International Regulators' Forum
Lifting Working Group

Guidance on using the Human / Technology / Organisation (HTO) classification of incident root causes

November 2007

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1 INVESTIGATION

Each regulator has their own procedures to decide which incidents they will investigate and the level to which they will be investigated. Broadly speaking, we follow similar principles in selecting which incidents to investigate. Typically, the most serious incidents are subject to immediate offshore investigation, less serious incidents may be investigated at the next convenient offshore inspection, and the least serious incidents may be addressed by a review of the duty holder's investigation.

Legal requirements for duty holders to report incidents vary from country to country; for example reporting of near miss incidents may not be required. The classification of the degree of injury is also different. For the purposes of the IRF work, a convenient classification is:

- Fatal accident
- Non-fatal accident
- Near miss.

The intention is for IRF members to carry out a similar number of investigations as they do now. The format of their investigation reports would continue to follow national custom and practice.

Additional resource is required to codify the root causes using a prescribed methodology (see section 2.1). On completion of the investigation, inspectors are required to complete an Investigation Response Form and email this to their local IRF database administrator for inclusion in the IRF lifting database.

2.1 Root cause analysis

There are several methodologies available to analyse the root cause of incidents. The techniques used by each regulator are different in both format and complexity. Adopting a common root cause methodology is a necessary precursor to developing an international database of lifting incidents.

2.1.1 HTO root cause methodology

Appendix 1 describes the system used to classify root causes according to the HTO (Human Technology Organisation) methodology. It provides an explanation of each HTO root cause along with practical examples from the offshore industry.

2.2 Investigation Response Form

An investigation response form should be completed after an inspector has conducted an investigation into a lifting incident. For IRF purposes, a lifting incident is defined as: *an incident that gave rise to actual or potential harm to persons during a lifting operation.* A lifting operation is defined as: *moving a load (materials or persons) between levels using a lifting appliance (machine).* Incidents relating to manual handling of loads are not required. Incidents involving dropped objects should only be included if the object was being lifted by a lifting appliance at the time.

Remember that the information supplied in the Investigation Response Form should be anonymised to preserve the confidentiality of injured persons etc.

Example of a completed Investigation Response Form

Country:	UK	NOTE: Drop Down List for each Country
Inspector:	JOE COOL	
Duty Holder:	GB EXPO	NOTE: Drop Down List for each Duty Holder
Facility Owner:	GB EXPO	NOTE: Drop Down List for each Facility Owner
Installation:	SEA BIRD ALPHA	NOTE: Drop Down List for each Installation
Installation Type:	FIXED INSTALLATION	NOTE: Drop Down List for each Installation Type
Date of Incident:	11 / FEB / 2004	NOTE: Should have set format for this field.
Operation in Progress:	OUTBOARD LIFTING	NOTE: Drop Down List for possible operations in progress
Lifting Appliance in Use:	PEDESTAL CRANE	NOTE: Drop Down List for lifting appliance in use
Incident Severity:	NEAR MISS	NOTE: Drop Down List for incident result
Summary of Incident:	Uncontrolled descent of pedestal crane boom whilst offloading supply vessel. Loud bang heard followed by screeching noises. Boom came to rest with boom tip touching the sea. Container load lost into the sea. Catastrophic failure of splined drive between boom hoist gearbox and the boom hoist drum. Excessive wear observed on splines. Abrasive dust and lack of lubrication. . Material properties outside of specification.	
Enforcement Action	SAFETY NOTICE	

Summary of Direct Causes and Contributing Factors

. Maintenance procedures failed to inspect the condition of the female splines as it was difficult to fully separate drum from gearbox due to surrounding crane structure. Only part of male spline visible during maintenance work

Root Cause Categories (Select all that apply):

A	**WORK ENVIRONMENT**		**B**	**WORK ORGANIZATION**	
AA	Deficient lighting / Poor visibility	(. .)	BA	Insufficient time allocated for work preparation	( )
AB	Poor house-keeping	( )	BB	Insufficient time for performance of the work task	( )
AC	Cramped / stressful /dangerous environment	( )	BC	Insufficient staffing / deficient work assignment	( )
AD	Uncomfortable temperature and / or humidity	( )	BD	Staff with deficient training / competence	( )
AE	Strong wind / High waves	( )	BE	Deficient planning / responsibility repartition	( )
AF	High noise level	( )	BF	Poor preparation (work material & documentation)	( )
			BG	Deficient operation readiness control	( )
C	**CHANGE MANAGEMENT**		**D**	COMPANY MANAGEMENT/PLATFORM ORGANIZATION	
CA	Deficient operation readiness control	( )	DA	Policy / objective not well defined/understood	( )
CB	Change not performed/identified in time	( )	DB	Poor safety culture	( )
CC	Consequence of change not correctly analysed	( )	DC	Deficient QA-programme	( )
CD	Poor routines/Change not correctly performed	( )	DD	Deficient experience feedback programme	( )
CE	Deficient information about performed change	( )	DE	Deficient responsibility repartition between dpts	( )
			DF	Corrective action not timely performed/ recurrence	( )
			DG	Insufficient staffing compared to commitment	( )
			DH	Deficient maintenance programme	(X)
			DI	Deficient training programme	( )
			DJ	Deficient testing programme	( )
			DK	Deficient safety analysis	( )
			DL	Deficient emergency preparedness	( )
E	**ERGONOMICS/TECHNIQUE/DESIGN**		**F**	**WORK SCHEDULE**	
EA	Deficient indication (difficult to read / hear)	( )	FA	Significant (too much) overtime	( )
EB	Deficient component labelling	( )	FB	Tiredness during night shift	( )
EC	Poor accessibility for test/calibration/maintenance	(X)	FC	Stress	( )
ED	Poor ergonomics / technique / design	(X)			
G	**VERBAL COMMUNICATION**		**H**	**INSTRUCTION / DOCUMENTATION**	
GA	Work task not discussed	( )	HA	Deficient content	( )
GB	Potential risks not discussed/understood	( )	HB	Deficient format	( )
GC	Deficient turnover/communication	( )	HC	Illegible instruction	( )
GD	Start/interruption/end of task not communicated	( )	HD	Instruction not updated/controlled	( )
GE	Important info. not correctly communicated	( )	HE	Instruction is missing	( )
GF	Deficient/inexistent communication tool	( )			
I	**SUPERVISORY METHODS**		**J**	**WORK PRACTICES**	
IA	Deficient assignment of responsibility	( )	JA	Instruction, drawing, etc. not utilized	( )
IB	Deficient follow-up of work task	( )	JB	Non-respect of instruction	( )
IC	Expectations not communicated	( )	JC	Poor preparation (instruction, work tools, etc.)	( )
ID	Too many work tasks given to the same person	( )	JD	Deficient self-checking	( )
IE	Priority put on time aspect, not on quality/safety	( )	JE	Deficient utilization of equipment/tool	( )
IF	Too few contacts with co-workers	( )	JF	Individual factor (tiredness, illness, motivation, etc)	( )
IG	Deficient feedback of experience within the group	( )			
K	**TRAINING / COMPETENCE**				
KA	Deficient competence/ practical experience	( )			
KB	Deficient training / re-training	( )			
KC	Deficient training in procedures/instructions	( )			

