WG1 PROPOSALS

Response to MIIB Recommendation 6

The sector should put in place arrangements to ensure the receiving site (as opposed to the transmitting location) has ultimate control of tank filling. The receiving site should be able to safely terminate or divert a transfer (to prevent loss of containment or other dangerous conditions) without depending on the actions of a remote third party, or on the availability of communications to a remote location. These arrangements will need to consider upstream implications for the pipeline network, other facilities on the system and refineries.

Response to MIIB Recommendation 7

In conjunction with Recommendation 6, the sector and the Competent Authority should undertake a review of the adequacy of existing safety arrangements, including communications, employed by those responsible for pipeline transfers of fuel. This work should be aligned with implementing Recommendations 19 and 20 on high reliability organisations to ensure major hazard risk controls address the management of critical organisational interfaces.

Annex 1, Management of Operations and Human Factors, sets out detailed guidance on improving safety of fuel transfers. Duty holders and all other parties involved in the transfer of fuel should:

- Adopt the principles for safe management of fuel transfer;
- Where more than one party is involved in the transfer operation, ensure that fuel is only transferred in accordance with consignment transfer agreements consistent with those principles;
- Ensure that suitable 'job factors' are considered and incorporated into systems and procedures to facilitate safe fuel transfer;
- For inter-business transfers, agree on the nomenclature to be used for their product types;
- For ship transfers, carry out a site-specific review to ensure compliance with the International Shipping Guide for Oil Tankers and Terminals (ISGOTT);
- For receiving sites, develop procedures for transfer planning and review them with their senders and appropriate intermediates; and
- Ensure that written procedures are in place and consistent with current good practice for safety-critical operating activities in the transfer and storage of fuel.

Response to MIIB Recommendation 9

Operators of Buncefield-type sites should introduce arrangements for the systematic maintenance of records to allow a review of all product movements together with the operation of the overfill prevention systems and any associated facilities. The arrangements should be fit for their design purpose and include, but not be limited to, the following factors:

1. *The records should be in a form that is readily accessible by third parties without the need for specialist assistance*
2. *The records should be available both on site and at a different location*
3. *The records should be available to allow periodic review of the effectiveness of control measures by the operator and the Competent Authority, as well as for root cause analysis should there be an incident*
4. *A minimum period of retention of one year*

Duty holders should identify those records needed for the periodic review of the effectiveness of control measures, and for the root cause analysis of those incidents and near misses that could potentially have developed into a Buncefield-type incident. The records should be retained for a minimum period of one year. Refer to annex 1, Management of Operations and Human Factors, Availability of Records for Periodic Review.

Further information relating to the retention and storage of records for safety instrumented systems can be found in the guidance provided against recommendation 2, management of instrumented systems for fuel storage tank installations

Response to MIIB Recommendation 10

The sector should agree with the Competent Authority on a system of leading and lagging performance indicators for process safety performance. This system should be in line with HSE's recently published guidance on Developing process safety indicators HSG254

Duty holders should measure their performance to assess how effectively risks are being controlled. Active monitoring provides feedback on performance before an accident or incident, whereas reactive monitoring involves identifying and reporting on incidents to check the controls in place, identify weaknesses and learn from failures.

Refer to annex 1, Management of Operations and Human Factors, Measuring process safety performance.

Response to MIIB Recommendation 19

The sector should work with the Competent Authority to prepare guidance and/or standards on how to achieve a high reliability industry through placing emphasis on the assurance of human and organisational factors in design, operation, maintenance, and testing. Of particular importance are:

1. *understanding and defining the role and responsibilities of the control room operators (including in automated systems) in ensuring safe*

transfer processes

2. *providing suitable information and system interfaces for front line staff to enable them to reliably detect, diagnose and respond to potential incidents*
3. *training, experience and competence assurance of staff for safety critical and environmental protection activities*
4. *defining appropriate workload, staffing levels and working conditions for front line personnel*
5. *ensuring robust communications management within and between sites and contractors and with operators of distribution systems and transmitting sites (such as refineries*
6. *prequalification auditing and operational monitoring of contractors' capabilities to supply, support and maintain high integrity equipment*
7. *providing effective standardised procedures for key activities in maintenance, testing, and operations*
8. *clarifying arrangements for monitoring and supervision of control room staff*
9. *effectively managing changes that impact on people, processes and equipment*

A high reliability organisation (HRO) has been defined as one that produces product relatively error free over a long period of time. Two key attributes of HROs are that they:

- Have a chronic sense of unease, i.e. they lack any sense of complacency. For example, they do not assume that because they have not had an incident for ten years, one won't happen imminently.
- Make strong responses to weak signals, i.e. they set their threshold for intervening very low. If something doesn't seem right, they are very likely to stop operations and investigate. This means they accept a much higher level of 'false alarms' than is common in the process industries.

The following factors should be addressed to achieve a high reliability organisation:

1. Clear understanding and definition of roles and responsibilities, and assurance of competence in those roles
2. Effective control room design and ergonomics, as well as alarm systems, to allow front line staff, particularly control room operators, to reliably detect, diagnose, and respond to potential incidents
3. Appropriate staffing, shift work arrangements and working conditions to prevent, control and mitigate major accident hazards
4. Setting and implementing a standard for effective and safe communication at shift and crew change handover
5. Effective management of change, including organisational change as well as changes to plant and processes

Refer to annex 1, Management of Operations and Human Factors for detailed guidance.

Response to MIIB Recommendation 23
The sector should set up arrangements to collate incident data on high potential incidents including overfilling, equipment failure, spills and alarm system defects, evaluate trends, and communicate information on risks, their related solutions and control measures to the industry

Response to MIIB Recommendation 24
The arrangements set up to meet Recommendation 23 should include, but not be limited to, the following:

1. *Thorough investigation of root causes of failures and malfunctions of safety and environmental protection critical elements during testing or maintenance, or in service*
2. *Developing incident databases that can be shared across the entire sector, subject to data protection and other legal requirements. Examples exist of effective voluntary systems that could provide suitable models*
3. *Collaboration between the workforce and its representatives, duty holders and regulators to ensure lessons are learned from incidents, and best practices are shared*

Response to MIIB Recommendation 25
In particular, the sector should draw together current knowledge of major hazard events, failure histories of safety and environmental protection critical elements, and developments in new knowledge and innovation to continuously improve the control of risks. This should take advantage of the experience of other high hazard sectors such as chemical processing, offshore oil and gas operations, nuclear processing and railways

The PSLG has addressed the issues of leadership and the sharing and learning of lessons from incidents from both a sector and duty holder specific perspective.

To demonstrate the delivery of high performance through culture and leadership, the Process Safety Leadership Group has established the PSLG Principles of Process Safety Leadership. A copy of the principles can be found in appendix 'x' of this report. These principles should be adopted by individual duty holders. Further guidance is provided in annex 1, Management of Operations and Human Factors.

A new process safety forum has been established to collectively review incidents and share the lessons and good practice. Refer to annex 'x' for the terms of reference for the process safety forum.

Move to PSLG Appendix for contributors

PSLG WG1 Members

Joanna Woolf (Chairperson)	Cogent
Mark Scanlon	Energy Institute
Alan Findlay	Ineos
Rob Turner	ABB Engineering Services
Bill Gall	Kingsley Management Limited
James Coull	Total
John Wilkinson	Health and Safety Executive
Kevin Smith	Murco
Peter Jefferies	ConocoPhillips
Walter Williamson	Cogent
Mike Wood	SABIC
Ron Wood	Shell
Stephen Clarke	BP
Tom Dutton	Rhodia
David Kelly	Petroplus
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Affiliations refer to the time of participation.

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Steve Walmsley	Shell
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Affiliations refer to the time of participation.

Annex 1

Management of Operations and Human Factors

Introduction

The purpose of this annex is to identify the guidance necessary to address the following MIIB Design and Operations Report Recommendations;

- Recommendations 6 and 7, relating to fuel transfers by pipeline
- Recommendation 9, Record retention and review
- Recommendation 10, Process safety performance
- Recommendation 19, high reliability organisations (HROs)
- Recommendations 23, 24 and 25, delivering high performance

However, all the Safety Management System (SMS) elements and associated human factors issues that are relevant to the control of major accident hazards, and specifically tank overfill situations, are also important.

A high reliability organisation (HRO) has been defined as one that produces product relatively error free over a long period of time [(3)]. Two key attributes of HROs are that they [(4)]:

- Have a chronic sense of unease, i.e. they lack any sense of complacency. For example, they do not assume that because they have not had an incident for ten years, one won't happen imminently.
- Make strong responses to weak signals, i.e. they set their threshold for intervening very low. If something doesn't seem right, they are very likely to stop operations and investigate. This means they accept a much higher level of 'false alarms' than is common in the process industries.

Recommendation 19 identified a number of HRO factors that were of particular importance in the context of the Buncefield investigation.

This annex aims to provide a route-map to existing good practice guidance, where such guidance exists. In situations where no such guidance has been found this annex establishes what constitutes good practice. Examples of the latter include the industry-specific guidance relating to fuel transfer and storage.

This annex is structured as follows:

- Leadership and safety culture
  - Leadership, and development of a positive safety culture
- Process safety
  - Process safety management
  - Hazard identification and layers of protection
- Organisational issues

    - Roles, responsibilities and competence
    - Staffing, shift work arrangements and working conditions
    - Shift handover
    - Organisational change, and management of contractors
    - Management of plant and process changes
- Key principles and procedures for fuel transfer and storage
    - Principles for safe management of fuel transfer
    - Operational planning for fuel transfer by pipeline
    - Principles for consignment transfer agreements
    - Procedures for control and monitoring of fuel transfer
    - Information and system interfaces for front line staff
- Learning from experience
    - Availability of records for periodic review
    - Measuring process safety performance
    - Investigation of incidents and near misses
    - Audit and review

References

(1) Buncefield Standards Task Group Final Report, Safety and Environmental Standards for Fuel Storage Sites http://www.hse.gov.uk/comah/buncefield/bstgfinalreport.pdf

(2) The Buncefield Incident 11 Dec 2005. The Final Report of the Major Incident Investigation Board, http://www.buncefieldinvestigation.gov.uk/reports/volume1.pdf

(3) The Report of the BP U.S. Refineries Independent Safety Review Panel, Jan 2007 (The Baker Panel Report) – available via http://www.safetyreviewpanel.com/

(4) Weick, K.E & Sutcliffe, K.M. 'Managing the Unexpected: Assuring high performance in an age of complexity'. Jossey-Bassey, 2001.

(5) Buncefield Standards Task Group, Working Group 3 Final Report: Management of Operations and Human Factors, 17 May 2007 (available on the Buncefield communities website at http://webcommunities.hse.gov.uk/)

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Leadership and Development of a Positive Safety Culture

Poor safety culture has been found to be a significant causal factor in major accidents such as those concerning Texas City, Chernobyl, Bhopal, the Herald of Free Enterprise disaster, several major rail crashes etc.

The leadership of senior managers, and the commitment of the chief executive, is vital to the development of a positive safety culture. The report of the BP US Refineries Independent Review Panel (the Baker Panel Report) [(1)] has recently drawn specific attention to the importance of:

- Process safety leadership at all levels of an organisation
- Implementing process safety management systems, and
- Developing a positive, trusting, and open process safety culture

CSB's Investigation Report [(2)] into the Texas City Refinery Explosion also identifies Safety Culture as a key issue requiring leadership of senior executives. It was particularly critical of the lack of a reporting and learning culture, and of a lack of focus on controlling major hazard risk.

Guidance

The safety culture of an organisation has been described [(3)] as the shared values, attitudes and patterns of behaviour that give the organisation its particular character.

The term safety climate has a very similar meaning to safety culture. Put simply, the term safety culture is used to describe behavioural aspects (what people do), and the situational aspects of the company (what the company has). The term safety climate is used to refer to how people feel about safety in the organisation [(3, 4)].

When implementing guidance on leadership and safety culture for fuel transfer and storage activities, duty holders should ensure that:

- Clear goals and objectives are set, and made visible by leadership throughout the organisation
- Expectations are translated into procedures and practices at all levels
- These procedures and practices are commensurate with the risk, consequence of failure, and complexity of the operation
- All hazards are considered when implementing these expectations - personal and process safety, security and environmental
- The workforce actively participates in the delivery of these expectations
- All members of the workforce are – and believe they are - treated fairly in terms of their responsibilities, accountabilities, access to leaders, rewards and benefits.
- There is open communication and consultation across all levels of the organisation
- Relevant metrics are set and performance assessed at appropriate

intervals to determine the effectiveness of leadership across the organisation.
- Lessons from incidents / near misses are shared across the organisation

When the organisation uses the services of others these additional requirements should be used, commensurate to the task they perform
Ref 1 (The Baker Panel Report) includes a questionnaire used for a Process Safety Culture Survey i.e. it is about process safety, and not personal safety, and could be adapted as required for a review of safety culture / climate.

Ref 2 (The CSB Investigation Report) includes an analysis of safety culture, in relation to the Texas City explosion, and recommendations for improvement.

Ref 3 (HSG48) summarises the organisational factors associated with a health and safety culture, and proposes a step-by-step approach to improving this culture.

Ref 4 (Human Factors Toolkit Briefing Note 7) is a concise briefing note providing a useful summary of the characteristics of a healthy safety culture.

