaluation of the various accident reporting systems has helped determine the content and structure of the accident reporting forms (WSFI and WSFII) described in this report.

Chapter Two describes the development and evaluation of the WSFI, which was based on an open reporting form used by British Airways. Individuals involved in an incident were required to describe the events leading up to the incident in their own words using the WSFI, with the expectation that more detailed information would be collected. The WSFI contains 11 open questions covering the following topics: a narrative description of the activities engaged in before the event; job planning; tools and equipment; working conditions; procedures; how they were feeling at the time of the incident, others involved in the task, training; better ways to handle the situation; how well the situation was handled; other comments on prevention.

The level of detail in the WSFIs was evaluated. This showed that over half the respondents completed the narrative description comprehensively but completed the remainder of the WSFI in very little detail. Incidents reported using WSFIs were found to produce significantly more immediate and underlying codes than reports that did not use WSFIs. In summary, the results illustrate that the WSFIs have helped increase the quantity of detail given in the analysis of the causes, however, there are still problems found with the form. The outcome of this examination of the Witness Statement Forms has shown that:

- The level of detail in the WSFIs was limited, especially in questions 2-11
- Personnel needed additional instruction and guidance on how to use the form, such as more guidance within the reporting form itself.

A Witness Statement Form II, was developed providing respondents with more prompts within the reporting form. Although the form contains similar topic areas to the WSFI, it is based on Reason’s Accident Causation Model and Wicken’s Information Processing Model. This form was tested using ten offshore case studies to assess its effectiveness in obtaining greater numbers and more specific human factors

causes. Overall, the examination of these case studies showed that the form has helped to extract additional information than the company's original report. Although some of this information may not be directly relevant to the investigation, it sheds light on possible hazardous situations.

In conclusion, the evaluation of the two Witness Statement Forms indicates that they both provide investigators and management with additional information about incidents than the Original Reports. The findings from the WSFII indicate even greater increases in the number of human factors causes than was found using the WSFI. It is most likely that this is due to the attention of the respondents being focused by the larger number of questions asked. However, some problems were also encountered with the WSFII (e.g. reluctance in giving open answers), which could be prevented if the form was completed confidentially (sent directly to an independent third party). The information obtained from the form would be more detailed and open, optimising the quality of the completed forms.

In conclusion, the evaluation of the two Witness Statement Forms indicates that they both provide investigators and management with additional information about incidents than the Original Reports. The findings from the WSFII indicate even greater increases in the number of human factors causes than found when using the WSFI. It is most likely that this is due to the attention of the respondents being focused by the larger number of questions asked. However, some problems were also encountered with the WSFII (e.g. reluctance in giving open questions), many of which could be prevented if the form were completed confidentially (sent directly to an independent third party). The information obtained from the form would be more open and full optimising the quality of the completed forms.

CONCLUSIONS

- Both Witness Statement Forms provide investigators and management with additional human factors information about incidents compared to the Original Reports.
- The WSFII showed the greatest increase in the number of human factors causes compared to the WSFI.
- The main problem in gathering human factors causal data was respondents' reluctance to give open and candid responses in the forms.

RECOMMENDATIONS

- Although the WSFII requires further testing (with larger number of incidents), it is recommended that this form be used, in addition to companies current investigation system, to collect additional human factors causes from personnel involved in incidents.
- It is recommended that this form is tested as part of a confidential reporting system to obtain more open and full responses in order to optimise the quality of the completed forms.

Executive Summary: Volume 3

Development of a Crew Resource Management course for offshore teams (RR 061/2002).

This is Volume 3 of the final report of project 3661 'Factoring the Human into Safety'.

Aim

The aim of this work-package was to design and evaluate a form of human factors training called Crew Resource Management (CRM) which is intended to improve safety, productivity, and to reduce down time on offshore installations.

Courses

The course was developed by liaising with CRM developers in other industries, analysing incidents, scrutinising previous human factors research in the offshore industry, interviewing people with offshore experience, and talking with onshore management.

Eight courses were delivered to a cross section of individuals working on five platforms from one operating company (n=104).

Evaluation

Each course was evaluated by receiving feedback from the participants regarding the content and delivery of the course. Participants' attitudes were evaluated before and after the course using an attitude questionnaire. Also, participants' evaluations of an accident scenario were analysed. The feedback from the courses was generally positive. However, a need to tailor the course further for the offshore environment with more videos and case studies of actual offshore incidents, and to provide more practical tools, and less theory was indicated by the course participants.

CONCLUSIONS

- CRM appears to be a valuable method of providing human factors training (non-technical skills training) to offshore installation crews.
- CRM can 'close the loop' between accident analyses/ human factors research and offshore safety training.

RECOMMENDATIONS

- The oil industry and the Offshore Safety Division of HSE should examine possible methods of introducing CRM training for offshore installation crews as part of the Safety Management System.



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