Submitted By: _____ Date: _____

APPENDIX 1

Guidelines for classifying HTO-related incidents
Jean-Pierre Bento January 2005

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1. Summary

This report is intended to provide guidelines for classifying the incidents on installations which relate to human – technology – organisation (HTO) aspects. It explains the various root causes included in the classification system used by the Petroleum Safety Authority Norway (PSA).

The report aims to achieve a unified and quality-assured classification of HTO-related incidents. It has been commissioned by the PSA.

2. Introduction

A dilemma with every classification system is to achieve an optimum combination of user-friendliness with the need for comprehensiveness, flexibility and systematisation. The variety of potential users and desired areas of application present a constant challenge.

The ability to perform robust trend analyses of root causes, for instance, requires that the classification system's structure does not alter significantly over time. However, it must be possible to make well-founded amendments.

The explanation given below of the various causes and root causes covered by the classification system is primarily intended for use in connection with inquiry reports compiled by the operators. It will also be applicable to other possible incidents such as near-misses and occupational injuries.

3. Causes of errors

Together with root causes, this category is one of the two most important in an HTO context. The 11 existing causes have so far proved adequate and unambiguous in providing an overall explanation of why different HTO-related incidents occur.

3.1. Working environment

The working environment describes the working conditions which prevail on offshore installations and at other facilities on land. These conditions can deteriorate, helping to create disruptions which affect people in their work. This effect can contribute in turn to an incident through such factors as physiological or mental stress.

3.2. Work organisation (for doing a job)

Work organisation embraces the methods and routines which underlie the planning and organisation of the various jobs. In planning terms, this spans from the preparatory stage including the basis for doing the work – to verification of operational readiness. It also covers the provision of personnel to perform the work. Work organisation often contributes to incidents where the analysis shows that those concerned were without the required training and competence, and not only or even necessarily the training/competence cause.

3.3. Change management

This category deals with methods used by the organisation and management to manage, document, check and inform about changes made to the system, components, procedures, training, etc. A typical consequence of deficient change management is that one or more of the necessary sub-activities fails to get done.

3.4. Company management/platform organisation

Company management/platform organisation deals with the methods adopted and applied by management to control the activity. These form part of corporate policy. The ability of management to administer available resources can have a considerable influence both on human performance and on equipment. Management is compelled to secure adequate resources to meet established targets, guarantee the quality of procedures, checks and tools/equipment, and demand high professional standards in order to help personnel minimise HTO problems.

3.5. Ergonomics/ technical solution

Also called the interface between humans and technology, ergonomics can be compared with communication and standards/procedures because these are all concerned with transmitting information. This category accordingly relates to a flow of information from the system (via instruments or computer monitors) to the person, and from the person (via keys, instruments, etc) to the system. The category embraces the ergonomic aspects of installations and equipment which people must control, monitor, maintain, adjust and so forth.

3.6. Work schedule

The work schedule deals with the effect shift work and/or extensive overtime, as well as high levels of stress, have on people. It involves periods when the sensory function and mental processing of the person concerned are greatly reduced. Their ability to function and perform is negatively affected. The scope (intensity and duration) of this reduced ability can be widened or narrowed by other factors, such as age and diet.

3.7. Communication

Verbal communication influences the outcome of almost all activities in which more than one person is involved. Regardless of the desired communication, information must be sent and received. It must also be correct and complete. The most important consideration is that the information has been understood by the recipient. A formal approach is important, particularly with jobs which involve the safety of personnel and/or platform. Well-functioning communication is often taken for granted, but experience shows that many factors can have a negative effect on the exchange of information between people.

3.8. Instructions

The collective term instructions refers to a set of written guidelines, administrative documents, operational or maintenance procedures, error messages, job instructions, etc.

Regardless of the level of knowledge and experience possessed by the worker, standards and procedures are necessary – but not sufficient – to guarantee both personal safety and safe production and to maintain the installation. The necessary steps in a test process, technical specifications and requirements, and warnings relating to the operating mode of a system are examples of things which people cannot remember perfectly each time a job is done. Instructions accordingly provide a necessary support for people, and can be compared with software for the action.

3.9. Supervisory methods

Supervisory methods embrace the methods and routines used by a supervisor to plan, delegate, manage and supervise work done by their subordinates.

A supervisor can contribute to a subordinate making error. The supervisor often occupies a key position for minimising HTO problems through active involvement in the work, establishing clear guidelines, demanding high standards, utilising the abilities and knowledge of subordinates as efficiently as possible, motivating subordinates and treating them in an equitable manner.

3.10. Working practice/human factors

Working practice is a collective term for methods and routines used by people to do a good job. It embraces methods for preventing and identifying errors, the application of procedures and equipment, and planning and preparations for doing the work.

Experience shows that poor working practice is the dominant cause of HTO problems in many of society's activities, either alone or in combination with other causes. It is also striking that deficient working practice (self-checking) is found just as widely at the desk as out in the field.

3.11. Training/competence

Deficient training as a causal category for HTO problems comprises two components. One relates to training methods and the other to the content of training.

Training methods

The effect of training on human behaviour is complex, and depends on a number of factors. If a technician seldom needs to carry out a certain job in their work, for instance, they must be given an opportunity to refresh their knowledge at regular intervals.

Generally speaking, detailed instructions are required for jobs which seldom need to done. If the technician has never done the relevant job before, it is important to analyse the organisation of the work to ensure that they have received the appropriate training. It will also be important to assess whether

the training method (classroom, video, demonstration models, etc) was appropriate in light of the job to be done.

Training content
A good training programme requires that the content for a given job or post is based on an analysis of the knowledge and skills required by the relevant job or post. In addition, the training should include a component which deals with the consequences of doing the relevant job wrong.

4. Root causes

Many definitions are provided in the international literature for the concept of root or underlying causes. The one probably used more frequently defines a root cause as a cause for which corrective measures will prevent or reduce the probability of a recurrence of the undesirable incident.