Ref 5 (Leadership for the Major Hazard Industries) provides very useful guidance for executive directors and other senior managers reporting to board members. It is divided into four sections:
- Health and safety culture
- Leadership by example
- Systems
- Workforce

Each section consists of brief key points followed by more detailed explanation, to refresh knowledge of effective health and safety leadership and to challenge continuous improvement of health and safety performance.

Ref 6 (Research Report RR367) provides a review of safety culture and safety climate literature. It is a comprehensive research report that highlights key aspects of a good safety culture, as outlined below.

Leadership:
Key criteria of successful leadership, to promote a positive safety culture, are:
- Giving safety a high priority in the organisation's business objectives
- High visibility of management's commitment to safety
- Effective safety management systems

Communication:
A positive safety culture requires effective channels for top-down, bottom-up and horizontal communications on safety matters.

Involvement of Staff:
Active employee participation is a positive step towards controlling hazards. In particular:
- Ownership for safety, particularly with provision of safety training

- Safety specialists should play an advisory or supporting role
- It should be easy to report safety concerns
- Feedback mechanisms should be in place to inform staff about any decisions that are likely to affect them

A Learning Culture:
A learning culture, vital to the success of the safety culture within an organisation:

- Enables organisations to identify, learn and change unsafe conditions
- Enables in-depth analysis of incidents and near misses with the sharing of feedback and lessons.
- Requires involvement at all levels.

A Just and Open Culture:
Companies or organisations with a blame culture over-emphasise individual blame for human error at the expense of correcting defective systems.

- Organisations should move from a blame culture to a just culture
- Those investigating incidents should have a good understanding of the mechanism for human error
- Management should demonstrate care and concern for employees
- Employees should feel that they are able to report issues or concerns without fear of blame or possible discipline.

Ref 7 (HSG217) provides more detailed guidance on employee involvement.

Summary

Duty holders should ensure that their executive management provides effective leadership of process safety to develop a positive, open, fair and trusting process safety culture. A review of the characteristics of their leadership and process safety culture should be carried out. The review should:

- Be owned at a senior level within the company
- Be developed as appropriate for each site
- Apply to all parties operating at each site
- Lead to the development of action plans to ensure that a positive process safety culture is developed and maintained

References

(1) The Report of the BP U.S. Refineries Independent Safety Review Panel, Jan 2007 (The Baker Panel Report) – available via http://www.safetyreviewpanel.com/

(2) U.S. Chemical Safety and Hazard Investigation Board Investigation Report, Refinery Explosion and Fire, http://www.csb.gov/assets/document/CSBFinalReportBP.pdf

(3) Reducing error and influencing behaviour, HSE, HSG48, 2nd edition 1999 (reprinted 2003) ISBN 0-7176-2452-83.

(4) Safety Culture – Human Factors Briefing Note No 7, HSE Human Factors Toolkit, http://www.hse.gov.uk/humanfactors/comah/07culture.pdf

(5) Leadership for the Major Hazard Industries, HSE, INDG277 (rev1), 2004, http://www.hse.gov.uk/pubns/indg277.pdf

(6) A Review of Safety Culture and Safety Climate Literature for the Development of a Safety Culture Inspection Toolkit, HSE RR367, 2005 http://www.hse.gov.uk/research/rrhtm/rr367.htm

(7) Involving Employees in Health and Safety, HSE, HSG217, 2001, HSE Books.

Process Safety Management

Process safety management involves a particular type of risk management - identifying and controlling the hazards arising from process activities, such as the prevention of leaks, spills, equipment malfunctions, over-pressures, excessive temperatures, corrosion, metal fatigue, and other similar conditions. Process safety programs focus on, among other things, the design and engineering of facilities; hazard assessments; management of change; inspection, testing and maintenance of equipment; effective alarms; effective process control; procedures; training of personnel; and human factors.

One of the recommendations of the Baker Panel Report [(1)] following the Texas City Refinery explosion was that BP should establish and implement an integrated and comprehensive process safety management system that systematically and continuously identifies, reduces and manages process safety risks at its U.S. refineries. The CSB Investigation Report [(2)] made similar recommendations. These recommendations are equally applicable to sites with Buncefield-type potential.

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Guidance

The Center for Chemical Process Safety (CCPS)<ref 3> of the American Institution of Chemical Engineers (AIChE) guidance identifyies good practice on process safety management.. It is structured as follows:

- Commit to Process Safety
  - Process safety culture
  - Compliance with standards
  - Process safety competency
  - Workforce involvement
  - Stakeholder outreach
- Understand Hazards and Risk
  - Process knowledge management
  - Hazard identification and risk analysis
- Manage risks
  - Operating procedures
  - Safe work practices
  - Asset integrity and reliability
  - Contractor management
  - Training and performance assurance
  - Management of change
  - Operational readiness
  - Conduct of operations
  - Emergency management
- Learn from Experience
  - Incident investigation
  - Measurement and metrics
  - Auditing

- Management review and continuous improvement
- Implementation (of a risk-based process safety management system)

TheHSE internal document (reference 8) also identifies principles of process safety management. Although intended for process safety management of offshore installations, many of the principles are equally applicable onshore. Key points are:

- There is no single "correct" model of a process safety management system; some companies have separate safety management systems for different sites, whereas others may adopt a more functional approach
- Some companies give greater emphasis than others to corporate procedures. Each should adopt arrangements that are appropriate for its business and culture
- In principle, different standards and procedures could be used within each of the sites or functions. In practice, however, systems need to be developed within the constraints of the corporate SMS, and there will inevitably be areas of overlap
- There is no legal requirement for a company to have a policy statement that is specific to process safety management, but it is recognised good practice, and helps to define the management requirements.
- A good policy statement, or supporting documentation, would indicate the organization's approach to process safety management. This would include commitment to matters such as:
  - Principles of inherent safety
  - A coherent approach to hazard and risk management
  - Communication of the hazard and risk management process
  - Ensuring competence, and adequacy of resources
  - Recognition of the role of human failure – particularly unintentional human failure – on process safety
  - Assurance that the reliability of process safety barriers that depend on human behaviour and performance are adequately assessed
  - Working within a defined safe operating envelope
  - Careful control of changes that could impact on process safety
  - Maintaining up to date documentation
  - Maintenance and verification of safety critical systems
  - Line management monitoring of safety critical systems and procedures
  - Setting of process safety performance indicators
  - Independent audits of management and technical arrangements
  - Investigation and analysis of incidents to establish root causes
  - Reviewing process safety performance on a regular (e.g. annual) basis
  - Continuous improvement, with regularly updated improvement plans
  - Principles of quality management e.g. ISO 9000

The COMAH regulations require duty holders to set out a Major Accident Prevention Policy (MAPP). This would be the logical place to record policies

relating to process safety management. Duty holders also need to ensure that they have effective arrangements to implement each element of the policy.

Summary

Duty Holders should ensure they have implemented an integrated and comprehensive management system that systematically and continuously identifies, reduces and manages process safety risks, including risk of human failure.

4.4 References

(1) The Report of the BP U.S. Refineries Independent Safety Review Panel, Jan 2007 (The Baker Panel Report) – available via http://www.safetyreviewpanel.com/

(2) U.S. Chemical Safety and Hazard Investigation Board Investigation Report, Refinery Explosion and Fire, available via http://www.csb.gov/assets/document/CSBFinalReportBP.pdf

(3) Guidelines on Risk Based Process Safety, AIChE Center for Chemical Process Safety (CCPS) 2007, ISBN 976-0-470-16569-0

(4) Guidelines for Implementing Process Safety Management Systems, AIChE Center for Chemical Process Safety (CCPS) 1994 ISBN 0-8169-0590-8

(5) Guidelines for Auditing Process Safety Management Systems, AIChE Center for Chemical Process Safety (CCPS) 1993, ISBN 0-8169-0556-8

(6) Guidelines for Technical Management of Chemical Process Safety, AIChE Center for Chemical Process Safety (CCPS) 1992, ISBN 0-8169-0423-5

(7) Plant Guidelines for Technical Management of Chemical Process Safety, AIChE, 1992, ISBN 0-8169-0499-5

(8) Process Safety Management Systems, HSE/HID/OSD Internal Document, available via http://www.hse.gov.uk/foi/internalops/hid/spc/spctosd13.pdf

Hazard Identification, Layers of Protection, and Assessment of Their Effectiveness

Prior to the Buncefield incident, the Safety Report Assessment Guide (SRAG) for Highly Flammable Liquids (HFLs) [2] implied that, unless there were clear areas of confinement or congestion, Vapour Cloud Explosions (VCEs) could be ignored from detailed analysis. The current uncertainty regarding the explosion mechanism at Buncefield suggests that such an approach may no longer be valid. The SRAG has therefore been amended accordingly.

Developing process safety performance indicators involves identifying the risk control systems in place for each scenario, and determining which of these are important to prevent or control the various challenges to integrity [4]. It is therefore essential to be able to provide an overview of:

- The barriers to major accidents (i.e. Layers of Protection)
- What can go wrong, and
- Risk control systems in place to control these risks.

Various techniques are in use within the industry to give an overview of the layers of protection and evaluate their effectiveness. There is an opportunity to extend good practice within the industry.

Guidance on the Hazards of Unconfined Vapour Cloud Explosions

The safety report should deal with unconfined VCEs by recognising that such events can happen following major loss of containment events, and should be dealt with by demonstration that the measures to prevent, control and mitigate such loss of containment events are of sufficiently high integrity.

Until the Buncefield explosion mechanism is known, it is not appropriate for safety reports to contain detailed assessment or quantification of the risks from VCEs. However, estimates of extent and severity should be included. The HSE guidance document SPC/Permissioning/11 [3] has been amended to include assumptions to be used, in terms of overpressure at distances from 250 to 400 metres, for estimating the “extent” information. Initial safety reports, five-yearly updates, and reports that are currently being assessed but have not yet gone through the ‘request for further information’ stage, should be updated in the light of thiscurrent guidance.

Guidance on Hazard Identification and Risk Assessment

One of the principles of a MAPP is that the duty holder should develop and implement procedures to systematically identify and evaluate hazards arising from their activities (in both normal and abnormal conditions) [1]. These procedures should address human factors with the same rigour as engineering and technical issues, and should be described in the SMS [6]. There should also be systematic procedures for the definition of measures to

prevent major accidents and mitigate their consequences.

Techniques used within the industry to help make decisions about the measures necessary include:

- Bow-tie diagrams
- Layer of Protection Analysis (LOPA)
- Fault / event trees
- Tabular records of the hierarchy of control measures.

A **bow-tie diagram** is a means of representing the causes and consequences of a hazardous occurrence, together with the elements in place to prevent or mitigate the event. The 'knot' in the middle of the bow-tie represents the hazardous event itself. Such an event might be 'Loss of containment' or 'Storage tank overfill' etc.

There may be a number of 'causes' that may lead to this event (e.g. human error, corrosion) and these are each listed on the left-hand side of the diagram. For each 'cause', safety elements that will serve to prevent or reduce the likelihood of the event are represented as 'barriers'. These 'barriers' may be physical (e.g. cathodic protection system to prevent corrosion) or procedural (e.g. speed limits).

If the event does occur, it is likely that there will be a number of possible 'outcomes' (e.g. fire, explosion, toxic effects, and environmental damage). These 'outcomes' are represented on the right-hand side of the diagram. As with the 'causes', safety elements serving to mitigate the effect of the hazardous event and prevent the 'outcome' are listed for each 'outcome'. Again, these may be hardware (e.g. bunding, foam pourers) or procedural (e.g. ignition control, spill response).

Bow-tie diagrams have a number of advantages. They:

- Provide a visual representation of causes/outcomes/barriers
- Are easily understood and absorbed
- May be developed in a workshop setting similar to a HAZID
- May be used to rank outcomes using a risk matrix
- Help identify 'causes' with inadequate barriers.

Bow-tie diagrams can be used as a stand-alone qualitative hazard identification tool or as the first step in a Quantified Risk Assessment. Depending on the software used, the data on a bow-tie diagram may be output as a hazard register and responsibilities for ensuring that barriers are effective may be assigned.

Layer of Protection Analysis (LOPA): In the last 10 years or so, LOPA has emerged as a simplified form of quantitative risk assessment (QRA). LOPA is a semi-quantitative tool for analysing and assessing risk. This analytical procedure looks at the safeguards on a process plant to evaluate the adequacy of the existing or proposed layers of protection against known hazards. It typically builds on the information developed during a qualitative hazard evaluation, such as a process hazard analysis (PHA) and can be used

to meet the risk assessment requirements of IEC 61508 and 61511. Significant scenarios are identified and frequencies are estimated for the worst-case events. Risk categories are assigned to determine the number of Independent Protection Layers (IPLs) that should be in place. For a measure to be an IPL it should be both independent and auditable.

ARAMIS: A project funded by the European Commission on Accidental Risk Assessment Methodology for Industries (ARAMIS), in the context of the Seveso II Directive, has recently been completed. The project aimed to develop a harmonised risk-assessment methodology, to evaluate the risk level of industrial establishments, by taking into account the accident-prevention tools (safety devices and safety management) implemented by the operators.

