RRC INTERNATIONAL

nebosh
Endorsed

RRC
Sample
Trainer Pack

MANAGEMENT OF INTERNATIONAL OIL AND GAS OPERATIONAL SAFETY

A GUIDE TO THE NEBOSH INTERNATIONAL TECHNICAL CERTIFICATE IN OIL AND GAS OPERATIONAL SAFETY

Fourth Edition

ENDORSED BY NEBOSH

NEBOSH
International Technical Certificate in Oil and Gas Operational Safety Unit IOG1

Sample Contents

RRC International

27-37 St George's Road
London SW19 4DS
United Kingdom

T: +44 20 8944 3100

E: info@rrc.co.uk

W: www.rrc.co.uk

NEBOSH
International Technical Certificate in Oil and Gas Operational Safety Unit IOG1

Introduction to the RRC Sample Resource Pack

RRC's Trainer Packs have been designed to include all the resources you need to deliver the NEBOSH International Technical Certificate in Oil and Gas Operational Safety course.

The full pack - of which this is a sample - includes the following resources:

- An electronic copy of the RRC study text (course notes) for the course, supplied for use by the tutor as reference only.
- Daily lesson plans (MS Word) - a suggested breakdown of how the detailed subjects specified in the qualification syllabus will be covered on each day of the course.
- Slides (MS PowerPoint) - full colour slides addressing the subjects specified in, and following the structure of, the qualification syllabus.

Some third-party resources may be suggested in the Lesson Plans, or in the notes to the slides - for example, video footage, further reading, etc. These are not essential and they are not included as part of the licensed Trainer Pack - it is up to the tutor to source the suggested material, should he or she wish to do so.

This 'Sample Trainer Pack' contains a selection of pages from the lesson plan, a number of corresponding slides, and the relevant pages from the study text. These pages and slides are representative of the presentation, design and language of the full materials.

For more information, please contact RRC's customer advisers on 020 8944 3100 or e-mail info@rrc.co.uk

RRC International

27-37 St George's Road
London SW19 4DS
United Kingdom

T: +44 20 8944 3100

E: info@rrc.co.uk

W: www.rrc.co.uk

RRC INTERNATIONAL

NEBOSH
International Technical Certificate in Oil and Gas Operational Safety
Unit IOG1

Sample Classroom Lesson Plan

RRC International

27-37 St George's Road
London SW19 4DS
United Kingdom

T: +44 20 8944 3100

E: info@rrc.co.uk

W: www.rrc.co.uk

NEBOSH International Technical Certificate in Oil and Gas Operational Safety

IOG1 (2010 syllabus) Full Course (5-Day Delivery)

This lesson plan is based on the requirements of the NEBOSH International Technical Certificate in Oil and Gas Operational Safety Specification and is designed as a guide for tutors in planning their teaching of the course.

The lesson plan is based on 5 days of teaching with teaching time of between 6.5 and 7.5 hours per day. Where the teaching time allocated does not match the NEBOSH recommended hours, clear guidance is given as to the required "Directed Study" to ensure the NEBOSH taught hours are met. This is in addition to Private Study.

The lesson plan can be easily adapted for other delivery structures, extending the number of days or delivering in shorter sessions.

The duration is based on NEBOSH Guidance and reflects the recommended teaching times. Whilst NEBOSH expect Lesson Plans that comply with the recommended study hours, in practice individual sessions can be shortened and extended depending on the experience, pre-knowledge and English language skills of the students in a particular group.

Lesson Plan Front Sheet

Tutor:	**Course Title and Topic:** NEBOSH International Technical Certificate in Oil and Gas Operational Safety - IOG
Venue:	**Date & Time:**
Number of Adult Learners:	**Knowledge/Ability assumed:** This 5-day course has been developed to fulfil the requirements of Unit IOG1 of the 2010 syllabus version of the NEBOSH International Technical Certificate in Oil and Gas Operational Safety. It is likely that some students will have practical experience of some of the issues covered in the course. Others are likely to have little or no knowledge of the subject matter. In the introduction at the start of the course, the individual students' present knowledge level should be assessed.
Course Duration: **33.75 Taught Hours** **3 Hours Directed Study**	

Lesson Aims - *the aims of the session are to*:
As per NEBOSH syllabus guide

Objectives (learning outcomes) - *by the end of the session students should be able to*:
As per NEBOSH syllabus guide, stated at start of each element on slides.