It is obviously important that the real root causes of an incident are identified, and that the analysis does not stop at a higher level where only the direct and noticeable causes emerge. However, it is well known that more root causes can always be found by digging deeper.

The root causes included in the PSA's classification system are discussed below with a text and/or examples. This survey is based on the same set of categories as the previous chapter.

4.1. Root causes for working environment

AA Deficient lighting/poor visibility
covers inadequate, excessive, flickering and/or poorly-positioned lighting

Example: Visibility up the derrick has deteriorated. Semi-darkness prevails at a height. It is twilight and heavily overcast. The spotlights point downwards and blind the drill floor crew.

AB Poor cleaning
covers cleaning/tidiness in the workplace before, during and after a job, such as water or oil on the deck/scaffolding, etc.

Example: A scaffolder loses his balance after tripping over a scaffold pole about 55 centimetres long which is laid across two longer poles.
Example: Worker A stretches a little to reach into a corner while standing with one foot on a railing. A loses his foothold and slips because the railing has become coated with oil/grease.

AC Cramped/stressful/hazardous working environment
covers a restricted working space which could affect a person physically or mentally while doing their job.

Example: A telecommunications technician discovers that the acoustic alarm over the PA system is not working. This alarm had been inhibited

earlier by forcing in the pushbutton on the radio panel in the central control room. This problem with acoustic alarms (stressful environment) in accidents is not new.

AD Uncomfortable temperature and/or humidity
covers working conditions were the temperature and/or humidity exceed (or fall short of) acceptable values in relation to the planned time for doing the job. When this root cause is involved, it is important to consider whether these conditions have been assessed under work organisation or supervisory methods.

AE Strong winds/high waves
covers winds and/or waves of a force/height which could disturb human sensory function and action. These external factors are often linked to high level of noise (see below) and to work organisation and supervisory methods, since a number of incidents show that the work should not have been initiated in the relevant wind and/or wave conditions.

Example: The wind was 42-46 knots. A pendulum effect occurred in the crane hoist during the lowering of a 3.1-tonne tank, and the crane operator was concentrating on correcting this in addition to carrying out both swinging and lowering operations.
Example: A rough wave hit the stern of m/v Active Lord, flushing two people and four containers/baskets 10 metres forward on the deck.

AF High level of noise
covers noise of such strength and/or frequency that misunderstandings, for instance, can arise in communication between several people, or that people find it difficult to concentrate on a job. This is often linked to a stressful working environment.

Example: A 40-knot wind was blowing, causing the tarpaulin providing weather protection to flap and create a noise together with the wind itself. People were unable to hear that work was taking place overhead.

4.2. Root causes for work organisation (for doing a job)

BA Insufficient time for work preparation
covers the time available to a person or group of people to prepare themselves and/or the actual job.

Example: The handover between coordinating process technicians is cut a bit short because the night shift supervisor goes to eat breakfast. On returning to continue the review with the day supervisor, he is called to a status meeting relating to problems with establishing double block and bleed (DBB).

BB Insufficient time to do the job

covers the time available to a person or group of people to do a job. Note that this root cause is relatively often linked to DG – insufficient personnel resources for the commitment.

Example: Problems with the MEG treatment plant mean that a normal shift handover fails to take place in the central control room or between the discipline leaders. No shift handover takes place between outside operatives either.

BC Insufficient staffing/division of labour
covers planning and/or execution of a job with limited or insufficient human resources in relation to the nature and scope of the work. These resources involve both the company's own employees and personnel from contractors.

Example: Three people with long experience are to carry out a lifting operation. The lifting supervisor is also the signaller (which breaches the company's own crane procedure).

BD Deficient personnel training/competence
covers planning and/or execution of a job with personnel who have not received the right training or who lack the competence required for the work. Generally speaking, this could involve incidents where people have not been given sufficient training and/or practical experience with the equipment they are using. In similar circumstances, deficient training/refreshing and/or deficient training programme could also be root causes of the incident.

Example: A water jetting job is being planned for the night shift. Two of the three workers (B and C) are relatively new, with little experience, and are on their second offshore tour. B and C have not received any review of the procedure for using high-pressure jetting equipment, and have only had a practical run through of its use. Nor have they taken a course in using the equipment, which is a requirement in the contractor company's procedures on such courses with a certificate of completion.

BE Deficient planning/division of responsibility
covers incidents where the planning of a job and/or allocation of responsibility for the work have not been unambiguously defined and/or made known to the members of the team.

Example: Worker A is precariously balanced at a height above the deck while slinging, using the radio and directing the crane operator, without anyone intervening – everyone has a duty to halt work being carried out unsafely. Practice on board means that no clear distinction is made between the duties and responsibilities of signaller and slinger.
Example: Nobody has been named to supervise a job, but the allocation of duties has been agreed. After the crane operator arrives, he is told to wind the wire rope slowly onto the drum. He has to leave the cab to ask which rope is to be replaced.

BF Deficient preparation (work materials and documentation)
covers organisational weaknesses which mean that the planned work had to be moved forward in time or was executed in a deficient way. Similar weaknesses could also relate to deficient planning/division of responsibility and possibly to other root causes such as work task not discussed.

Example: The work permit for the relevant job (including the C-14 header valve) is issued too early (before the work site has been secured). This represents a breach of the procedure for issuing such permits.
Example: Plans call for critical valves to be replaced on a number of installations. No specific organisational chart or lines of communication have been prepared for this job in the offshore operations unit.
Example: A well is being monitored for inflow. The perforation tool is 50 metres below the shot point to avoid flow on the tool. Plans in the safe job analysis call for the well to be monitored for 10 minutes. No written plan/emergency procedure exists for handling a backflow from the well.

BG Deficient checking of operational readiness
covers a failure to meet the correct systematic and administrative requirements when checking the operational readiness of components or systems, or returning them to their original condition. Identifying this root cause is particularly important, since such latent weaknesses could mean that components and systems remain operationally unready or out of their original condition for lengthy periods without operational personnel being aware of it.

Example: The container has not been checked by the signaller before the lift. Its doors are open. A person is inside. The container is not ready for lifting.
Example: An operative checks the facility before transfer begins. No checklist is used. The piping and instrumentation diagram (P&ID) is not checked against the system in the field. The operative does not notice a 10-millimetre non-return valve.
Example: Conflicting information exists about exactly what was communicated concerning valve positions. However, it seems clear that no adequate review of the safe job analysis and documentation was carried out. Not enough was done to verify that the facility could be brought on line. The manifold was prepared for gas release/intervention, not for starting up wells. It should not be operated towards the wells if the blowdown lines are blocked.