The user guide to ARAMIS, which has the following major steps, is available online [5]:

- Methodology for identification of major accident hazards (MIMAH)
- Identification of safety barriers and assessment of their performances
- Evaluation of safety management efficiency to barrier reliability
- Identification of reference accident scenarios
- Assessment and mapping of the risk severity of reference scenarios
- Evaluation and mapping of the vulnerability of the plant's surroundings

MIMAH is a standardised systematic approach for the identification of hazards. MIMAH is complementary to existing methods, such as HAZOP, FMEA, checklists etc. and ensures a better exhaustiveness in terms of hazard- and safety-barrier identification. Bow-ties are the basis of MIMAH methodology in ARAMIS. LOPA is a means of assessing the performance of the safety barriers.

The evaluation of the safety-management-system (SMS) efficiency is based on:

a) The identification of the safety barriers in the technical system
b) The assessment of the SMS using an audit and
c) An assessment of safety culture using questionnaires.

The results from b) and c) are processed and modify the nominal reliability of the safety barriers, thereby linking the quality of the SMS with the quality of the barrier.

Summary

Duty holders should ensure that they have suitable techniques to demonstrate and assess their layers of protection for prevention and mitigation of major accident scenarios.

Duty holders should update their COMAH safety reports in the light of current guidance on extent and severity, and to describe the process for identification and assessment of control measures.

References

(1) A guide to the Control of Major Accident Hazard Regulations 1999 (as amended), Schedule 2, HSE, L111, 2006 HSE Books.

(2) Safety Report Assessment Guide: Highly Flammable Liquids, HSE, http://www.hse.gov.uk/comah/sraghfl/index.htm

(3) SPC/Permissioning/11 COMAH Safety Reports: Technical Policy Lines to Take for Predictive Assessors, Annex 17, available via http://www.hse.gov.uk/foi/internalops/hid/spc/spcperm11.pdf.

(4) Developing process safety performance indicators –HSE/CIA 2006, HSG254, HSE Books.

(5) Accidental Risk Assessment Methodology for Industries in the Context of the Seveso II Directive, http://mahbsrv3.jrc.it/aramis/home.html

(6) HSE Managing human performance webpages http://www.hse.gov.uk/humanfactors/majorhazard/index.htm

Roles, Responsibilities and Competence

Clear understanding and definition of roles and responsibilities, and assurance of competence in those roles, are essential to achieve high reliability organisations for the control of major accident hazards.

The final Buncefield MIIB Report [1] makes a specific recommendation for the sector to prepare guidance for understanding and defining the roles and responsibilities of control room operators (including in automated systems) in ensuring safe transfer operations. It also makes a recommendation regarding supervision and monitoring of control room staff.

Problems have also been found, in the past, with competence assessment in the UK hazardous industries sector. A review of practices in 2003 indicated that there was a wide variation in standards [2]. In some cases companies had developed systematic approaches, and made explicit links to the COMAH risk assessment. Others relied on unstructured on-the-job reviews.

Elsewhere, the Gas Plant explosion in Longford, Australia [3] is an example of a major incident in which organisational changes and a lack of skills or knowledge led to errors that contributed to the incident.

Organisational changes such as multi-skilling, delayering or downsizing, in which staff are expected to take on a wider range of responsibilities with less supervision, increase the need to assure competence.

Duty holders have a responsibility to ensure their medical (including mental) and physical fitness standards are suitable for the risks involved [10]. Fitness may be impaired through, for example, drink, drugs or fatigue.

Guidance on Roles and Responsibilities

COMAH guidance [4] identifies a range of personnel for which the roles, responsibilities, accountability, authority, and interrelation of personnel should be identified. They include all those involved in managing, performing or verifying work in the management of major hazards, including contractors.

To help specify the roles and responsibilities of control room operators, duty holders should identify the tasks they carry out. For fuel transfer operations, control room operation at a receiving site typically involves:

- Interfacing with the planning function (shortly before transfer of a parcel of product)
- Agreement in writing for the transfer into specified tanks (the Consignment Transfer Agreement, which is discussed in Section 13 of this report)
- Preparation for the transfer into the specified tanks
- Direct verbal confirmation, to a specified protocol or procedure, of key details of the transfer, and of readiness to start the transfer

- Execution of start-up and transfer
- Confirming to the sender that product is going into the correct tank(s)
- Monitoring of the transfer, including stock reconciliation at set periods, through manual checks or automated systems as appropriate
- Handling any disturbances, and taking correct action in response to alarms
- Implementing contingency arrangements for abnormal occurrences
- Communication with the sender when critical stages are approaching, such as running tank changes, or when there are abnormal circumstances or trips
- Communicating with the sender regarding significant changes that may occur during transfer, and recording those changes
- Providing effective communication at shift handover (if applicable)
- Ensuring a safe shutdown at the end of transfer, and confirming to the sender that movement has stopped
- Communicating / agreeing transfer quantities with the sender
- Conducting / arranging analysis as appropriate

In practice, those involved in fuel transfersmay also have other responsibilities, not specifically related to fuel transfer, for example: preparation for maintenance, issuing permits to work, conducting plant checks, security monitoring etc.

Organisational arrangements for the transfer of fuel vary considerably from site to site. The provision of dedicated control room staff, or a combined control room and field operating function, is likely to depend on the scale and complexity of the plant, as is the provision and level of supervision. In the storage industry (which is normally only involved with storage and transfers) it is generally the case that operations are controlled in the field rather than from a control room. Some receiving sites are unstaffed and controlled from the sending site.

However, whatever the make-up of the operating function, the precise roles and responsibilities of those involved in it need to be clearly defined, either in job descriptions or elsewhere. It is essential for the identification of training needs, and assurance of competence, that this should cover each of the above-mentioned phases of fuel transfer operations.

Industry guidance on Human-Computer Interfaces (HCIs) [56] and Alarm Systems [67] also discusses the role of the control room operator, and notes how this has changed as control systems have developed. This is discussed in , ‘Information and System Interfaces for Front Line Staff’ of this appendix.

The main source of guidance on supervision is HSG65, Successful Health and Safety Management [5]. This establishes the importance of supervision, stating that adequate supervision complements the provision of information, instruction and training to ensure that the health and safety policy of an organisation is effectively implemented and developed. Good supervision regimes can form a powerful part of a proper system of management control.

It is for the duty holder to decide on the appropriate level of supervision for particular tasks. The level depends on the risks involved as well as the competence of employees to identify and handle them, but some supervision of fully competent individuals should always be provided to ensure that standards are being met consistently.

Organisation of supervision arrangements should ensure:

- An appropriate span-of-control
- That supervisors are accessible and have the time to actively supervise (i.e. they are not overloaded with administration and meetings)
- That supervisors have appropriate inter-personal skills and competence to be effective in the supervisory role.

Duty holders should Monitor risk control systems. HSG65 [5] is clear that organisations need to decide how to allocate responsibilities for monitoring at different levels in the organisation, and what level of detail is appropriate. Managers and supervisors responsible for direct implementation of standards should monitor compliance in detail. Further guidance on monitoring with regard to fuel transfer is given in 'Measuring Process Safety Performance' contained within this appendix.

Guidance on Competence

HSE and EI Briefing Notes [78-910] provide useful summaries of requirements for competence management. They specifically identify the need to link the competence assurance process to control of major accident hazards.

Competence is a combination of practical and thinking skills, experience and knowledge [8-11]. It means the ability to undertake responsibilities and to perform activities to a recognised standard on a regular basis [10].

Training and development seek to create a level of competence for the individual or team, sufficient to allow individuals or teams to undertake the operation at a basic level. Over time, as practical experience grows, operations can be carried out at a more complex level. Training is required not just for normal operation but also for abnormal/upset and emergency conditions etc.

Training alone is not sufficient. Duty holders need to recognise the difference between merely recording a person’s experience and training, and assessing their competence [2].

The purpose of a competence management system is to control, in a logical and integrated manner, a cycle of activities that will assure competent performance. The aim is to ensure that individuals are clear about the performance expected of them, that they have received appropriate training, development and assessment, and that they maintain or improve their competence over time.

A key issue is to make sure that on-the-job training is sufficiently well structured, and that the training and assessment is by competent people. In practice this relies heavily on the quality of the procedures for safety-critical tasks. A key piece of evidence for this would be a well structured plan for training and assessment. (Guidance on Procedures for Control and Monitoring of Fuel Transfer is included in this appendix).

Ongoing assurance of competency (e.g. through refresher training), is also important, as is validation of the understanding of the training provided.

The ORR Guide "Developing and Maintaining Staff Competence" [11] is a particularly useful text on competence management. (This supersedes the HSE guide HSG197, which had the same title.) It was written for the rail industry, but it is equally applicable to many other industries. The competence management system (CMS) described consists of 15 principles linked under 5 phases, as follows:

- Establishing the requirements of the CMS
- Designing the CMS
- Implementing the CMS
- Maintaining competence
- Audit and review of the CMS

The guidance on Maintaining Competence includes requirements for monitoring, and reassessing, the performance of staff to ensure performance is being consistently maintained and developed. Guidance is also given on updating of the competence of individuals in response to relevant changes.

The integrity of the competence management system will only be maintained if it is regularly checked against the design, and improvements made when needed. Some form of verification and audit of the system should be undertaken. Verification should support the assessors, check the quality of the competence assessments at a location and individual level, including the competence of the managers operating the system, and ensure the assessment process remains fit for purpose. Audit should inspect the whole competence management system and judge compliance against the defined quality assurance procedures.

The ORR Guide can be used from any point in the cycle for improving existing systems, or for setting up and implementing new competence management systems. It describes:

- The principles and factors that should be considered in any CMS
- How to ensure that the competence of individuals and teams satisfy the requirements of existing legislation
- Guidance and responsibilities relating to medical and physical fitness

Appendix 1 of the ORR Guide defines what is meant by fitness. It provides an outline of fitness assessments, and of the roles of those involved in the process (e.g. the responsible doctor). These principles are similarly applicable here.

The ORR Guide refers to the need for Directors and senior managers responsible for the overall policy of the company to be aware of the general objectives and benefits that may result from the use of the guidance. However, implementation is more likely to be successful if Directors and senior managers are more than just "aware", but demonstrate commitment to the process.

A key issue for duty holders to consider is the competence of staff in relation to the control of major accident hazards (MAHs), and how this is identified, assessed and managed. MAH competency needs to be appropriately linked to the MA hazard and risk analysis and key procedures. The aim is to assure competence in safety critical tasks, and associated roles and responsibilities.

Competency in MAH prevention is necessary at all levels in the organisation, not just the front line. There should be standards set for competency at all levels, and these should be process / job specific.

The research report "Competence Assessment for the Major Hazard Industries" [2], is also a very useful reference for COMAH sites. This appendix aims to provide:

- An authoritative view of what comprises good practice in the field of competence assessment in relation to control of MAHs, and
- A model of good practice.

The National or Scottish Vocational Qualification (NVQ/SVQ) system can provide some general and some site-specific competencies, but they are not usually linked to MAHs [7, 8]. Operators of COMAH sites need to adjust their systems to make this link.

Cogent, in conjunction with the petroleum industry, has developed National Occupational Standards (NOS) for:

- Bulk Liquid Operations (Level 2)[12]) and
- Downstream Field Operations (Level 3)[13]
- Downstream Control Room Operations [14]

Draft documents have been produced describing job profiles (Duties and Responsibilities), and proposed requirements for Gold Standard Qualifications.

A further job role for Operational Planning, titled "Products Movements Scheduler", has also been developed.

The Level 2 Bulk Liquid Operations NVQ has been used at several fuel storage terminals in the UK. It is used for field operations, and consists of the following units:

1. Monitor & Maintain Equipment & Infrastructure
2. Prepare Pipelines & Hoses
3. Control the Transfer of Bulk Liquid Products
4. Provide Product Control Information

5. Establish & Maintain Effective Working Relationships
6. Contribute to the Safety of Bulk Liquid Operations
7. Cleaning Measurement & Test Equipment
8. Clean & Clear Bulk Liquid Storage Tanks
9. Package Bulk Liquid Products

In respect of fuel transfer operations, the following Level 2 units are applicable to the various stages of product transfer:-

1. Pre Receipt Activities
    a. Notification processes
        i. Unit 3 Control the Transfer of Bulk Liquid Products
        ii. Unit 5 Establish & Maintain Effective Working Relationships
    b. Stock Reconciliation Activities
        i. Unit 4 Provide Product Control Information
            (a) Sampling
            (b) Tank Dipping / Gauging
2. Pre Receipt Operational Activities
    a. Unit 2 Prepare Pipelines & Hoses
        i. Rig Lines & Set Valves on Pipelines
    b. Unit 3 Control the Transfer of Bulk Liquid Products
    c. Unit 6 Contribute to the Safety of Bulk Liquid Operations
3. Initial Receipt
    a. Unit 2 Prepare Pipelines & Hoses
        i. Fill Pipelines with Product
    b. Unit 3 Control the Transfer of Bulk Liquid Products
    c. Unit 6 Contribute to the Safety of Bulk liquid Operations
4. During Receipt
    a. Unit 3 Control the Transfer of Bulk liquid Product
    b. Unit 6 Contribute to the Safety of Bulk Liquid Operations
5. Post Receipt
    a. Unit 2 Prepare Pipelines & Hoses
        i. Displace Pipeline & Hose Contents
    b. Unit 3 Contribute to the Control of Bulk Liquid Products
    c. Unit 4 Provide Product Control Information
    d. Unit 6 Contribute to the Safety of Bulk Liquid Operations

The Level 3 Downstream Field & Control Room Operations S/NVQs have not been extensively applied in fuel storage terminals but, if applied correctly, these National Occupational Standards could be equally well applied to control room (automatic control systems) or field operations (manual control systems and/or a mix of the two control systems.