Brief reasoning for the way the lesson has been planned:
The following are guidelines on how the course should be taught. Different tutors obviously have different styles and experiences and these should be taken into account when delivering the course. To keep the students interested, a variety of different methods should be used and the tutor should not rely solely on slides.

Any constraints:
- The course will require students to undertake some research.
- They will require at least some access to the Internet resources for this purpose.

Equipment/Aids to be used:
- Computer (with Internet and sound capability), data projector, flip charts/whiteboard.
- Use of PPT presentations. Though PPT slides exist for most (if not all) subjects covered, they should be used judiciously rather than exclusively.
- Internet access.
- Students are provided with a set of printed course notes.
- Tasks are stated on PPT slides (these are, with a few exceptions, short activities to assist students' learning; tutor's decision on how they should be delivered, e.g.

class discussion, student group work, and student solo work).
- Prepared Workshop sheets are available for most elements of the course (these are usually more in-depth learning activities than tasks).
- Questions set for directed study may constitute study questions and exam skills questions in textbook, RRC mock exam questions or other relevant questions - tutor to make the decision.

IOG Day 1

7.5 Taught Hours
1 Directed Study Hour

TIME	DURATION (MINS)	CONTENT AND TUTOR ACTIVITY	AIDS AND EQUIPMENT	STUDENT ACTIVITY
9.00-9.20	**20**	Introduction to the course - Overview and aims. Note: Students to be given a copy of the textbook if not already received.	Flip chart	Listening
9.20-11.20	**120**	**ELEMENT 1: HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT IN CONTEXT**		
		1.1. Learning from Incidents - **Group Discussion: Why investigate accidents and near-misses? Should we apply the same level of investigation for each?** - Types of Incident - Basic Investigation Procedures - Learning from Incidents - The importance of learning lessons from major incidents - The failures that lead to such incidents - **Resources: IOG Element 1.1 Exercise Learning from Incidents** Play video clip of Piper Alpha & analyse & discuss the incident and understanding of the initial (immediate) and root (underlying) causes. Students to complete the exercise/tabulation during/after the video to	Slides Notes Resources Video	Listening and contributing to discussions and exercises

		understand the management, cultural and technical failures that contributed to the incident.		
11.20-11.35	**15**	**MORNING BREAK**		
11.35-13.35	**120**	1.2. Hazards Inherent in Oil and Gas - Meaning and relevance of terms and definitions regarding flammability and toxicity - **Resources: IOG Element 1.2 Exercises** Hazards inherent in Oil & Gas Exercise 1: In pairs review your notes and then summarise and define the following properties and hazards and the significance of how they could be used in, or apply to the oil and gas industry. Be prepared to explain to the group your understanding of these properties and hazards as selected by your tutor. - The properties and hazards of gases - **Resources: IOG Element 1.2 Exercises** Hazards inherent in Oil & Gas Exercise 2: In pairs review your notes and then summarise and define the following properties and hazards and the significance of how they could be used in, or apply to the oil and gas industry. Be prepared to explain to the group your understanding of these properties and hazards as selected by your tutor.	Slides Notes Resources	Listening and contributing to discussions and exercises
13.35-14.05	**30**	**LUNCH BREAK**		
14.05-15.35	**90**	1.2. Hazards Inherent in Oil and Gas (continued) - The properties and hazards of associated products and control measures - **Resources: IOG Element 1.2 Exercises Hazards inherent in Oil & Gas** **Exercise 3:** In pairs review your notes and then summarise and define the following properties and hazards and the significance of how they could be used in, or apply to the oil and gas industry. Be prepared to explain to the group your understanding of these properties and hazards as selected by your	Slides Notes Resources	Listening and contributing to discussions and exercises

		tutor.		
15.35-16.35	**60**	1.3. Risk Management Techniques - The purpose and use of risk management techniques - How to apply risk management tools - **Resources: IOG Element 1.3 Exercises** Risk Management Techniques In pairs review your notes and identify the key principles of the following quantitative techniques: HAZOP, HAZID, FMEA	Slides Notes Resources	Listening and contributing to discussions and exercises
16.35-16.50	**15**	AFTERNOON BREAK		
16.50-17.50	**60**	1.3. Risk Management Techniques – continued - Industry related process safety standards - The concept of hazard realization - Risk control and barrier models - Use of modelling for risk identification	Slides Notes	Listening and contributing to discussions
17.50-18.00	**10**	End of session summary and close		

IOG Day 1 - Self-reflection	
Assessment of Learning – how will I tell whether learning has taken place? By: ● Continuous assessment through Q&A and discussions. ● Assessment through participation in workshops.	**Directed Private Study Set:** • Time: Element 1.1 – 30mins Element 1.2 – 30mins • Set a relevant question(s) for homework. • Self-revision of key principles from element(s) covered today. • Students to look at websites identified in course notes under 'More...' sections.
Lesson Evaluation – how did the lesson go? Any changes? Etc.	