4.3. Root causes for change management

CA Deficient verification of operational readiness
characterises the same kind of weaknesses as BG – deficient checking of operational readiness, with the difference that these arise directly from a (major) change to the facility/installation.

Example: New client PCs are installed in the control room. The server configuration has not been correctly updated after the introduction of new clients. The facility is therefore inadequately readied for operation.

CB Change not made/identified in time
ought to be self-explanatory. However, it should be pointed out that this root cause often requires attention to be directed at measures not taken in time/recurrence and deficient experience transfer, which come under company management/platform organisation.

Example: An emergency brake to prevent lowering in an unsecured area (anti-collision system) has not been installed. This was an action registered in Synergi after a similar incident when the travelling block collided with the upper racking arm. The proposal to install an anti-collision system was recorded as performed in Synergi in 1998. According to the procedure for incident reporting, it should have been recorded as cancelled.

CC Consequences of change incorrectly analysed
covers an implemented change which had undesirable consequences for personnel or the system (this applies to operation, testing and maintenance of logic and/or component).

Example: A new human-machine interface is installed. The practice develops of not presenting insignificant alarms in the central control room. Among these suppressed alarms is one for a communication failure between the server and the process network.

CD Deficient routines/change incorrectly made
applies beyond the actual implementation of the change to cover necessary updating of instructions and training, for instance. This root cause accordingly applies to such aspects as administrative and physical weaknesses identified during or after a change has been made.

Example: A new interstage scrubber is installed and made operational. It is taller and heavier than its predecessor. The gas lift compressor is started and stopped a number of times because of several loose bolts on the level glass and a flange on the compressor outlet, false signals because of loose cables and damaged fittings on top of the inspection glass for the new scrubber. This is because vibration from the compressor causes oscillations in the scrubber and process piping.
Example: The decision was taken to modify a trolley designed for permanent installation on a tubular feeding machine (TFM). Eyebolts installed on the trolley do not comply with the BP lifting equipment manual. Lifting points have not been designed in accordance with BP's specifications. The eyebolts are neither CE-marked nor marked with a yearly colour code. BP representatives did not spot the incorrect eyebolts on the trolley during factory acceptance testing (FAT).

CE Deficient information about changes made
applies to providing information to the company's own personnel, relevant contractors and in some cases the regulatory authorities about an important and otherwise significant change.

Example: The diesel storage tank was full. After a similar incident, a modification was made so that the diesel pump automatically stopped at level H1 in the tank. This was done as a corrective job, and the piping and instrumentation diagram (P&ID) showing the modification was therefore not updated.
Example: The operations organisation for the installation was not aware that the piping system to the flare had been designed with/constructed in materials which could not withstand a temperature over 600°C.

4.4. Root causes for company management/platform organisation

DA Policy/objectives not well defined/understood
relates to the company's guidelines and regulations as well as defined goals for the business. This root cause covers both the definition of the company/platform policy in the various parts of the activity, and workforce understanding and knowledge of that policy.

Example: The division of responsibility between the turnaround coordinator and the operations manager is ambiguous, and it is unclear how far this position has been formalised.
Example: Problems with cargo/return cargo have been raised earlier by platform personnel with the company management, the supply base and another oil company.
Example: The company's senior management is not familiar with the contractor's management system, and have received no training on this.
Example: Because the field has various different cranes, no guidelines have been drawn up for such work as changing pulleys at the boom tip and A frame and replacing the boom rope, despite the big potential for an accident.

DB Deficient safety culture
covers weaknesses in views, attitudes and behaviour relating to safety and safety-related issues. These weaknesses could be at either individual or collective level.

Example: The crane boom is in the cradle. This position means that people must work over the open sea when replacing pulleys at the boom tip and the boom rope.
Example: The supervisor asks the workforce not to do anything until he returns. In the meantime, the personnel have begun to prepare for demounting and disassembling the manifold from the lubricator (they assumed that demounting could begin).

Example: A roustabout enters a container, but the slinger does not inform the signaller about this. Communication routines have not been agreed between those involved. The crane operator does not contact the signaller for confirmation that the container is ready to lift, and starts the operation without waiting for a signal from the signaller.
Example: A person in a safety harness was crushed between drill pipe and the upper racking arm. The equipment was operated with the harnessed person on the fingerboard because of inadequate checking by the manipulator arm operation and inaction by the responsible driller.

DC Deficient QA system
covers the overall structure, scope and quality of the company/platform quality assurance programme and the way this fulfils regulatory requirements. It also applies to the QA programmes at suppliers/contractors.

Example: The bolt which fell, and the other bolts, do not accord with the drawings and documentation. The bolt was welded at the top with a poorly-executed weld. While the specification requires the bolts to be galvanised steel, they are actually stainless steel and are not cast in one piece as specified. A complete history of the equipment is not available.
Example: After it has been closed, the elevator hits the upper racking arm. Shear pins on the arm are broken. The upper racking arm tilts down, but does not come free of the top-drive drilling machine. The user manual gives a misleading description of the shear pins' safety function. It is not possible to tilt so far down that free passage is provided between the drilling machine and the upper racking arm.
Example: The substance in the sea is established to have come from the caisson. The design of the overflow valve on the storage tank is sub-optimal, since it leads directly to the sump caisson. According to Norsok P-100, overflow from treated diesel must be routed back to the raw diesel tank.

DD Deficient experience transfer
covers company/platform management of resources and routines for reporting, analysis, follow-up and transfer (in-house and externally) of operational experience. For corrective action, see below under measures not taken in time/recurrence.

Example: The inquiry team identifies three earlier events in the company with direct relevance to this incident. No incident report (RUH) has been written on these occurrences.
Example: Loose bolts and clamps are observed when inspecting the flare burner during the maintenance shutdown in June 2002. Loose bolts on flanges and supports are again observed in a further inspection during September. Observations during the September 2002 turnaround also revealed cracking in fillet welds on supports and railings as well as loose gratings. The flare inspection report has not been found in the follow-up system for the pipeline inspection system (RIS).

Example: A notification issued in May 2003 is not known, the experience has not been transferred and compensatory measures have not been taken.

DE Deficient division of responsibility
covers responsibility for all activities/jobs – which could involve making a system change during a maintenance shutdown of a facility – and the associated allocation of resources and personnel between various departments and/or companies. Responsibility should be unambiguously defined, clearly expressed and known to everyone involved in the job.

Example: Personnel from the special maintenance department arrive on the installation for maintenance of the Molde crane. A contract crane operator from IKM is brought from another installation, with an extra signaller also called in. Nobody is assigned to supervise the job, but agreement is reached over the allocation of duties.