The Level 3 S/NVQ consists of the following units:

1. Contribute to the safety of processing equipment
2. Respond to incidents, hazardous conditions, and emergencies
3. Work effectively as a team
4. Start-up equipment

5. Monitor and maintain process and equipment conditions
6. Handle non-routine information on plant condition
7. Shut down equipment
8. Prepare for maintenance
9. Carry out maintenance within agreed scope of authority
10. Provide samples for analysis
11. Analyse samples
12. Provide on-plant instruction

These new versions of the Level 3 standards, adapted from the previous (2005) Refinery Control Operations and Refinery Field NOS, are awaiting approval by the scheme's regulator, but are unlikely to change significantly.

Importantly, the schemes (Level 2 or Level 3) define the key performance criteria required to safely perform the task of receiving bulk liquid product into storage, and can therefore be used as effective gap analysis tools when considering individual companies' management systems and training provisions.

In the Level 3 NOS, the link to Major Accident Hazards should be made in Unit 6 (Handling non-routine plant information) and Unit 2 (Response to incidents, hazardous conditions and emergencies).

The Cogent standards are quoted as an example of a system that has been adopted by the industry (at Level 2 at least), and generally been found suitable.

Although this report gives considerable prominence to the S/NVQ option, it is recognised that there may well be other competence assurance systems, including in-house systems are also effective.

Summary

Duty holders should ensure that they have:

- Clearly identified the roles and responsibilities of all those involved in managing, performing, or verifying work in the management of major hazards, including contractors
- In particular, defined the roles and responsibilities of control room operators (including in automated systems) in ensuring safe fuel transfer operations
- Defined the roles and responsibilities of managers and supervisors in monitoring safety-critical aspects of fuel transfer operations

Duty holders should ensure that they have implemented a competence management system, linked to major accident risk assessment, to ensure that anyone whose work impacts on the control of major accident hazards is competent to do so.

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Staffing, Shift Work Arrangements, and Working Conditions

Staffing, shift work arrangements and working conditions are critical to the prevention, control and mitigation of major accident hazards.

Inadequate staffing arrangements were a factor in the explosion at Longford, Australia in 1998. Some high hazard organisations in the UK were setting staffing levels based on steady-state operations.

Staffing levels should be sufficient to react effectively to foreseeable events and emergencies. Duty holders should be able to demonstrate that there are sufficient alert, competent personnel to deal with both normal operation and hazardous scenarios arising from abnormal events. Contract Research Report CRR 348/2001 was commissioned by the HSE to provide a method to demonstrate that staffing arrangements are adequate for hazardous scenarios as well as normal operations. [1]

Fatigue has been cited [4, 13] as a factor in numerous major accidents including Three Mile Island in 1979, Bhopal in 1984, Challenger Space Shuttle in 1986, Clapham Junction in 1988, Exxon Valdez in 1989, and Texas City in 2005. Sleepiness is also thought to be the cause of one in five accidents on major roads in the UK [5] with shift workers being second after young men for risk. Shift work arrangements, and working conditions, should be such that the risks from fatigue are minimised.

Guidance on Safe Staffing Arrangements

CRR 348/2001 [1] gives a practical method for assessing the safety of staffing arrangements and is supplemented by a user guide: *Safe Staffing Arrangements – User Guide for CRR 348/2001 Methodology* [2]. Other methodologies could also be used, provided they are robust.

The CRR 348/2001 method provides a framework for duty holders to assess the safety of their staffing arrangements with focus on assessing the staffing arrangements for capability to detect, diagnose and recover major accident scenarios. It is a facilitated team based approach taking several days for each study and using control room and field operators as team members.

The method has 3 key elements:

(1) Definition of representative scenarios (preparation for study)
(2) Physical assessment of the ability of staff to handle each scenario by working through 8 decision trees for each scenario (approx 2 hours per scenario).
(3) Benchmarking of 11 organisational factors using “ladders” – this is a general assessment by the team and not scenario based (approx 1 hour per ladder).

Note that both CRR 348/2001 [1] and associated User Guide [2] are required

for the method since the Guide gives an additional benchmarking ladder for assessing automated plant/equipment.

The effectiveness of the method is dependent on selecting a suitably experienced and competent team. The User Guide [2] gives guidance on the team including suggested membership:

- Facilitator (familiar with the method)
- Scribe
- 3 experienced operators (including control room and field operators)
- Management, Shift Supervisors and Technical Specialists as required on a part-time basis

The basis for the method can be found in HSG 48 [3] as an assessment of individual, job and organisational factors. The physical assessment using the 8 decision trees for each scenario focus on job factors:

- Decision trees 1 – 3 assess the capability of the operators to detect a hazardous scenario e.g. is the control room continuously manned?
- Decision trees 4 and 5 assess the capability of the operators to diagnose a hazardous scenario
- Decision trees 6 – 8 assess the capability of the operators to recover a hazardous scenario including assessment of communications.

The general benchmarking uses the team to make judgements of performance against a series of graded descriptions (ladders) on 11 factors including:

- Situational awareness (workload)
- Alertness and fatigue (workload)
- Training and development (knowledge and skills)
- Roles and responsibilities (knowledge and skills)
- Willingness to initiate major hazard recovery (knowledge and skills)
- Management of operating procedures (organisational factors)
- Automated plant and/or equipment (added by User Guide)

Guidance on Safe Shift Work Arrangements

An overview is given in *Managing Fatigue Risks – HSE Human Factors Toolkit, Specific Topic 2* [8].

More comprehensive guidance is given in HSG 256 *Managing Shift Work* [4], and in the oil and gas industry guide “Managing Fatigue Risks in the Workplace [12].

The introduction to HSG 256 *Managing Shift Work* [4] outlines the aim of the guidance to improve safety and reduce ill health by:

- Making employers aware of their duty under law to assess any risks associated with shift work;

- Improving understanding of shift work and its impact on health and safety;
- Providing advice on risk assessment, design of shift work schedules and the shift work environment;
- Suggesting measures… to reduce the negative impact of shift work;
- Reducing fatigue, poor performance, errors and accidents by enabling employers to control, manage and monitor the risks of shift work.

The main principle of the Health and Safety at Work (HSW) Act is that those who create risk from work activity are responsible for the protection of workers and the public from any consequences. Generically, the risk arising from fatigue derives from the probability of sleepiness and the increased probability of error.

Consistent with this and HSG 65 *Successful health and safety management* [6], HSG 256 details a systematic approach to assessing and managing the risks associated with shift work under the following five headings:

1. Consider the risks of shift work and the benefits of effective management. For example, fatigue particularly affects vigilance and monitoring tasks particularly on night shifts.
2. Establish systems to manage the risks of shift work; the need for senior management commitment is highlighted.
3. Assess the risks associated with shift work in your workplace.
4. Take action to reduce these risks. The guidance includes a number of useful tables giving non-sector specific examples of factors relating to the design of shift work schedules, the physical environment and management issues such as supervision.
5. Check and review your shift-work arrangements regularly. Includes suggested performance measures such as the HSE Fatigue and Risk Index Tool [9] and Epworth sleepiness scale.

HSG 256 is a comprehensive and practical guide with Appendices covering a summary of legal requirements and practical advice for shift workers along with a listing of assessment tools such as the HSE Fatigue and Risk Index Tool. HSG 256 should be supplemented by any sector specific guidance, for example, the EI *Improving alertness through effective fatigue management* [7], or the oil and gas industry guide “Managing Fatigue Risks in the Workplace [12].

Managing Fatigue Risks in the Workplace [12] is intended primarily as a tool to assist oil and gas industry supervisors and occupational health practitioners to understand, recognise and manage fatigue in the workplace. It sets out to: explain the health and safety risk posed by fatigue; provide the necessary background information on sleep and the body clock; and describe the main causes of fatigue and provide strategies for managing the causes.

Implementation of a fatigue management plan (FMP) in accordance with established guidance is recommended. Ref 12 describes an FMP as a framework designed to maintain, and when possible enhance safety,

performance, and productivity, and manage the risk of fatigue in the workplace. FMPs typically contain the components of:

- Policy (including a requirement for auditing processes)
- Training (to help identify signs and symptoms of fatigue, and to adopt coping strategies)
- Tracking incidents / metrics, and
- Support (including medical and wellbeing support)

Monitoring of actual shifts worked and overtime, on an individual basis, is a key practical point for duty holders and managers.

Control room Working Conditions

Control room issues should focus on ensuring operators (both individually and as teams) can develop, maintain and communicate shared situation awareness.

It is well established that shift work and fatigue may affect safety [e.g. HSG48 [(3)], p35-36; HSG256 [(4)], paras. 30-34] and failure to provide suitable and sufficient breaks is a contributory factor. Guidance on rest and meal breaks is given in HSG256, which states that frequent short breaks can reduce fatigue, improve productivity and may reduce the risk of errors and accidents, especially when the work is demanding or monotonous.

Breaks are better taken away from the immediate workplace i.e. in this case, away from the control room and the immediate work station(s). It is recognized that there may need to be some flexibility in doing this, but the flexibility should not override the principle of allowing adequate rest and meal breaks away from the job.

EEMUA Guide 201 [(11)] notes that the overall environment of the control room can also contribute heavily to the effectiveness of control room staff. This includes e.g.:

- Different users of the control room
    - Dividing into primary and secondary users
    - Considering the needs of each set of users
    - Ensuring there is no conflict between users
    - Controlling access
- Environment
    - Blast resistance
    - Lighting
    - Heating and ventilation
    - Noise levels
    - Furnishings & colour schemes
- Console design
    - Many factors to take into account – (see Ref 11 for detail)
- Safety requirements
    - Fire prevention, control & emergency exits
- Other operational support requirements

- Meeting room / office facilities
- PCs (if not incorporated into the console)

Summary

Duty holders should ensure they can demonstrate that staffing arrangements are adequate to detect, diagnose and recover any reasonably foreseeable hazardous scenario.

Duty holders should develop a fatigue management plan, to ensure that shift work is adequately managed to control risks arising from fatigue.

Duty holders should review working conditions, in particular for control room staff, and develop a plan.

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Shift Handover

Transfer of volatile fuels into storage frequently continues across shift changes, and there is little doubt that unreliable communications about plant or transfer status at shift change could potentially contribute to a tank overfill. It has been a contributory factor in several previous major accidents, including Piper Alpha, Longford, and Texas City.

The HSE publication HSG48 [(1)] discusses how unreliable communications can result from a variety of problems. It identifies some high-risk communication situations, and some simple steps that can be used to improve communications in the workplace.

HSE's Safety Alert review of oil / fuel storage sites in early 2006 indicated that many sites had structured shift handover formats in place, but some relied on event-type logs or unstructured logs that did not clearly specify the type of information that needed to be communicated.

The minimum provision is a handover procedure that specifies simple and unambiguous steps for effective communications at shift and crew change. These include carefully specifying what information needs to be communicated, using structured easy-to-read logs or computer displays, ensuring key information is transmitted both verbally and in writing, and encouraging two-way communication.

Guidance

The handover procedure should be based on the principles described in HSG48 [(1)] or similar guidance available via the HSE website [(2)]. It should:

- Carefully specify what key information needs to be communicated at shift and crew change, at key positions in the organisation. The requirements may well be different for different positions, but should consider issues such as:
    - Product movements, both ongoing and planned
    - Control systems bypassed
    - Equipment not working or out of commission
    - Maintenance and permitry
    - Isolations in force
    - Trips defeated
    - Critical or high priority alarms activated & actions taken,
    - Health, safety or environment incidents or events
    - Modifications
    - Personnel on site
- Use suitable aids, such as logs, computer displays etc. to provide a structured handover of key information, whilst aiming to cut out unnecessary information
- Capture key information that needs to be carried forward across successive shifts (e.g. equipment out of service)
- Allow sufficient time for handover, including preparation time
- Ensure that key information is transmitted both verbally and in writing

- Encourage face-to-face, and two-way communication, with the recipient asking for confirmation, repetition, clarification etc. as appropriate
- Specify ways to develop the communication skills of employees

The procedure should take account of situations that are known to be especially liable to problems, including:

- During maintenance, if the work continues over a shift change
- During deviations from normal working
- Following a lengthy absence from work (either as a result of a regular long shift break, or individual absence)
- Handovers between experienced and inexperienced staff

Techniques that have been reported from the industry, and that duty holders may wish to consider in development of their procedures, include:

- Use of electronic logs, with password systems for acceptance
- Systems to project electronic logs onto a screen (for team briefing)
- Use of team briefings e.g. with staggered shift changes between supervisors and operators
- Use of pre-printed paper logs in a structured format
- Use of white boards for recording systems that may be out of service for several shifts

Duty holders must have the facilities and management arrangements necessary to ensure that the procedures set are indeed complied with. These include:

- Arrangements to minimise distractions during handover
- Instruction and training of employees in handover procedures
- Supervision, audit and review to ensure that the procedure is complied with and the necessary information is communicated and understood

Safety-critical tasks, such as commencement of fuel transfer, tank changeover, and end of transfer, should generally be scheduled to avoid shift handover times.

