HSE Human Factors Briefing Note No. 3

Humans and Risk

Briefing Note 1 – 'Introducing Human Factors' explains the background to these Briefing Notes.

A 'hazard' is anything that can cause harm (e.g. chemicals, electricity, working at height); 'risk' is the chance that someone could be harmed by the hazard. Any company will be able to manage risks better if it understands where the hazards are and how to control them.

Case study

"From the perspective of the individual facility manager, catastrophic events are so rare that they may appear to be essentially *impossible*, and the circumstances and causes of an accident at a distant facility in a different industry sector may seem *irrelevant*. However, while chemical accidents are not routine…..they are a monthly or even weekly occurrence, and there is much to learn from the story behind each accident."

"…when we look beyond the obvious to the underlying systemic causes of an accident, we see that *the same root and contributing causes* keep popping up again and again. This indicates that government and industry together are not doing a good enough job at sharing accident information and implementing lessons learned."

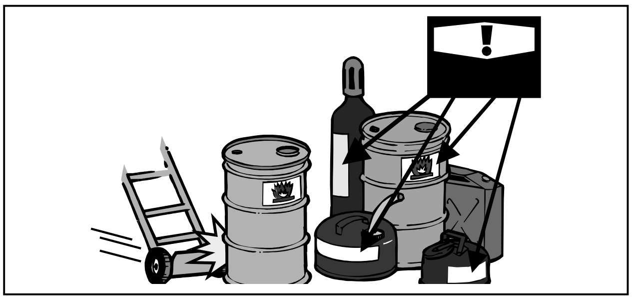
The investigation team quoted above reported these interesting findings:

- before each major accident, there was a series of similar accidents, near-misses and other failures
- new equipment had been installed before some of the accidents.

These two findings suggest that the companies involved did not investigate and learn lessons from earlier events and did not manage the change to the new equipment properly.

- the following root causes were responsible for many different accidents:
    - hazard review or process hazards analysis were inadequate
    - operators used inappropriate or poorly-designed equipment
    - indications of process condition were inadequate
    - management did not act on early warnings signs of problems.

"One common and useful method of determining root cause is to keep asking "why?" This method must be used with a good dose of engineering judgement. The idea is to ask "why?" enough times to get to the underlying systemic cause of the event, but not so many times that the cause becomes obscured in an overarching general concern which is too vague to address. This sort of over-analysis results in abstractions and doesn't serve any useful purpose."
Source: Ref.1



HSE concerns

Companies focus too much of their current risk management effort (performance measures, audits, behaviour modification) on low consequence high frequency events, such as single minor injuries caused by people tripping over.

More effort needs to be given to the lower frequency high consequence events such as large releases of hazardous chemicals. These are caused by underlying system failures and triggered, typically, by human error.

Most companies still use very basic methods for accident investigation, rarely looking beyond the immediate causes of the accident and with little supporting procedures or checklists for the investigation.

Your MAPP should describe how you identify major accident hazards and assess risks. It should also describe your system for reporting and investigating accidents and near misses (see Briefing Note 12)

The case study on the left shows that risk management and incident/accident investigation have a common aim: to find out what could lead to a loss of control over hazards.

This Briefing Note provides information on the reasons why you can sometimes lose control over hazards and what you can do to control them more effectively.

There is a brief checklist of best practices on page 4.

If you don't do a good risk assessment today, you may have to do an accident investigation tomorrow.

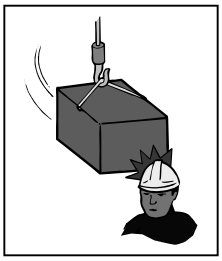
Learning more about humans and risk

'Humans and Risk' is used in this Guidance Note to describe the management system and human failures that can make people lose control over hazards. To prevent or reduce the chance of such failures, you have to know what the failures are and what causes them. These failures form a 'chain' that leads from people in the company who made decisions long before an incident or accident to the person who seems to be immediately responsible. You need to understand this chain and be able to move logically forwards along it – to do risk assessments; and backwards – to do accident investigations.

Slips, lapses, mistakes and violations

By directly observing people at work, specialists in human reliability found that there are four basic types of human failure. It is important to know that there are different types of failures, because there are slightly different ways of preventing each type.