DF Measures not taken in time/recurrence relate to an administrative or systematic weakness which the organisation has been aware about as a result of one or more earlier incidents, without appropriate corrective action being initiated or completed in time to prevent a repetition.

Example: The inquiry team called special attention to the similarities between this incident in October 2002 and the gas leak in April 2002. Consideration of the previous incident has not been completed. According to the inquiry team, the conditions which are likely to have caused the October 2002 incident are well known in the organisation.
Example: The gas alarm sounds when the valves to the gas lift pig trap are opened. This trap has had leak problems since the time it was commissioned, and a notification has been compiled which specifies that the trap should depressurised and taken out of use. However, no job order has been created for this.
Example: Leaks in some of the manual valves from the wells to the pressure-equalisation manifold have been known about for a long time.

DG Insufficient personnel resources for the commitment
relates to conditions where planning and/or execution of a project or job has been deficient because insufficient human resources were available or involved in the work.

Example: Surface treatment activity on board is considerable. This is why such work has been pursued during the night shift over a period. This is not usual and does not accord with good practice. Additional measures and resources have been committed by the platform management during the day. No extra measures have been adopted at night.

DH Deficient maintenance programme

covers company/platform management of resources and routines for deciding, planning, executing and monitoring maintenance activities on one or several installations.

Example: An outdoor operative makes several attempts to start the pump in the sump caisson. The pump starts but stops immediately. It was last tested a month earlier, when it also failed to work. Outdoor operatives have told the inquiry commission that they knew the pump failed to work.
Example: A Dymabrake stops as a result of a fan fault on the power feed. The inquiry reveals that no maintenance programme has been established for the power feed's cooling fans.

DI Deficient training programme
covers company/platform management of resources and routines for deciding, planning, executing and monitoring personnel training in relation to the various activities and jobs pursued on the installation.

Example: The platform's computer-based control system (DCSS) gave erroneous alarms about water intrusion in the platform's structure. These alarms persisted for about one-two hours, creating uncertainty in the central control room when activating programmable control units (PCUs) in the DCSS. Sounding the water level in columns is possible, but this not a familiar procedure.
Example: The technician responsible for the emergency generator was not trained in operating this equipment, and did not know how to shut down the generator motor.

DJ Deficient testing programme
covers company/platform management of resources and routines for deciding, planning, executing and monitoring all activities relating to testing the installation's components and systems.

Example: Problems with pressure testing of 9 5/8-inch casing and seal element. The difficulty lies in getting satisfactory test results. Several tests were carried out, and have been poorly documented in terms of pumped volume and pumping rate.

DK Deficient safety analysis
covers company/platform management of resources and routines for deciding, planning, executing and monitoring all risk analyses related to design, construction, installation, testing, operation and maintenance of installations.

Example: The leak was quickly localised to the flange on the pulsation dampener facing the process piping. The direct cause of the leak is fatigue cracking following vibration. Action concentrated on repairing cracks in the pulsation dampener and correcting gaps between the dampener and process piping. None of the measures were directed at supporting the scrubber and process piping.

Example: Hazop was not carried out on the pilot burner system. There was also insufficient understanding of the way the system worked at that time.
Example: Data provided to the supplier by the project in connection with calculating displacement forces were based on 30.2 million standard cubic metres per day (earlier calculations referred to pressure release rates up towards 50 million scm/d).

DL Deficient emergency preparedness
covers company/platform management of resources and routines for deciding, planning, executing and monitoring all activities related to emergency preparedness in the company and on installations.

Example: PA-B is out of operation, so that only every other cabin receives PA announcements. A search of the living quarters is carried out. This is not done properly on the seventh floor, with the result that two people are not wakened. Proposals for a new emergency response plan do not include search teams in the living quarters.
Example: On an outside tour, the safety supervisor observed hydrocarbons in the sea. It was again concluded that this was MEG from the on-going cleaning of the top deck and modules. No samples of the spill were taken. No use was made of the potential of the service vessel to secure further clarification of the spill, its size and its thickness.
Example: First-aid equipment installed around the installation is not always easy to spot, and its labelling is unsatisfactory.
Example: Communication between the emergency response centre and the hospital was difficult at times, and couriers had to be used.

4.5. Root causes for ergonomics/ technical solution

EA Deficient/poor indication (difficult to read/hear)
relates to ergonomic weaknesses which disrupt the ability of those concerned to read, follow up or observe the correct indication for process parameters, for instance.

Example: No alarm system is installed to indicate that the emergency generator's air relief valve has ceased to function.
Example: Nobody involved reacted to an alarm in the driller's cabin when the elevator approached the telescopic section of the upper racking arm. The alarm is both audible and visual. The audible alarm is weak and comprises only three short pips.
Example: An outside operative decided that the substance observed on the sea could be hydrocarbons from the caisson. There are level indicators on the latter, but these are difficult to interpret. In choppy seas, as with this incident, the level indicators produce more or less continuous alarms because of wave-related fluctuations in the caisson. These alarms were therefore not followed up by the central control room.

EB Deficient/poor component labelling (hard to read)

covers ergonomic weaknesses which disrupt the ability of those concerned to identify a given component correctly.
Example: A pipe socket with two valves is discovered on the deck in the central corridor. It weighs 26 kilograms and has fallen from a height of roughly four metres. It is subsequently established that the socket has broken off with great force. This component was installed during fabrication of the module in 1986 and was used for pressure testing in the construction period. With no operational function, it is not shown in the piping and instrumentation diagram (P&ID) and is consequently undocumented.

EC Poor accessibility (calibration/testing/maintenance)
covers the physical positioning of components which people must regularly manoeuvre, calibrate, test and maintain.

Example: The parked wire rope has become entangled behind a bolt on the mud hose connection to the top drive. The configuration of the fingerboard makes it fairly difficult to manoeuvre the rope back to its correct position.
Example: The cotter pin holding the limit switch is not correctly fastened. The person who worked on the switch has said that he had problems attaching the pin properly.

ED Poor ergonomics
covers deficient construction (design and technology) of components and systems and deficiencies in the human-machine interface as well as the deficiencies described above. These deficiencies also relate to problems with accessibility to and proper functioning of the equipment.

Example: The outside operative locates the gas leak. The direct cause is a fatigue fracture owing to vibration. Attachment of a new scrubber has been calculated on a static basis with an addition for the effect of dynamic vessel loads. However, it does not appear that account has been taken of vibration effects from the reciprocating compressor.

4.6. Root causes for work schedule

FA Extensive overtime relates to conditions in where a person or a group of people have worked almost continuously for an extremely long time and without adequate rest.

Example: The log shows that the captain and two deck hands had had 2-2.5 hours of rest over a period of 36 hours when the accident happened.