Summary

Duty holders should set and implement a arrangements for effective and safe communication at shift and crew change handover.

Top Tier COMAH sites should include a summary of the arrangements for effective and safe communication at shift and crew change handover in the next revision of the safety report.

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Organisational Change and Management of Contractors

Effective management of change, including organisational change as well as changes to plant and processes, is vital to the control of major accident hazards. This section deals with organisational change, particularly change involving contracting out of core business activities. Management of changes to plant and processes is discussed in 'Mangement of Plant and Process Changes' within this appendix.

Organisational changes that can adversely affect the management of major hazards include various types of internal restructuring, re-allocation of responsibilities, changes to key personnel, and contractorisation.

Failure to manage organisational change adequately was found to be a factor in major accidents at Castleford in 1992, and at Longford, Australia in 1998.

In high-hazard industries policies regarding use of contractors or outsourcing need to be clear. If safety-critical work is to be contracted out then the company should ensure that it remains an "intelligent customer". In other words, it should retain adequate technical competence to judge whether, and ensure that, work is done to the required quality and safety.

Guidance

Ref (1) (Guide to the COMAH Regulations) summarises the range of changes, including changes to people and the organisation, which should be subject to management of change control procedures.
Ref (2) is a publicly available HSE Information Sheet (CHIS7). It sets out a framework for managing organisational changes, and is recommended for high-hazard industries.
Refs (3) and (4) are documents used internally by HSE's Nuclear Safety Directorate to assess and inspect contractorisation and intelligent customer issues.
Ref (5) is a guide for employers in managing contractors in the chemical industry.
Ref (6) is an HSC review of contractorisation in the railways (primarily) and other high hazard industries, including nuclear, offshore, and onshore chemicals.
Ref (7) provides a methodology for interfacing / integrating safety management systems between clients and contractors.
Ref (8) provides a link to the Client Contractor National Safety Group Safety Passport scheme.
Ref (9) is an unpublished draft update of Refs (3) and (4).

Organisational Change

Ref 2 describes the types of organisational change that can affect the management of major accident hazards. These include:

- Business process engineering

- De-layering
- Introduction of self-managed teams
- Multi-skilling
- Outsourcing / contractorisation
- Mergers, demergers and acquisitions
- Downsizing
- Changes to key personnel
- Centralisation or dispersion of functions
- Changes to communication systems or reporting relationships.

The main focus of Ref 2 is on changes at operational and site level and it is specifically about major accident prevention. It sets out a 3-step framework for managing change, as follows:

- Step 1 – Getting organised for change
- Step 2 – Assessing risks
- Step 3 – Implementing and monitoring the change.

Contractorisation, and Intelligent Customer Capability

A principle, well known within the nuclear industry, is that duty holders should maintain the capability within their own organisations to understand, and take responsibility for, the major hazard safety implications of their activities. This includes understanding the Safety Case for their plant and the limits under which it must be operated. It is known as 'intelligent customer capability' [3, 4, 9].

As an intelligent customer (in the nuclear industry), the management of the facility should know what is required, should fully understand the need for a contractor's services, should specify requirements, should supervise the work and should technically review the output before, during and after implementation. The concept of intelligent customer relates to the attributes of an organisation rather than the capabilities of individual post holders [9].

The HSE publication CHIS7 [2] extends this principle more widely to high hazard industries, stating that, if you contract out safety-critical work, you need to remain an ‘intelligent customer’.

An organisation that does not have intelligent customer capability runs the risk of:

- Not understanding its Safety Report, and operating unsafely.
- Not having appropriate staff to adequately deal with emergencies.
- Procuring poor safety advice, or wrongly implementing advice received.
- Not recognising that significant plant degradation or safety critical events are arising, or not addressing them correctly.
- Not identifying the requirements for safety-critical projects, modifications or maintenance, or carrying them out inadequately.
- Employing inadequate contractors or agency staff.

A duty holder who proposes to contractorise should have organisational change arrangements in place to review the proposal and demonstrate that safety will not be jeopardised. Choices between sourcing work in-house or from contractors should be informed by a clear policy that takes due account of the potential major accident implications of those choices. The approach to identifying and managing core competencies and sustaining an intelligent customer capability should be set out in the safety management system.

The guidance [3, 4, 9] makes no reference to the concept of "contracting-in" an intelligent customer resource e.g. for the evaluation of other contractors. The implication from the guidance is that the resource should be in-house.

The HSE publication Managing Contractors (HSG159) [5] is aimed at small to medium sized chemicals businesses. It primarily focuses on ensuring safe working practices of contractors when on site to do specific jobs. A weakness of this guidance is that it does not deal specifically with the principle of contracting out of core business on major hazard sites, or of intelligent customer capability. However, it does contain a checklist to help duty holders to gain an overview of health and safety in managing contractors, and this contains statements that would infer some requirement for intelligent customer capability, such as:

- Staff know their responsibilities for managing contractors on site
- Staff responsible have enough knowledge about the risks and preventative measures for all jobs involving contractors, and
- Staff responsible know what to look for when checking that contractors are working safely, and know what action to take if they find problems

A report [7] by the HSC in 2002 into the use of contractors in the maintenance of the mainline railway infrastructure came to the conclusion that:

- Contractorisation is a feature of all industrial sectors worldwide
- It is entirely possible to run a safe operation using contractors so long as management systems are good, and
- It is not invariably true that an in-house operation is better managed.

There are now well-established principles for good contractor management that, if followed, will provide the basis for safe operation. Duty holders cannot contract out their responsibilities and must accept that they are responsible for taking appropriate steps to ensure the overall safety of the operation.

This report also reviewed contractorisation in other high hazard industries, including nuclear, offshore, and onshore chemicals.

A national passport scheme (the Client Contractor National Safety Group Safety Passport) [8] is used widely to provide levels of assurance of the quality of contractor staff against a broad health and safety framework, rather than for specific contractor disciplines.

Retention of Corporate Memory

The duty holder also needs to have adequate arrangements for retention of

corporate memory. Ref 3 discusses requirements for retention of corporate memory in the context of the nuclear industry, and Ref 2 briefly refers to it in the wider context of organisational change and major accident hazards.

The most common circumstances under which the loss of corporate memory could occur are [3]:

- Staff turnover: The accumulated knowledge of the experienced staff, which is often extensive, can be lost when knowledge is not transferred from the outgoing to the incoming staff.
- Unavailability of information: This occurs when information is not recorded, or not archived appropriately, or when information is not provided through pre-job briefing. Of particular importance is the availability of the as-built design knowledge that changes over the life of the facility.
- Ineffective use or application of knowledge: Despite the existence of information within the organisation, individuals may not be aware or may not understand they had access to information.

To counter the above, duty holders should develop succession plans to respond to situations involving staff movements and have in place formal arrangements for knowledge archiving and transfer of information.

Management Systems Interfacing

HSG159 [5] includes a checklist of items, organised under the headings of: Policies; Organising; Planning and Implementing; Monitoring; Reviewing and Learning, to give an overview of a client's arrangements for managing contractors.

This checklist deals with relevant elements of a safety management system (SMS) that need to be considered when engaging contractors. It doesn't deal specifically with how the SMS of the client might interface with that of the contractor, but it is a useful starting point.

On major hazard sites, the more the contractor becomes involved with managing core business activities of the site, the more important it becomes for formal interfacing / integration of the SMS of the client with that of the contractor.

Ref (3) states, that "where complex management arrangements and several duty holders contribute to complying with the requirements, HSE will usually expect a duty holder to describe the arrangements for "interfacing" with others". However, it provides no further guidance on how this might be done.

The UK offshore industry has developed guidance for interfacing health and safety management systems between duty holders involved in shared activities

The guidance deals with all the elements of an SMS; it includes issues such

as:

- Identifying minimum training needs and competencies
- Identifying responsibilities for training and competence
- Agreement of criteria and mechanisms for handling changes
- Responsibility for hazard identification and risk assessment of changes
- Identifying key safety performance indicators

The extent to which the guidance needs to be applied is a function of the risk associated with the shared activities. Thus, before developing SMS interfacing arrangements, a risk assessment must be undertaken by the parties involved. This may be a simple matter of making a judgement about the degree of hazard and duration of activity.

It would seem to be potentially useful (with minor tailoring) for onshore application, particularly where a significant element of core business activity is contracted out (e.g. maintenance).

Summary

Duty holders should ensure that there is a suitable policy and procedure for managing organisational changes.

Duty holders should ensure that there is a suitable policy and procedure for retention of corporate memory.

Duty holders should ensure that it retains adequate technical competence and 'intelligent customer' capability when work impacting on the control of major accident hazards is outsourced or contractorised.

Duty holders should ensure that suitable arrangements are in place for management and monitoring of contractor activities.

Duty holders should ensure that in addition to retaining intelligent customer capability, they consider using industry guidance for SMS interfacing where core business is contracted out.

HSE should consider reviewing its guidance (HSG159) on Management of Contractors to ensure that it is appropriate for major hazard sites and consistent with other relevant guidance (e.g. CHIS7) in terms of requirements to maintain 'intelligent customer' capability. Guidance on SMS interfacing between clients and contractors should also be considered.

References

(1) A Guide to the Control of Major Accident Hazard Regulations 1999 (as amended) - HSE, L111, 2006, Schedule 2 HSE Books.

(2) Organisational Change and Major Accident Hazards, HSE Information Sheet, Chemical Information Sheet No CHIS7, available via the HSE website at http://www.hse.gov.uk/pubns/chis7.pdf

(3) Principles for the assessment of a licensee's intelligent customer capability, HSE Nuclear Safety Directorate, Business Management System T/AST/049, Issue 002, 23/10/2006. http://www.hse.gov.uk/foi/internalops/nsd/tech_asst_guides/tast049.pdf

(4) Contractorisation, HSE Nuclear Safety Directorate, Business Management System T/AST/052, http://www.hse.gov.uk/foi/internalops/nsd/tech_asst_guides/tast052.pdf
(5) HSG159, Managing Contractors – A Guide for Employers, HSE Books, ISBN 0-7176-1195-5
(6) The Use of Contractors in the Maintenance of the Mainline Railway Infrastructure - A report by the Health and Safety Commission, May 2002, http://www.rail-reg.gov.uk/upload/pdf/contrail.pdf
(7) Health and Safety Management Systems Interfacing (2003) – download available via Step Change in Safety Website http://stepchangeinsafety.net/stepchange/
(8) The Client Contractor National Safety Group Safety Passport, http://www.ccnsg.com/
(9) Draft Revision of Ref (3) T/AST/049 (also replacing Ref (4) T/AST/052), 20 Mar 09)

Management of Plant and Process Changes

Experience (for example the Flixborough disaster in 1974) has shown management of change (MOC) to be an essential factor in the prevention and control of major accidents. This section discusses plant and process changes. Management of organisational change is discussed in Section 9 of this report, 'Organisational Change and Management of Contractors'.

Duty holders should adopt and implement management procedures for planning and control of all changes in plant, processes and process variables, materials, equipment, procedures, software, design or external circumstances which are capable of affecting the control of major accident hazards.

This approach should cover permanent, temporary, and urgent operational changes, including control of overrides / inhibits, as well as changes to the management arrangements themselves [(1)].

Guidance

Ref (1) (Guide to the COMAH Regulations) summarises the range of changes that should be subject to management of change control procedures.

Each site should have guidance to help its personnel to determine the difference between like-for-like replacement and a change. This should cover items such as:

- Valves
- Piping and flanges
- Vessels / tanks
- Rotating machinery
- Instrumentation
- Software
- Process materials
- Operational changes
- Maintenance procedures
- Purchasing changes
- Equipment relocation

As part of its commitment to process safety leadership, UKPIA has developed guidance and a self assessment tool for MOC [(3)]. This provides a means by which organisations can assess themselves against a common framework of excellence in process safety. It is specifically intended for UKPIA members at their refinery and fuel storage facilities in the UK but is available to non-UKPIA members involved in the fuel transfer and storage business.

MOC processes which align to current good practice may be further improved using the UKPIA self-assessment tool, which provides a suitable methodology for advancing an organisation’s MoC processes to achieve excellence in process safety.

The self assessment tool is divided into five phases, as follows:

Phase 1: Definition and Scope

The purpose of this phase is to determine if the MOC process has been robustly developed to address each category of change, and the roles and responsibilities of each person involved in the change.

Phase 2 – Types of Change

This phase is to determine if all the potential types of change have been identified, and that any specific requirements for dealing with these changes have been addressed. It covers the range of changes described above (including organisational change as well as plant and process changes).

Phase 3 – Key Steps

This phase is to determine if the MOC process has a clearly defined structure and workflow and, where appropriate, controls in place to ensure that each change is raised, reviewed, approved, implemented, verified, and closed in accordance with a documented procedure.

Phase 4 – Audit

This phase is to determine if audit take place at appropriate intervals, against defined criteria, and that auditing reviews the status of corrective actions. It also considers any changes that have been made without engaging MOC.

Phase 5 – Metrics, Training and Improvement Plans

This phase is to review the strategy for measuring the performance of MOC, through Key Performance Indicators and, where necessary, implementing improvements to the process.