Slip



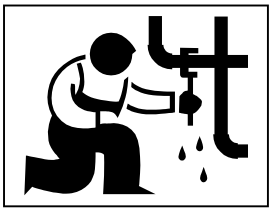
A simple frequently performed physical action goes wrong. You reach for 'button A' (which is the 'raise' control for a hoist) but push 'button B' (the 'lower' control) instead. On the control pad, Button B is below Button A. Your error lowers the object being moved onto electrical cables that carry a critical power supply to the plant. Another type of 'slip' is reading the wrong instrument. Again, if gauges are too close to each other, there is a risk of reading the wrong one. **Example solutions:** better layout of controls (and displays); design of controls to make it difficult to operate them accidentally; strict control so you never lift loads above vulnerable equipment (or physical barriers above if you can't avoid this).

Lapse

A lapse of attention or memory. At Step 9 in your 25-step start-up procedure the phone rings and you answer. Afterwards you go back to the task, forgetting where you were in the sequence. You miss out steps 10 and 11 and go straight to step 12. However, steps 10 and 11 are important safety precautions. **Example solutions:** provide written procedures that have 'place markers' or spaces to tick off each step. Supervise key tasks; and strictly enforce rules about interrupting staff on critical tasks.

Mistake

Not understanding properly how something works or an error of diagnosis or planning. Your plant starts to behave oddly - you notice fluid flowing in a waste pipe through a valve that you believed was closed. You try to work out why it's doing this and how to get the plant back to normal. You don't have exactly the right information or experience. Therefore, your diagnosis, and recovery plan, are wrong. You think the valve has been opened in error so you close it. This diverts fluid via an overflow to a tank. The maintenance crew in the tank had actually opened the valve manually to drain hazardous waste to a treatment vessel while they work. It was their error that they did not tell you, but your 'solution' sends the hazardous waste into their work area. **Example solutions:** increase the knowledge and experience applied to such problems (by improving operator competence or by ensuring that operators discuss complex situations in a group and later share knowledge around the plant); use special procedures that guide you to a safe solution.



Violation

A deliberate breach of rules and procedures; you are fitting a new pump and stores have given you the wrong type of seal. It's almost the same specification as the one you want. It would take too long to get the right one so you fit the one you have and leak test it. It works OK. After a few weeks of operation, the seal fails because it is not designed for that pump. **Example solutions:** learn from violations; improve culture and attitudes towards safety.

Risk management and incident/accident investigation logic

You can use this table in two ways. As a guide for incident and accident investigations, it shows the logic of working from what happened down to different underlying causes. As a guide to risk management, you work logically from hazards up to possible outcomes and see what factors could lead to a hazard happening. In the centre column, the words in brackets are an example case study about moving flammable gas bottles across a worksite.

INCIDENT/ACCIDENT INVESTIGATION (what did happen and how?)	INCIDENT OR ACCIDENT SEQUENCE	RISK MANAGEMENT (what could happen and how?)
Start here and work down the column		*Start at the bottom of the column and work up*
Gather facts about the accident or incident	**HARMFUL OUTCOME** (Personnel injured, plant damage by fire)	What is the worst case in terms of consequences of the events identified below?
What were the immediate causes of the harmful outcome? What happened just before the damage or injury?	**EVENT(S)** (1st operator pushes trolley into door post; 2nd gas bottles fall off and roll down stairwell; 3rd some bottles crack and ignite)	Could the human failures identified earlier still lead to release of the hazard? What are the likely consequences of those failures?
What barriers were reduced or removed that allowed the event to take place?	**BARRIER BETWEEN PEOPLE AND HAZARD** (Restraining straps are main barrier; operator competence is another)	Are there enough barriers in place to keep the hazard under control? Or does the risk of releasing this hazard still seem too high? What other barriers are needed?
What job, person or organisational factors contributed to the event? What particularly reduced the barriers against the hazard?	**PERFORMANCE INFLUENCING FACTORS** (Operator under time pressure – truck ready to go immediately)	What could happen to trigger a human failure on a particular day? Environment, operator fatigue, overload? What could we have lost control over?
What did the person(s) doing the critical task do (or not do) that reduced their control over the hazard?	**HUMAN FAILURES** (Operator does not fasten restraining straps; rushes to good lift)	Could a slip, lapse, mistake or violation lead to a major accident?
Were there any earlier human or system failures that contributed to the accident?	**LATENT FAILURES** (Operator is not fully trained; poor design of workplace (doors narrow); poor design of restraining device)	Are we confident that there are no 'latent failures' in our systems (that is, all job, person and organisational factors are adequate)?
What was the task meant to achieve? What were the critical aspects of the task (those things which the operator had to do to keep the hazard under control)?	**CRITICAL TASK** (To move 12kg propane bottles by trolley to load and dispatch area)	What are the 'critical tasks' involving this hazard? (A critical task being one where human failure could result in a harmful outcome).
What hazard needed to be kept under control? Can you remove the hazard or contain it? If not, did you design suitable systems of work or protective clothing/safety equipment to reduce risk?	**HAZARD** (Flammable gas – propane)	What hazards do we have on this site? Make a list. Take each one in turn and move up this column. ***Start here and work up the column***