FB Tiredness (from night working) covers conditions at such times as the early morning when a person performs a job poorly because of a physiological inability to concentrate on the work. In such circumstances, the person cannot be held responsible for the deficiencies which have occurred. This issue has attracted greater attention in recent years, and

the companies now take a more restrictive approach to the execution of demanding testing and jobs related to night work.

Example: The vessel was due to perform tests in accordance with a checklist before entering the 500-metre zone (the time is 02.46). The checklist was logged as performed, but had not been carried out adequately. The autopilot was not turned off, but the officer of the watch was convinced that this had been done.

FC Stress relates to conditions where the specified and/or available time for planning, executing, checking or reporting on one or more jobs was too short for the scope of the work and the personnel available. This root cause is closely related to work organisation and company management/platform organisation. Stress can also result from a combination of undesirable incidents and misunderstandings.

Example: The work order was signed out by a member of the work team and the area operator. Nobody noticed that a safe job analysis is required by the relevant work order. The area operator has a great deal to do during the turnaround.
Example: Working conditions for the central control room operators were disrupted by requests from personnel following their demobilisation from the lifeboats. These included permission to enter areas. This distracted the operators from the job of restarting the plant.
Example: Reception and processing of information in the central control room, and its onward transmission to the emergency response centre, were sub-optimal. A contributory cause was the high level of stress in the control room and a large number of audible alarms.

4.7. Root causes for communication

GA Work task not discussed
covers conditions where no verbal communication occurred before the job was begun. This deficiency could involve an individual or a group of workers. Closely-related causes linked to work organisation and supervisory methods are not infrequently found. Many examples show that a written instruction concerning maintenance or testing should be complemented by verbal information before the work starts.

Example: The crane operator and signaller arrive too late to participate in this review. The signaller arrives when the discussion on implementing the job has been completed and the crane operator is already in the cab. After the crane operator arrives, he is told to wind the wire rope slowly onto the drum. He has to leave the cab to ask which rope is to be replaced.
Example: The fuel gas system has been modified to increase the rate of flow during ballistic ignition of the pilot flame. This was not discussed with the supplier of the flare burner.

GB Potential risks not discussed/understood
covers risks associated with executing a job. This risk should be regularly discussed by the supervisor and personnel doing the work before it begins. Risk in this context covers the safety of both plant and personnel.

Example: A water jetting job is being planned for the night shift. This is not normal or in accordance with good practice. The safe job analysis is deficient. HSE conditions are not adequately covered in the SJA.
Example: Worker A hears a bang whilst up on the top deck. He looks towards the crane and sees that the hook has overridden the boom tip, and that the safety clamp has fallen onto the gangway. He does not communicate this to the crane operator.
Example: The crane operator is not in radio communication or visual contact with the signaller, even though he does not have an overview of the position and cannot see the drum container.

GC Deficient turnover/communication
relates to communication between individuals who relieve each other while a job is in progress. This root cause covers both shift handover in the central control room and relieving various teams during an extensive testing or maintenance job. It also relates to deficient quality of any communication, primarily with regard to data important for plant and/or personnel safety.

Example: A problem arises during adjustments to a limit switch. It is not logged or communicated to others working on the crane.
Example: A handover meeting takes place between the night and day shifts. The management is present. The subject of the meeting is crush injuries. The day shift does not raise conditions with the night shift because "people quickly get annoyed if you criticise the work done by the other shift". Conditions on deck are not discussed. The night shift does not inform the day shift about non-conformances in container stacking.

GD Start/interruption/end of task not communicated
covers communication between a worker, for instance, and their supervisor or the central control room in which one or more of these times are not reported. Noting this root cause is important, particularly in connection with incidents which occur during periods with a high level of activity – such as turnarounds.

Example: The main control room is not informed about or registers at any time that work on the heat exchanger has begun.
Example: The crane operator starts the operation without waiting for a signal from the signaller, and does not contact the signaller for confirmation that the container is ready to lift.

GE Misuse of communication equipment/radio
relates to deficient behaviour/culture in using communication equipment/radio. It is important that personnel observe established practice and rules when using such devices, particularly in operations which involve high risk or at times when the level of activity is high.

Example: Only the crane/deck personnel are on the radio's crane channel. Drillfloor crew are on their own channel. This is a breach of the company's crane procedure.

GF Deficient/non-existent communication tools
relates to such hardware as telephones and headsets which are unable to filter out background noise adequately, or communication devices which lack frequencies or have inadequate coverage of the installation – in connection with a general alarm and assembly, for instance.

Example: Problems arose this morning with radio communication in the West Complex, which meant that process technicians periodically lost contact with each other and the central control room. These problems were caused by poor battery capacity.
Example: A complete blackout hit the installation because of an ENS 1.1 signal. The UHF radio base station in the central control room is out of order. Only the handsets work. Only UHF channels 1-3 (normal channels) and 8-13 (radio-radio/simplex channels) are functioning. Contact between the central control room and the outside world fails for about two minutes as a result. PA-B is out of order, and only every other cabin receives PA announcements. After 30 minutes, all PA and VHF channels 1-3 cease to function.

4.8. Root causes for instructions

HA Deficient content
covers information in all written documentation, such as instructions, procedures, work orders, work permits, piping and instrumentation diagrams, etc. It can also apply to incompatible references – such as process values – between an operating instruction and a operating order, a misprint or overlooked steps/measures in a test instruction, and a deficient logic or flow diagram.

Example: The work description for operating the condensate system does not provide sufficiently precise "driving rules" to avoid degassing in the condensate export tank.
Example: The safe job analysis was deficient because the risk relating to the design of the blowdown line was not sufficiently highlighted.

HB Deficient format
relates to deficiencies in the layout of the documentation. This could involve, for instance, the chronological order in which the various steps

in an instruction are to be performed. The deficiencies can also relate to references between several written job instructions.

Example: The decision was also taken not to inspect the first stage cooler because this activity was not compatible with the remaining jobs (simultaneous activities in the same area, with one beneath the other). The original procedure for bleeding down had been written for the first-stage cooler and had been to the land organisation for verification.
Example: The safe job analysis form used for this job is not the standard version developed by the company.

HC Illegible instruction (also diagrams)
covers the quality of the documentation in terms of legibility. This also applies where the relevant documentation is a copy of a copy, and particularly when a diagram – logic or flow – appears in the document. Finally, all or part of a page could be missing in a copy of a document.

HD Instructions not updated/checked relates to all documentation, including maintenance and operating instructions, procedures, work orders, work permits, piping and instrumentation diagrams, etc. This root cause accordingly means that part of the documentation has not received a timely updating in connection with changes made, or have become outdated. The documentation may also have been updated but not checked before it was taken into use.