The self assessment tool uses a scoring system for each item examined, with scores ranging from 0 (Awareness building, where practice is essentially non-existent or ad-hoc) to 4 (Optimising, where an effective and efficient system is in place). A weighting is applied to each of the items before aggregating into an overall score.

Summary

Duty holders should ensure they have suitable guidance for their staff about what constitutes a plant or process change, and that they have suitable arrangements in place for management of the range of permanent, temporary, and urgent operational changes.

10.4 References

(1) A Guide to the Control of Major Accident Hazard Regulations 1999 (as amended) - HSE, L111, 2006, Schedule 2, para. 368-369, HSE Books.
(2) Guidelines for the Management of Change for Process Safety, CCPS, AIChE, June

2007 ISBN: 978-0-470-04309-7
(3) UKPIA Ltd Self Assessment Module 1 and Appendix 1 – Management of Change. www.ukpia.com

Principles for Safe Management of Fuel Transfer

The Initial Report of the Buncefield Major Incident Investigation Board identified an issue with regard to safety arrangements, including communications, for fuel transfer. No authoritative guidance was found that adequately describes these principles. To address this, the set of principles for safe management of fuel transfer provided in section 11.2 were developed. These include the adoption of principles for consignment transfer agreements, as set out in section 13.

Guidance

These guiding principles should be developed into specific procedures and protocols by all organisations involved in the transfer of fuel to ensure that at all times the operation is carried out in a safe and responsible manner without loss of containment.

All parties involved in the transfer of fuel must ensure that:

- Responsibility for the management of the safe transfer of fuel is clearly delineated.
- There are suitable systems and controls in place to adequately manage the safe transfer of fuel commensurate with the frequency and complexity of the operation.
- There is clear accountability and understanding of all tasks necessary for the transfer operation.
- There are sufficient, adequately rested, competent persons to safely execute all stages of the operation.
- Shift handover procedures comply with latest available industry guidance.
- Receiving site operators:
    - Positively confirm that they can safely receive the fuel before transfer commences.
    - Positively confirm that they are able to initiate emergency shutdown of the fuel transfer.
- There is clear understanding of what events will initiate an emergency shutdown of the fuel transfer operation
- As a minimum the following information is communicated between all relevant parties prior to commencing fuel transfer:
    - Grade / type
    - Consignment size (including common understanding of units used)
    - Flow rate profiles (significant [1] unplanned changes in flow rate during the transfer should be communicated)
    - Start time
    - Estimated completion time
    - Any critical operations / periods when transfer could adversely affect other operations [2]
- There is an appropriate degree of integrity in the method of communication [3] with positive confirmation of all critical exchanges.

- There is an agreed process to communicate changes to the plan in a timely manner
- There is clearly understood nomenclature
- Key performance indicators are in place to monitor and review performance.

Notes:

(1) All parties to agree what constitutes a 'significant' change for their operation

(2) E.g. slow load requirements, roof on legs

(3) E.g. telephone, radio, facsimile, e-mail, common server.

Checklist of Job Factors for Safe Fuel Transfer

The following checklist comprises a set of job factors identified in a review of the various safety-critical stages in fuel transfer operations: it is intended for use as an *aide-memoire* in reviews of systems and procedures.

Planning tools

- Provision of clear information on short-term and long-term outages of plant or instrumentation.
- Provision of job aids for calculating availability e.g. when filling multiple tanks.
- Provision of equipment to allow effective communication between all parties.
- Provision of user-friendly plans to communicate and agree plans between planners / senders and receivers.
- Good planning tools to predict end of transfer.

Site facilities

- Clear information on expected and actual flows and rates.
- Clear displays of levels / ullages.
- Manageable alarm and information systems - good practice applied in design.
- Clear labelling of plant and equipment, in the field and in the control room.
- Labelling systems to avoid confusing tanks, pipes and pumps.
- Adequate lighting.
- Facilities / arrangements to minimise distractions at shift handover.
- Reliable equipment e.g. valves that work.
- Adequate maintenance of facilities.

Job design

- Jobs designed to keep operators motivated.
- Operators not overloaded / distracted from responding.

Information, Instructions and Procedures

- Clear, unambiguous, user-friendly information and diagrams of plant.
- Instructions / job aids for line setting allowing operators to see clearly all valves needing to be checked.

- Procedures for non-routine settings.
- Procedures to transfer product from sender to receiver.
- Procedures for verification that the correct movement has begun.
- Arrangements to identify unauthorised line movement.
- Procedures for monitoring flow and fill.
- Clear unambiguous displays of levels / alarms and plant status.
- Clear instructions to take on alarm.
- Procedures for changeover.
- Feedback to confirm correct operation of valves.
- Check lists for complex, infrequently used, or critical systems.
- Contingency procedures for abnormal situations.
- Ability to recover current or established settings after a system crash.

Emergency Response Systems and Procedures

- Emergency procedures taking account of power / air failures, fires / explosions and floods.
- Systems for emergency shutdown.
- Reliable communication links, including inter-site links.
- Emergency Control Centre with adequate equipment and information aids.
- Criteria for activating emergency response plans.
- Suitable means of raising the alarm, onsite and offsite.
- Efficient call-out system (e.g. automated phone system, duty rota).
- Suitable PPE.
- Suitable muster areas, including safe havens, and equipment.
- Suitable means of detection, including patrols, CCTV, gas detection.
- Suitable isolations.
- Clear identification and labelling of plant.
- Suitable site access arrangements.
- Planning for recovery after an event.

Summary

Duty holders involved in the transfer and storage of fuel should adopt good practice principles for safe management of fuel transfer.

Duty holders involved in the transfer and storage of fuel should review ‘job factors’ to facilitate safe fuel transfer.

Operational Planning for Fuel Transfer by Pipeline

Human factors issues are important at various safety-critical stages in fuel transfer operations including operational planning.

Guidance

Operational planning takes into account all stages of the plan development and approval, up to the stage of implementation via the consignment note.

The planning process will generally not be triggered by a request for a delivery of fuel by the receiving site; such a plan will generally be contract-driven and involve many parties.

Job Factors

Job factors for effective planning include:

- Provision of a clear stock control policy e.g. maximum and minimum working levels, maximum flow rates, maximum number of parcels, strategic stock levels, workable contractual rules, tank throughput per year etc.
- Clear communication protocols between planning / sender and receiver (e.g. the consignment transfer agreement)
- Effective tools to communicate receiver plant information to planners (INPUT)
- Effective tools / programmes to communicate plans to receivers (OUTPUT)
- Reliability of equipment and systems
- Availability of suitable planning procedures
- Jobs designed to keep staff motivated
- Flexibility in the planning arrangements

Person Factors

Person factors include the following characteristics, skills and competencies:

- Understanding of the site
- Numeracy
- Communication skills (including command of English and IT systems)
- Negotiation skills
- Ability to work under pressure and multi-task
- Job interest / motivation

Organisational Factors

Factors important to organisational success include:

- The safety culture of all parties involved
- Use of suitable stock control policies
- Provision of adequate resources to cover all modes e.g. absence of

key staff, out-of-hours issues, changes to plan, emergencies
- Defining clear roles and responsibilities, and providing adequate supervision
- Defining clear communication channels between sender and receiver
- Identifying potential conflicts, and providing mechanisms to resolve them.
- Ensuring staff (e.g. shift team members) are not fatigued and have a manageable work load
- Empowering people to stop imports if necessary

Note: As discussed under Section 6: Roles, Responsibilities and Competence, Cogent, in conjunction with the industry, is currently developing job profiles and standards for competence assurance of Products Movements Schedulers.

Assurance Factors

Factors important to assuring overall success include:
- Setting Key Performance Indicators for deviations from plan (e.g. hitting the high level alarm, number of stock outs, number of in-line amendments, highest level etc.)
- Investigation of incidents and near misses arising from planning failures, and sharing the lessons across all parties.
- Ensuring there is a mechanism for feedback from the receiver to the sender on the quality of operational plans.
- Including the examination of operating practice against the policy and procedure as part of audit arrangements.

Summary

Duty holders that are receivers of fuel should develop procedures for successful planning and review them with their senders and all appropriate intermediates. The stages to be considered in the planning process should include:
- Contract strategy for deliveries of fuel (long term planning process)
- Development and agreement of monthly movement plans
- Amendments to monthly plans
- Development of weekly and daily operational plans
- Amendments to weekly and daily operational plans
- ‘In line’ amendments

Principles for Consignment Transfer Agreements

The Initial Report of the Buncefield Major Incident Investigation Board identified an issue with regard to safety arrangements, including communications, for fuel transfer. To address this, a set of principles was developed for safe management of fuel transfer, as detailed in Section 11. These include the adoption of principles for consignment transfer agreements, as described below.

Guidance

The following principles apply to pipeline transfers where separate parties control

a) The supply of material to a tank or tanks, and
b) The tank or tanks.

This includes, for example, transfers between sites belonging to one business. It does not apply to transfers where a single person or team controls both 'ends' of the transfer, although an equivalent standard of control is necessary.

For the purposes of these agreements the sender is the party primarily responsible for the final transfer of fuel to the receiving terminal.

For transfers from ships into tanks, the current edition of the International Shipping Guide for Oil Tankers and Terminals (ISGOTT) [(1)] is considered to be the appropriate standard.

The agreement involves three stages:

Stage 1 – a common written description of what is to be transferred.

Stage 2 – direct verbal confirmation (e.g. by telephone landline) to a specified protocol or procedure, of

- Key details of the transfer from the written material, and
- The decision to 'start' by the receiver.

An analogy is flight control, where there is a written flight plan, but permission to 'take off' is always verbally confirmed by the control tower.

Stage 3 – a procedure for handling significant change during a transfer

Stage 1 – Agreed Description of Transfer

Agreed in writing, between sender and receiver, as close as practicable to Stage 2 (for example, during the current or previous shift).

The common written description of the transfer should, so far as possible, be kept free of clutter; for example, it should not generally include a significant

amount of product quality data. It should include (but not necessarily in this order):

- Nominated batch number (schedules/sequential)
- Product grade / type (in agreed terms)
- Density (if required to enable conversion of volume to weight and vice versa)
- Amount to be transferred, stating units
- Expected rate of transfer, including initial rate, steady cruise rate, and changes during plan
- Date and expected time of start (Note: should include the need to agree verbally)
- Estimated completion time
- Notes regarding abnormal conditions that may affect product transfer and mitigations in place, including risk assessment.
- Name of sender (named individual)
- Name of receiver (named individual)
- Other responsibilities for involvement in the transfer and receipt process, as agreed locally
- Arrangements for receipt terminal to stop the flow in the event of an emergency
- Target tank/s for receipt

Receiving terminal to sign draft consignment (after considering any abnormal conditions) and return to sending terminal to provide confirmation that product can be safely received.

Stage 2 – Verbal Confirmation and Decision to Receive

Following consignment agreement a verbal agreement should be made, confirming details on the consignment note and the receiver giving permission to start. This should include confirmation of:

- Batch number(s) being ready
- The product grade / type and quantity, including a check of units
- No significant changes to the written agreement that may affect safe receipt
- Receiving party ready to receive

Stage 3 – Procedure for Handling Significant Change

Significant changes should be communicated between sender and receiver, and recorded by both parties.

The appropriate party should also record actions taken.

Summary

Duty holders involved in the transfer of fuel by pipeline should develop Consignment Transfer Agreement procedures consistent with good practice

principles.

Duty holders involved in inter-business transfer of fuel by pipeline should agree on the nomenclature to be used for their product types.

Duty holders receiving ship transfers should, for each relevant terminal, carry out a review to ensure compliance with the current edition of the *International shipping guide for oil tankers and terminals* (*ISGOTT*).

References

(1) International Shipping Guide for Oil Tankers and Terminals (ISGOTT), International Chamber of Shipping, Fifth Edition, 2006.

Procedures for Control and Monitoring of Fuel Transfer

Procedural problems are frequently cited as the cause of major accidents, contributing to some of the world's worst incidents, such as Bhopal, Piper Alpha and Clapham Junction. In the major hazard industries, fit-for-purpose procedures are essential to minimise errors, and to protect against loss of operating knowledge (e.g. when experienced personnel leave).

Guidance on Written Procedures

Procedures are agreed safe ways of doing things. Written procedures usually consist of step-by-step instructions, and related information, to help carry out tasks safely. They may include checklists, decision aids, diagrams, flow-charts and other types of job aids. They are not always paper documents, and may appear as 'on screen' help in control system displays.

Procedures should be robust, followed in practice and audited: otherwise, input values in risk assessments (e.g. human reliability input data to LOPA studies for safety critical equipment) may be invalidated.

Ref 1 (Revitalising Procedures) provides guidance for employers responsible for major hazards on how to develop procedures that are appropriate, fit-for-purpose, accurate, 'owned' by the workforce and, most of all, useful. It is commended as a source of good practice, describing:

- The linkage between procedural problems and major accidents
- What procedures are, and why they are needed
- Procedural violations, and why people do not always follow them
- How to encourage compliance with procedures
- Different types of procedures
- Involvement of procedure users
- Where procedures fit into risk control
- Links between training, competency and procedures
- A three-step approach to improving procedures
- Review of procedures
- Presentation – formatting and layout (including use of warnings to explain what happens if…)

Guidance on Procedures for Fuel Transfer by Pipeline

Procedures should be consistent with the Principles for Safe Management of Fuel Transfer (Section 11) and Consignment Transfer Agreements (Section 13).