Risk management and incident/accident investigation checklist

The list below outlines how good companies approach risk management and incident/accident investigation.

At this site we:

- Have a thorough risk management process and… ☐
- …use experienced risk assessors either from within the company or brought in from outside the company to do the assessment ☐
- …have identified all hazards and risks in every job we do (including normal operational, maintenance and emergency tasks and supervision/management tasks) ☐

And using these resources we…

- Know which parts of every job are ‘safety critical’ (where an error could reduce our control over hazards) ☐
- Know fairly accurately how likely it is that a task could go wrong and cause an accident ☐
- Are confident that we have put in effective barriers that reduce the risk of a hazard causing harm to a level that is as low as is reasonably practicable ☐

We also:

- Thoroughly and systematically investigate all accidents and near-misses ☐
- Can clearly identify the causes of accidents and incidents we investigate ☐
- Use an accident ‘model’ that separates causes into system/‘latent’ and ‘immediate’ human failures ☐
- Have good system to allow personnel to report incidents and accidents ☐
- Always act on information put into the system…… ☐
- … feed back information to personnel about reports put into the system ☐
- ….provide solutions following an incident or accident that everyone accepts and that are effective in addressing immediate and underlying causes of the incident or accident ☐
- Have highly competent incident/accident investigators with extensive procedures and checklists to help them ☐
- Use information from the system to update our risk assessments ☐

Root causes are the underlying prime reasons for an accident or incident. For example, failures of particular management systems allow faulty design, inadequate training, or deficiencies in maintenance to exist. These, in turn, lead to unsafe acts or conditions which can result in an accident. Contributing causes are factors that, by themselves, do not lead to the conditions that ultimately caused the event. However, these factors facilitate or encourage the occurrence of the event or increase its severity.

People may debate whether particular factors should be classed as root causes, contributing causes, or neither. However, major accidents generally involve more than one root cause. “Virtually none of the accidents investigated involved only a single cause. More commonly, half a dozen root and contributing causes were identified.
Source: Ref. 1

Some principles of error management

- "Human error is both universal and inevitable"
- "Errors are not intrinsically bad"
- "You cannot change the human condition, you can only change the conditions in which people work"
- "The best people make the worst mistakes"
- "People cannot easily avoid those actions they did not intend to commit"
- "Effective error management aims at continuous reform rather than local fixes."

Source: Ref. 4

References

1. James C. Belke, 'Recurring Causes of Recent Chemical Accidents', U.S. Environmental Protection Agency Chemical Emergency Preparedness and Prevention Office. Presented at an International conference and Workshop on Reliability and Risk Management organised by IChE/CCPS in September 1998, San Antonio, Texas
2. HSE (1998) 'Five steps to risk assessment: case studies' HSG183, ISBN 0 7176 1580 4
3. HSE (2000), 'Human Factors Assessment of Critical Tasks'. OTO 1999 092
4. Reason, J. & Hobbs, A. (2003), 'Managing Maintenance Error', Ashgate, London.