Example: The activity list for the production shutdown is reviewed. The metering technician gives a verbal presentation of what he intends to do in the same period. This is not included in the shutdown list.
Example: Publications on the bridge were found to be out of date.

HE Instructions missing
relates to conditions where a job is done without access to written documentation, and where it can reasonably be concluded that the presence and use of this would have prevented the incident.

Example: Nor has a procedure existed for physically locking values in addition to a red label.
Example: No checklist exists for the job of hanging up coflex hoses. General practice on the rig is that a chicksan crossover is always disassembled before storage at a height. However, this is not described in writing in any procedure.
Example: The drawworks and MPA unit are to be replaced. Drawings for attaching the drawworks to the deck beams are not available. No allowance has been made for this deficiency in the planning work.

4.9. Root causes for supervisory methods

IA Deficient delegation of responsibility

means that the management has not correctly delegated responsibility to the right person/group, or that the responsibility has been delegated to an inappropriate person.

Example: Those involved have agreed in advance on who will do what in the operation. Roughneck C operates the winch and has been designed the lifting supervisor. The assistant driller standing by the rotary table claimed afterwards that he was supervisor for the whole operation.
Example: Worker A has not been told that he will serve as an extra signaller. The crane operator has understood that A has been asked to do this job.

IB Deficient supervision of the work
covers conditions where the supervisor either fails to monitor the worker's job or does not check it often enough while the work is being done. A contributory reason could be that the supervisor has been given so many simultaneous tasks that he has no opportunity to discharge his supervisory role. Such cases also relate to BC – insufficient staffing/division of labour and/or DG – insufficient personnel resources for the commitment.

Example: A change was initiated to overcome a problem. The established proposal for improvement (FTF) system was not used.

IC Expectations (self-checking, etc) not communicated
covers deficiencies by the supervisor in clearly communicating to the employee which requirements, assumptions and expectations are associated with the job.

Example: The safe job analysis was deficient. HSE aspects were not adequately covered.
Example: According to the work permit, an safe job analysis should be carried out before the work begins. This was not done.

ID Too many tasks given to the same person
covers conditions where an employee is given several simultaneous tasks or keeps being asked to interrupt their work to start and/or take part in another job. Occurrences of this root cause often indicate that other causes relating to work organisation have contributed to the incident.

Example: A meeting is held to discuss problems with establishing a double block and bleed (DBB) in production train 3. The process technician responsible for coordination and for the area, who cleared the work order, is primarily concerned with the outside process. This means that he does not keep himself sufficiently updated on such aspects as the problems in establishing the DBB.
Example: Diesel oil is being transferred to the storage tank. According to an earlier work description, the outside operative is responsible for monitoring the filling process and must not leave the area without

stopping the pump. After about an hour, the central control room asks the outside operative to help get control over levels in the glycol (MEG) regeneration unit. The operative leaves the area without stopping the GC702 pump. The control room does not tell the operative to stop this unit.

IE Giving more weight to time than to quality/safety
covers conditions where the supervisor has consciously or unconsciously given priority to the time aspect rather than the quality of the work. Incidents involving this root cause often reveal other causes linked to work organisation as well as company management/platform organisation.

Example: The work was only planned over the radio. It was unclear whether everyone involved had been informed. The instruction was not in writing. Alternative approaches to the work were not assessed nor used.
Example: After a bolt had fallen down, the deck crew did not secure the site. They picked up the bolt from the site by the driller's cabin. It was resolved to send a person in safety harness to check the equipment. The bolt was welded.
Example: The management resolved to start production. The process systems were reset. The process had not been depressurised when the platform management decided that the necessary barriers were in place. Given earlier problems, start-up of the test separator should have been delayed until the ambient conditions had been clarified.

IF Insufficient contact with subordinates
refers to lack of contact between a supervisor and their subordinates. The focus here is primarily on the supervisor's role as a coach, in the sense of being visible to, meeting, informing and motivating the employees and developing relationships within the group.

IG Deficient transfer of experience
relates to the experiences gained within or of interest to the group for which the supervisor is responsible. The supervisor has an important job here as a gatherer of information and as a catalyst for experience transfer within the group. That applies both to incidents and near-misses in which their subordinates have been involved, and to experience from similar activities in companies and the industry.

Example: The seven-kilogram blind plug is turned off. The plug remained hanging from the cementing head by a safety wire for about 13 hours until the head was to be dismounted. Many people fail to react to hanging blind plug.

4.10. Root causes for work practice/human factors

JA Instructions/drawings not used
relates to conditions where a person or group of people fail to observe existing instructions/documentation to support the planning, execution, checking and reporting of their work.

Example: Equipment is installed by the contractor without the person responsible for it being present. The procedure for installing the cementing head is not followed.

JB Non-conformance with instructions
relates to conditions where a person or group of people consciously or unconsciously fail to conform with existing documentation (instructions, operating orders, work permit, etc) when planning, executing, checking and reporting their work.

Example: The crane operator starts the lift without a signaller or deck hand being present to guide it.
Example: Worker A climbs to the top of the ladder and bends over the container. The top of the uppermost container is about 4.5 metres above the deck. A is working at a height without taking the required precautions. Nobody intervenes.
Example: The gas detectors in D22 had been disconnected for more than two days, without any compensatory measures. The area had been unstaffed several times during this period.

JC Deficient preparation (use of wrong instructions, tools, etc)
characterises conditions where a person or a group of people have made inadequate preparations for a job by not checking the currency of necessary documentation (instructions, flow diagrams, drawings) or the appropriateness of the tools, or by using the wrong instructions/tools.

Example: The crane operator stops lifting when he realises that something might be wrong. He tries to contact the signaller, and then notices that the VHF radio is not turned on.
Example: The equipment is not checked before being used. This includes the reduction valve, a 1-1 type which could reduce pressure by as much as the bottle pressure.
Example: After maintenance has been completed, the original shutdown plan is updated and signed by the night shift. The day shift resets the condensate export pump in accordance with the shutdown plan. A copy of the plan is used which does not accord with the original.

JD Deficient self-checking to avoid errors
indicates that a person is following a practice which does not observe the Stark principle (stop, think, act, review, communicate) when planning, execution, checking and reporting of their work. It should be mentioned that this root cause applies equally to an individual and a

group. The latter case, with a collective deficiency, should also be linked to DB – deficient safety culture.