The **sender's** procedures should specify:

- The minimum communications required, including:
  - Confirmation of start of movement
  - Deviations from plan
- The correct sequence of operations to avoid overpressure or surge.

- Arrangements to monitor flow (based on risk assessment)
- Circumstances where transfer must stop, e.g.:
  - No confirmation is received of tank changeover when expected
  - When the agreed parcel has been sent.

The **receiver's** written instructions should cover all key phases of its operations, including:

- Preparation and start-up
- Monitoring the transfer and stock reconciliation, including response to alarms if required
- Tank changeover
- Closing / shutting down
- Routine checks
- Contingencies for abnormal occurrences

Further details of the requirements for each phase are given below.

Preparation and Start-Up

This requires an effective means of communication between sender and receiver, which should be achieved by means of a **Consignment Transfer Agreement**.

In addition the receiver should have written procedures in place to ensure that the necessary preparatory checks and line setting are carried out effectively. These procedures should specify clearly defined routings for all standard transfers, including alignment of valves etc. **except** when risk assessment determines that this is not necessary, taking consideration of the complexity, frequency and criticality of the task.

If a non-standard routing is to be used there should be a clear, detailed specification of the required route.

Monitoring and reconciliation, including response to alarms

Procedures for monitoring and reconciliation should include initial verification that the fuel movement phase is as expected, by initial dip/telemetry as appropriate, after around 15-20 minutes (determined by transfer speed and capacity, etc.). If "Yes" this should be confirmed to the consignor / sender.

If "No" it should be treated as an abnormal situation and contingency arrangements should be specified (see 3.7 below). Robust arrangements, based on a risk assessment of local circumstances, must be made to identify 'unauthorised' movements.

There should be continuous verification at **set periods** (within defined tolerances) through manual checks or automated systems as appropriate. Checking at set periods is necessary to check that the 'mental model' is correct or if there has been an unexpected change (e.g. an unexpected process change, or a measurement error due to a stuck instrument). The set

periods and tolerances should be defined and clear to operators, and be derived from risk assessment, taking account of:

- Fill and offtake rates
- Capacity
- Degree of automated control of movement
- Potential speed of response
- Planned staffing cover arrangements/if a problem
- Anticipated completion time.

Communication requirements must be specified, including the need for the receiver to contact the sender when critical steps are approaching, such as 'running' tank changes or when there are abnormal circumstances or trips.

Procedures should specify that all filling operations must be terminated at or before the normal fill level, which should be set sufficiently far below the Level Alarm High (LAH) to avoid spurious activation of the alarm. (In this context alarms do not include alerts for process information).

Procedures should also be clear about the response required on LAH and Level Alarm High High (LAHH). If the LAH is reached, then appropriate action should be taken to reduce the level to below the alarm setting in a controlled and timely manner. If the LAHH is reached, immediate action must be taken to terminate the transfer operation and reduce the level to, or below, the normal fill level.

Tank changeover

There may well be a plan to change tanks during the transfer. In this situation there should be clear designated routings for the changeover. Procedures must detail arrangements for verification and communication in the period up to an anticipated tank change, again clearly based upon risk assessments of local circumstances. The receiver retains primacy in a decision to cease the transfer at any time.

Unless a process risk assessment shows it to be unnecessary, operational procedures should require the receiver to communicate with the sender:

- When changeover is imminent, and
- When the changeover has been completed.

Then go to the monitoring and reconciliation procedure.

Closing/shutting down

Procedures should detail the actions to take to ensure safe isolation, and to prevent damage to plant and equipment, after completion of the transfer. They should require the receiver to confirm to the sender that movement has stopped.

Routine plant checks

All tank farms should ensure that there is a physical site check, to defined routes or activities, which can pick up sounds, odours etc. that may indicate a problem. All parts of the tank farm should be inspected at an adequate frequency (e.g. 2 x per day and 2 x per night) with guidance on what to look for (e.g. source of ignition, breaches in containment, leaks, unattended machinery, security breaks etc). This, together with any anomalies found and actions taken should be recorded.

Operators of normally unstaffed installations should consider, through an assessment of risks, how they would carry out routine plant checks, record and act on the findings

Contingencies for Abnormal Occurrences

For each phase of the operation foreseeable abnormal occurrences should be identified, such as:

- Loss of critical equipment
- Unable to use receipt tank or swing tank valves
- Incapacity or unavailability of staff
- Unable to contact key personnel etc

Written instructions, based on an assessment of risks, should give clear guidance for staff on the action to take to take to mitigate such occurrences.

Summary

Duty holders should ensure that written procedures are in place, and consistent with current good practice, for safety-critical operating activities in the transfer and storage of fuel.

(The above notes on Procedures for Fuel Transfer by Pipeline provide further information on the scope and standards expected of the review, which should be conducted against Ref (1), or similarly effective guidance).

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Information and System Interfaces for Front Line Staff

Control room design and ergonomics, as well as effective alarm systems, are vital to allow front line staff, particularly control room operators, to reliably detect, diagnose, and respond to potential incidents. They should comply with recognised good practice appropriate to the scale of the operation.

Guidance on Human-Computer Interfaces

In the past, most control rooms consisted of hard-wired equipment laid out on large metal panels and desks, which required the operator to patrol the panels, monitoring key plant variables, adjusting set-points and operating equipment. These have now commonly been replaced by computer screen based ('soft-desk') systems, through which the operator both views the plant and operates it. In the majority of such cases there is no hard-wired facility at all. This is known as a Human-Computer Interface (HCI) [(1)] (or Human-System Interface (HSI) [(2)]).

In the fuel transfer and storage industry, there is a range of equipment still found, from hard-wired panel-based equipment with a high degree of manual control, to computer-screen based control systems with a high degree of automatic control. Refineries typically have computer-screen based systems. However, most tank storage terminals do not, and the majority of control actions are still carried out by the operator.

Ref 1 (EEMUA Guide 201) discusses the changing nature of control centres, and how these changes have affected the role of the control room operator. It is the primary and authoritative industry guide to HCIs, and is intended to help those involved in the design, procurement, operation, management and maintenance of these systems. It includes material derived from cooperation with the US-based Abnormal Situation Management Consortium (ASM). ASM publications should be consulted where further information is required. (A second edition of EEMUA Guide 201 is under development).

HCIs provide the vital means by which the operator obtains information on the state of the plant, enters operational data, and by which any automatic control action can be overridden and manual control of the plant be taken.

As plants have become more automated, the automatic system, rather than the operator, performs the majority of the control actions. The operator tends to have a more reactive role, devoting more time to analysing potential problems or dealing with shortfalls in performance. Major intervention by the operator is only required when the plant moves away from its normal operating parameters.

Therefore a modern HCI is required to perform satisfactorily for two very different situations. For most of the time the plant will be operating normally and the HCI must be designed to aid the operator maximise plant efficiency, but when an abnormal situation arises the HCI must aid the operator in returning the plant to normal operation as soon as possible.

Design of the system is crucial to the operator's role, including the number of screens, the design of displays, and the means of navigation around the system. The HCI to a process control system is critical in allowing an operator:

a) To develop, maintain and use an accurate and up to-date awareness of the current and likely future state of the process, and
b) To interact with the system quickly and efficiently under all plant conditions.

In order to achieve this, the following categories of operation, in order of importance, need to be considered:

- Category 1 Abnormal situation handling, including start-up and shutdown
- Category 2 Normal operation
- Category 3 Optimisation
- Category 4 General information retrieval

Many issues need to be taken into account, ranging from the detailed design of display formats, and the way these formats fit together in the hierarchy, through to the actual desk layout, number of screens, and the overall operational environment. This interface is the nerve centre of the operator's work, and its design is very much a Human Factors issue.

In order to design the HCI it is imperative that the operator's activities are well understood, and all the different operational circumstances considered. EEMUA Guide 201 details a number of steps that should be taken including:

- Task analysis, to capture the full remit of the operator's role
- End-user involvement in the system design
- Ensuring that the number of screens allows for complete access to all the necessary information and controls under all operational circumstances
- Ensuring that the design allows for a permanently viewable plant overview
- Providing continuous access to alarm indications
- Providing the capability to expand the number of screens

The Guide provides further advice on issues that have to be considered in taking these steps, including:

- The physical layout and number of screens
- Use of multi-windows
- Use of large screen displays
- Navigational requirements – based on a hierarchy of screens
- Information access
- Management of abnormal situations
- Automation
- Plant size

- Process complexity
- Staffing levels, and multi-unit operation
- Reliability/Redundancy/System failure

Ref 2 (BS EN ISO 11064) sets a standard for Ergonomic Design of Control Centres. It is divided into 7 Parts, as follows:

- Part 1:Principles for the design of control centres
- Part 2:Principles for the arrangement of control suites
- Part 3:Control room layout
- Part 4:Layout and dimensions of workstations
- Part 5:Displays and controls
- Part 6:Environmental requirements for control centres
- Part 7:Principles for the evaluation of control centres

In the absence of a more up-to-date company standard, procedure or specification, projects should follow this standard for new control rooms, and it can be usefully referred to for modifications and upgrades to existing ones, especially where there are known problems.

Part 1 sets up a generic framework relating to ergonomic and human factors in designing and evaluating control centres, with the view to eliminating or minimizing the potential for human errors. It includes requirements and recommendations for a control centre design project in terms of philosophy and process, physical design and design evaluation. It can be applied to the elements of a control room project, such as workstations and overview displays, as well as to the overall planning and design of entire projects.

Other parts of ISO 11064 deal with more detailed requirements, and may be considered as advanced references.

Guidance on Alarm Systems

Management of abnormal situations often concerns the effectiveness of the alarm system. Increased automation provides a relatively calm operating scenario when the plant is in a steady state. However, given the importance of alarms in times of upset, the display of alarm information has to be given high priority. Even if there are relatively few alarms on the system and the system is not a Distributed Control System (DCS) the same principles apply, to ensure a reliable response to alarms.

Duty holders should proactively monitor control systems, such as the tank gauge system, so that designated level alarms etc. do not routinely sound. (This does not exclude the use of properly managed variable alarms or warnings set below the established alarm levels).

Refs 3-5 provide useful summaries of alarm handling issues, with Case Studies.

Ref 6 (EEMUA Guide 191) covers the topic fully, and is referenced as good

practice guidance in each of the above summaries. It identifies the following characteristics of a good alarm:

- Relevant — Not spurious or of low operational value
- Unique — Not duplicating another alarm
- Timely — Not long before response needed, or too late
- Prioritised — Indicating importance to the operator
- Understandable — Message clear and easy to understand
- Diagnostic — Identifying the problem that has occurred
- Advisory — Indicative of action to be taken
- Focusing — Drawing attention to the most important issues

Ref 6 provides a roadmap to direct different users to different parts of the Guide, relevant to their particular needs. There are separate roadmaps for:

- Where an alarm system is already in operation, and
- Where an alarm system is in the conceptual phase

For situations where an alarm system is already in operation, users are provided with guidance on how to review:

- The alarm system philosophy
- The principles of alarm system design, especially
  - The design process
  - Generation of alarms
  - Structuring of alarms
  - Designing for operability
- Implementation issues, especially
  - Training
  - Procedures
  - Testing
- Alarm system improvement.

Summarys

Duty holders should ensure that their control room information displays, including human-computer interfaces and alarm systems, are reviewed in relation to recognised good industry practice.

Where reasonably practicable, duty holders should put plans in place to upgrade control room information displays, including human-computer interfaces and alarm systems, to recognised good industry practice.

Duty holders should ensure that modifications or development of new control rooms or HCIs comply with recognised industry good practice both in their design, and their development and testing.

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(1) EEMUA Publication No 201: 2002. Process Plant Control Desks Utilising Human-Computer Interfaces – A Guide to Design, Operational and Human Interface Issues. (Note: A Second Edition is currently being produced)
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(4) HSE Human Factors Briefing Note No 9 – Alarm Handling http://www.hse.gov.uk/humanfactors/comah/09alarms.pdf
(5) HSE Information Sheet, Chemicals Sheet No 6 – Better Alarm handling http://www.hse.gov.uk/pubns/chis6.pdf
(6) EEMUA Publication No 191 Second Edition (2007). Alarm Systems – A Guide to Design, Management and Procurement.

Availability of Records for Periodic Review

Retention of relevant records is necessary for the periodic review of the effectiveness of control measures, and the root cause analysis of those incidents and near misses that could potentially have developed into a major incident.

Guidance

The following records are considered to be particularly relevant:

- Stock records to demonstrate compliance with a stock control policy
- Operational plans
- Consignment transfer agreements
- Local records of changes to consignment transfers
- Stock reconciliation records
- Incidences of high level alarm activation
- Incidences of high high level / trip activation
- Maintenance / proof testing for high level trip and alarm systems
- Faults discovered on high level alarm or protection systems
- Communications failures between sender and receiver
- Plant / process changes
- Organisational changes
- Approval / operation of inhibits / overrides of safety systems
- Competence / training records
- Shift work / overtime records
- Shift handover records
- Routine plant tour records
- Permits to Work
- Risk assessments
- Method statements
- Active monitoring records

Summary

Duty holders should identify those records needed for the periodic review of the effectiveness of control measures, and for the root cause analysis of those incidents and near misses that could potentially develop into a major incident. The records should be retained for a minimum period of one year.