Example: Worker B enters the doorway as worker A begins to close the door. B fails to take the necessary precautions before entering the hydraulic door. A hears shouts/screams and turns to the doorway, where he sees B stuck fast.
Example: The manipulator arm operator thought the person in the safety harness had been lowered in order to operate the upper racking arm. The person in the safety harness was crushed between drill pipes and the upper racking arm.

JE Erroneous/deficient use of equipment/tool
covers conditions in which appropriate equipment (tools, video camera, testing and metering instruments, administrative aids, etc) are used either in a deficient way or not at all. This root cause also applies to conditions where unintended or inappropriate equipment/data are used.

Example: Worker A reaches for something in a corner while standing with one foot on a railing. A loses his foothold and slips because the railing has become coated with oil/grease. A trestle was available but not used. This would have provided a considerable improvement in access for the operative.
Example: A new hook has been installed on the personnel winch and taken into use. The hook lacks a locking pin and accordingly breaches the procedure for transporting personnel with the winch.

JF Human factors (tiredness, illness, motivation, etc)
indicate that a person's concentration and ability to perform were substantially affected by tiredness or illness at the time the job was done. Human factors also include motivation. Lack of motivation can strongly affect the outcome of an action. It can also be mentioned that the supervisor should be on the lookout for these factors in their contact with subordinates and take action in time. This is particularly important when the job concerned calls for great concentration and/or significant mental or physical effort.

4.11. Root causes for training/competence

KA Deficient competence/practical experience
indicates that the competence displayed by a person and/or a group of people during the execution of a job has not been adequate. In addition to this root cause, KB – deficient training/refreshing and BD – deficient personnel training/competence could have contributed to the incident.

Example: The helicopter landing officer (HLO) lacks the competence specified by the helicopter manual from the Norwegian Oil Industry Association (OLF).

KB Deficient training/refreshing

indicates that the operative's basic training and/or refresher courses have been inadequate in providing the required knowledge of the component, system and process function as well as of their safety impact and significance for the facility. This root causes relates to the content of both theoretical and practical training, including simulator sessions. Basic training/refresher courses also embrace knowledge of the tools and equipment to be used.

Example: The work team has opened the flare system, but is relatively unfamiliar with the process plant. This type of job would normally be carried out by the permanent staff, which is aware that the 14-inch pipeline belongs to the flare and seawater system.
Example: The central control room discusses the observation of an abnormal flame. The inquiry report indicates that the organisation's knowledge about the pilot burner system has been inadequate.

KC Deficient training in procedures/routines
indicates that the operative's basic training and/or refresher courses have been inadequate in providing the knowledge required for the job in terms of company/installation policy, procedures, routines, HSE culture and self-checking, emergency response plans, etc.
Example: Surface treatment activity on board is considerable. Additional measures and resources have been committed by the platform management during the day. HSE training and review of procedures have been inadequate for these new personnel.
Example: The incident was not reported to the platform management by those involved.
Example: The nurse assembled first at the lifeboat rather than the first-aid team. The nurse was new on board, a temporary replacement, and had only had four days' overlap.

KD Deficient practical experience
indicates that the practical experience demonstrated by a person in executing a job has not been adequate. In addition to this root cause, KB – deficient training/refreshing and BD – deficient personnel training/competence could have contributed to the incident.

Example: The company's personnel have little experience with (or established routines for) well cleaning via the test separator, since this is normally done via the flare boom on other platforms.

KE Training not updated for changes
covers conditions where changes to the system, components and instructions are made without personnel involved receiving the necessary updating/refreshing of their training. This root cause applies to the content of both theoretical and practical training, including simulator sessions.

KF Deficiencies in educational material

covers conditions where the basis for the training (course compendium, simulator course, mock-up, etc) has been deficient in terms of the knowledge and skills required for correct execution of the job.

Appendix A: Classification for the root causes of incidents

The following codes are used during investigations and periodic HTO reviews:

A WORKING ENVIRONMENT
AA Deficient lighting/poor visibility
AB Poor cleaning
AC Cramped/stressful/hazardous working environment
AD Uncomfortable temperature and/or humidity
AE Strong winds/high waves
AF High level of noise

B WORK ORGANISATION
BA Insufficient time for work preparation
BB Insufficient time to do the job
BC Insufficient staffing/division of labour
BD Deficient personnel training/competence
BE Deficient planning/division of responsibility
BF Deficient preparation (work materials and documentation)
BG Deficient checking of operational readiness

C CHANGE MANAGEMENT
CA Deficient verification of operational readiness
CB Change not made/identified in time
CC Consequences of change incorrectly analysed
CD Deficient routines/change incorrectly made
CE Deficient information about changes made

D COMPANY MANAGEMENT/PLATFORM ORGANISATION
DA Policy/objectives not well defined/understood
DB Deficient safety culture
DC Deficient QA system
DD Deficient experience transfer
DE Deficient division of responsibility
DF Measures not taken in time/recurrence
DG Insufficient personnel resources for the commitment
DH Deficient maintenance programme
DI Deficient training programme
DJ Deficient testing programme
DK Deficient safety analysis
DL Deficient emergency preparedness

E ERGONOMICS/ TECHNICAL SOLUTION
EA Deficient/poor indication (difficult to read/hear)

EB Deficient/poor component labelling (hard to read)
EC Poor accessibility (calibration/testing/maintenance)
ED Poor ergonomics

F WORK SCHEDULE
FA Extensive overtime
FB Tiredness (from night working)
FC Stress

G COMMUNICATION
GA Work task not discussed
GB Potential risks not discussed/understood
GC Deficient turnover/communication
GD Start/interruption/end of task not communicated
GE Misuse of communication equipment/radio
GF Deficient/non-existent communication tools

H INSTRUCTIONS (all those in writing)
HA Deficient content
HB Deficient format
HC Illegible instruction
HD Instructions not updated/checked
HE Instructions missing

I SUPERVISORY METHODS
IA Deficient delegation of responsibility
IB Deficient supervision of the work
IC Expectations (self-checking, etc) not communicated
ID Too many tasks given to the same person
IE Giving more weight to time than to quality/safety
IF Insufficient contact with subordinates
IG Deficient transfer of experience

J WORKING PRACTICE/HUMAN FACTORS
JA Instructions/drawings not used
JB Non-conformance with instructions
JC Deficient preparation (use of wrong instructions, tools, etc)
JD Deficient self-checking to avoid errors
JE Erroneous/deficient use of equipment/tool
JF Human factors (tiredness, illness, motivation, etc)

K TRAINING/COMPETENCE
KA Deficient competence/practical experience
KB Deficient training/refreshing
KC Deficient training in procedures/routines
KD Deficient practical experience
KE Training not updated for changes
KF Deficiencies in educational material