Measuring Process Safety Performance

Measuring performance to assess how effectively risks are being controlled is an essential part of a health and safety management system [1, 2]. **Active monitoring** provides feedback on performance before an accident or incident, whereas **reactive monitoring** involves identifying and reporting on incidents to check the controls in place, identify weaknesses and learn from mistakes.

The presence of an effective personal safety management system does not ensure the presence of an effective process safety management system. The Report of the BP U.S. Refineries Independent Safety Review Panel (the 'Baker Panel report') [3], following the Texas City refinery explosion in 2005, found that personal injury rates were not predictive of process safety performance at five U.S. refineries.

Used effectively process safety indicators can provide an early warning, before catastrophic failure, that critical controls have deteriorated to an unacceptable level. The use of process safety performance indicators fits between formal, infrequent audits and more frequent inspection and safety observation programmes. It is not a substitute for auditing, but a complementary activity.

The main reason for measuring process safety performance is to provide ongoing assurance that risks are being adequately controlled. In order to measure safety performance, many duty holders have incorporated leading and lagging indicators, also known as 'metrics' or 'key performance indicators', into their safety management systems. Managers use these metrics to track safety performance, to compare or benchmark safety performance.

Many organisations rely on auditing to highlight system deterioration. However, audit intervals can be too infrequent to detect rapid change, or the audit may focus on 'compliance', i.e. verifying that the right systems are in place rather than ensuring that systems are delivering the desired safety outcome [4].

Many organisations do not have good information to show how they are managing major hazard risks. This is because the information gathered tends to be limited to measuring failures, such as incident or near misses. System failures following a major incident frequently surprise senior managers, who believed the controls were functioning as designed [4].

Guidance

Active Monitoring

Active monitoring is primarily a line management responsibility [2]. It should be distinguished from the requirement for 'independent' audits, which are a separate activity. HSG 65 [2] refers to auditing as the structured process of collecting **independent** information on the efficiency, effectiveness, and

reliability of the **total** health and safety management system, and drawing up plans for corrective action.

Active monitoring should include inspections of safety-critical plant, equipment and instrumentation as well as assessment of compliance with training, instructions and safe working practices.

Active monitoring gives an organisation feedback on its performance before an incident occurs. It should be seen as a means of reinforcing positive achievement, rather than penalising failure after the event. It includes monitoring the achievement of specific plans and objectives, the operation of the SMS, and compliance with performance standards. This provides a firm basis for decisions about improvements in risk control and the SMS.

Duty holders need to decide how to allocate responsibilities for monitoring at different levels in the management chain, and what level of detail is appropriate. In general, managers should monitor the achievement of objectives and compliance with standards for which their subordinates are responsible. Managers and supervisors responsible for direct implementation of standards should monitor compliance in detail. Above this immediate level of control, monitoring needs to be more selective, but provide assurance that adequate first line monitoring is taking place.

Various forms and levels of active monitoring include:

- Examination of work and behaviour
- Systematic examination of premises, plant and equipment by managers, supervisors, safety representatives, or other employees to ensure continued operation of workplace risk precautions.
- The operation of audit systems
- Monitoring of progress towards specific objectives e.g. training / competence assurance objectives.

Many of these topics are not specific to process integrity, but are equally applicable to all areas. Topics of particular relevance to process integrity include:

- Change control
- Process safety study (e.g. HAZOP or PSA) close out
- Control of process plant protection systems / inhibits etc
- Control of alarms / alarm system status
- Operating procedures, including consignment transfer procedures and stock reconciliation procedures
- Shift handover procedures
- Management of fatigue and shift work
- Maintenance of safety-critical systems
- Control of contractors

They should also include other key systems that may not be so relevant to preventing a major incident, such as:

- Workplace risk assessments
- Permit to work systems

- Isolation standards
- Controls at high pressure / low pressure interfaces
- Control of relief devices etc.

Reactive Monitoring

Reactive monitoring involves identifying and reporting on incidents to check the controls in place, identify weaknesses and learn from mistakes [1, 2]. It includes:

- Identification and analysis of injuries / causes of ill health
- Identification and analysis of other incidents, near misses, and weaknesses or omissions in performance standards
- Assessing incident / near miss potential
- Investigation and identifying remedial actions to deal with root causes
- Communication of lessons learned
- Tracking of remedial actions arising from incidents / near misses etc
- Contributing to the corporate memory

Process Safety Performance Indicators

HSE has recently published Developing Process Safety Indicators, A Step-by-Step Guide for Chemical and Major Hazard Industries [4]. The guidance outlines six main stages needed to implement a process safety management system. It provides a methodology for leading and lagging indicators to be set in a structured way for each critical risk control system within the process safety management system.

The OECD has also developed useful Guidance on Safety Performance Indicators [5] to assess the success of chemical safety activities.

Leading indicators are a form of active monitoring focused on a few critical risk control systems to ensure their continued effectiveness. They require a routine systematic check that key actions or activities are undertaken as intended. They can be considered as measures of process or inputs essential to deliver the desired safety outcome.

Lagging Indicators are a form of reactive monitoring requiring the reporting or investigation of specific incidents and events to discover weaknesses in that system. These incidents represent a failure of a significant control system that guards against or limits the consequences of a major incident.

The six key stages identified in the guidance are:

1. Establish the organisational arrangements to implement the indicators
2. Decide on the scope of the measurement system; consider what can go wrong and where
3. Identify the risk control systems in place to prevent major accidents. Decide on the outcomes for each and set a lagging indicator
4. Identify the critical elements of each risk control system (i.e. those actions or processes that must function correctly to deliver the

outcomes) and set leading indicators
5. Establish the data collection and reporting system
6. Review

Worked example

A worked example for developing Process Safety Performance Indicators, using HSG254 methodology, for a terminal fed by pipeline and by ship is included as appendix 1 of this annex (This is BSTG Appendix 5).

The example identifies potential leading and lagging indicators for challenges to integrity such as:

- Overpressure of ship-to-shore pipework
- Accidental leakage from ship to water
- Bulk tank overfilling (i.e. above safe operating limits)
- Accidental leakage during tanker loading
- Tank subsidence
- Leak from pumps
- Pump / motor overheating
- Corrosion of tanks
- High pressure in terminal pipework during pipeline delivery
- Static discharge
- Physical damage

Summary

Duty holders should ensure that a suitable active monitoring programme is in place for key systems and procedures for the control of major accident hazards.

Duty holders should develop an integrated set of leading and lagging performance indicators for effective monitoring of process safety performance.

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Investigation of Incidents and Near Misses

As technical systems have become more reliable, the focus has turned to human causes of accidents. The reasons for the failure of individuals are usually rooted deeper in the organisation's design, decision-making, and management functions.

HSG 48 [1] gives several examples of major accidents where failures of people at many levels (i.e. organisational failures) contributed substantially towards the accidents. Human factors topics of relevance to process integrity include:

- Ergonomic design of plant, control and alarm systems
- Style and content of operating procedures
- Management of fatigue and shift work
- Shift / crew change communications, and
- Actions intended to establish a positive safety culture, including active monitoring.

Investigation procedures should address both immediate and underlying causes, including human factors.

Guidance

HSG65 [2] is a suitable reference on investigation of incidents and near misses. Not all events need to be investigated to the same extent or depth. Duty holders need to assess each event (for example using a simple risk-based approach) to identify where the most benefit can be obtained. The greatest effort should concentrate on the most significant events, as well as those that had the potential to cause widespread or serious injury or loss

HSG 65 Appendix 5 describes one approach that may be used as a guide for analysing the immediate and underlying causes of effects. Various other approaches are also available, and widely used within the industry. These include various in-house or proprietary systems.

Other suitable references include those available on the HSE and Energy Institute websites [3, 4].

Summarys

Duty holders should ensure they have suitable procedures for:

- Identifying incident/near miss potential
- Investigating according to the identified potential
- Identifying and addressing both immediate and underlying causes
- Sharing of lessons learned
- Tracking of remedial actions.

References

(1) Reducing error and influencing behaviour, HSE, HSG48, 2nd edition 1999 (reprinted 2003) HSE Books
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Audit and Review

The terms 'audit' and 'review' are used for two different activities [1, 2].

In addition to the routine monitoring of performance (i.e. active monitoring) the duty holder should carry out periodic audits of the SMS as a normal part of its business activities.

An audit is a structured process of collecting independent information on the efficiency, effectiveness, and reliability of the total SMS. It should lead to a plan for corrective action. In this context 'independent' means independent of the line management chain.

Reviews are a management responsibility. They need to take account of information generated by the measuring (active and reactive monitoring) and auditing activities, and how to initiate remedial actions.

The requirements for audit and review are well established. The main issue is to ensure that process safety is adequately included in audit and review programmes.

Guidance on Auditing

Auditing provides an independent overview to ensure that appropriate management arrangements (including effective monitoring) are in place, together with adequate risk control systems and workplace precautions.

Various methods can achieve this. AIChE Guidelines [3 - 4] draw a distinction between Process Safety Auditing, and Process Safety Management Systems (PSMS) auditing.

The focus of Process Safety Auditing is the identification and evaluation of specific hazards (e.g. inspecting hardware and finding the absence of a relief device, or an independent trip system). PSMS auditing, however, involves assessment of the management systems that ensure ongoing control (e.g. the management systems in place to ensure that pressure relief devices have been designed, installed, operated, and maintained in accordance with company standards).

Both types of audit are important. The Process Safety Audit addresses a particular hazard found at a specific time. It could lead to correction of the hazard without addressing the underlying reason why the hazardous condition came to exist. The PSMS audit addresses the management systems intended to preclude the creation of hazards.

The audit programme should include a selection of range of controls in place for preventing or mitigating the risk of a Buncefield-type scenario. These include, but are not limited to:

- Commitment to process safety management

- Application of principles for safe management of fuel transfer
- Risk assessment procedures
- Effectiveness of process safety barriers
- Definition of roles and responsibilities
- Ensuring competence
- Assessment of staffing arrangements
- Management of fatigue associated with shift work
- Safety-critical communications, including shift handover
- Management of organisational change
- Management of contractors
- Retention of intelligent customer capability
- Retention of corporate memory
- Operational planning, and consignment transfer procedures
- Safety-critical operating procedures
- Provision of information
- Document control procedures
- Control of overrides / inhibits of safety-critical instrumentation systems
- Alarm systems
- Inspection and maintenance of safety-critical systems
- Permit to work & isolation arrangements
- Detection measures for loss of containment
- Integrity of secondary and tertiary containment measures
- Control of ignition sources
- Fire protection measures
- Management of plant and process changes
- Maintenance of records
- Active monitoring arrangements
- Reactive monitoring arrangements
- Setting and reviewing of process safety performance indicators
- Investigation procedures / analysis of underlying causes
- Sharing of lessons learned
- Emergency procedures / testing of emergency plans
- Review arrangements / improvement plans

Such audits are formal and infrequent. Duty holders may decide to audit a small range of activities on a more frequent basis (e.g. yearly), or a more extensive range on a less frequent (e.g. 3 – 5 years basis). The duty holder should decide the range and scope of its audit programme, taking into account such factors as audits / inspections imposed by others (e.g. the Competent Authority, Parent companies or Joint Venture partners, Insurers, Trade Associations), and the extensiveness of the active monitoring programme.

Audits that focus primarily on 'compliance' (i.e. verifying that the right systems are in place rather than ensuring that they deliver the right safety outcome) are not sufficient.

Guidance on Review

Reviewing should be a continuous process undertaken at different levels in the organisation. An annual review should be the norm, but duty holders may decide on a system of intermediate reviews at e.g. department level. The result should be specific remedial actions which establish who is responsible for implementation, with deadlines for completion.

Issues to be considered in the review process include:

- The Major Accident Prevention Policy
- Audit programme achievement and findings
- Active monitoring records and findings
- Process Safety Performance Indicators
- Incident / near miss history
- Relevant lessons from incidents etc elsewhere
- Analysis of root / basic causes of incidents and near misses
- Issues from safety committees
- Tracking of safety actions
- Risk assessment status, including reviews against changing standards

Summary

Duty holders should adopt and implement audit plans defining:

- The areas and activities to be audited, with a particular focus on process safety/control of major accident hazards
- The frequency of audits for each area covered
- The responsibility for each audit
- The resources and personnel required for each audit
- The audit protocols to be used
- The procedures for reporting audit findings, and
- The follow-up procedures, including responsibilities

Duty holders should ensure that they have implemented suitable arrangements for a formal review of arrangements for control of major accident hazards, including:

- The areas and activities to be reviewed, with a particular focus on process safety/control of major accident hazards
- The frequency of review (at various levels of the organisation)
- Responsibility for the reviews
- The resources and personnel required for each review
- Procedures for reporting the review findings, and
- Arrangements for developing and progressing improvement plans.

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Appendix 1 – Process Safety Performance Indicators

Insert here appendix 5 from the BSTG report – Note this is an appendix to annex 1, Management of Operations and Human Factors

Appendix 1 – PSLG Principles or Process Safety Leadership

Insert here a copy of the signed principles document – Note this is an appendix to the main PSLG report, not annex 1