IOG Day 2

6.5 Taught Hours
1 Directed Study

TIME	DURATION (MINS)	CONTENT AND TUTOR ACTIVITY	AIDS AND EQUIPMENT	STUDENT ACTIVITY
9.00-9.20	**20**	Review answers to questions from previous evening directed private study. Overview of previous day training	Flip chart	Whole group feedback on answers
9.20-10.50	**90**	**ELEMENT 1: HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT IN CONTEXT (continued)**		
		1.4. An Organisation's Documented Evidence - Examples of documented evidence (safety cases and reports) - Where such evidence is used - The purpose of such documented evidence	Slides Notes	Listening and contributing to discussions
10.50-11.05	**15**	**MORNING BREAK**		
11.05-12.05	**60**	1.4. An Organisation's Documented Evidence (continued) - The content of safety case and safety report documents	Slides Notes	Listening and contributing to discussions

NEBOSH
International Technical Certificate in Oil and Gas Operational Safety
Unit IOG1

Sample PowerPoint Slides

RRC International

27-37 St George's Road
London SW19 4DS
United Kingdom

T: +44 20 8944 3100

E: info@rrc.co.uk

W: www.rrc.co.uk

RRC INTERNATIONAL

Learning from Incidents

Why investigate accidents and near-misses?

Should we apply the same level of investigation for each?

RRC INTERNATIONAL

Learning from Incidents

Types of Incident:

- Near-miss
- Accident
  - Injury accident
  - Damage-only accident
- Dangerous occurrence
- Ill-health

RRC INTERNATIONAL

Learning from Incidents

FIRST: Treat Injured, Secure/Make Safe

Basic Investigation Procedures

Step 1: Gather facts.

Step 2: Analyse to determine immediate and root/underlying causes.

Step 3: Identify suitable corrective measures.

Step 4: Plan the remedial actions.

Learning from Incidents

Step 1: Gathering Information

- Secure the scene.
- Identify and interview witnesses.
- Collect factual information.
- Check documentation.

RRC INTERNATIONAL

Learning from Incidents

Step 2: Analysing Information

Draw conclusions about the **immediate** and **root/underlying** causes.

Immediate causes	Underlying or root causes
*E.g. a worker slips on a puddle of oil spilt on the floor – immediate causes are the slip hazard (**unsafe condition**) and the worker walking through it (**unsafe act**).*	*E.g. the failure to adequately supervise workers or provide appropriate PPE.*

Step 3: Identify Suitable Control Measures

Remedy immediate and root/underlying causes.

Learning from Incidents

Step 4: Plan the Remedial Actions

- What must be done to fix the problems?
- What must be done as an interim measure?

(To remedy immediate and underlying/root causes)

Recommended action	Priority	Timescale	Responsible person

RRC INTERNATIONAL

Learning from Incidents

Cost of the remedial actions

Remedial Costs	Ongoing Costs
• Buying personal protective equipment • Providing adequate storage • Putting in place inspection and maintenance programmes	• Carrying out regular inspections • Replacing PPE as it wears, etc. • Maintaining the storage facility, with ongoing training for operators

RRC INTERNATIONAL

Learning from Incidents

- Bhopal (1984) – Toxic-gas release
- Piper Alpha (1988) – Explosion and fire
- Esso Longford (1998) – Gas leak, explosion and fires
- Buncefield (2005) – Oil-storage depot explosions and fire
- Deepwater Horizon (2010) – Explosion, fire and oil spill

RRC INTERNATIONAL

Learning from Incidents

The Importance of Learning from Major Incidents

Piper Alpha incident:

- **Permit-to-Work systems**
- **Safety Management**
- **Rig Design**
- **Maintenance Systems**
- **Safety Training**
- **Safety Audits**

Learning from Incidents

The outcomes of other incidents include:

- **Bhopal, India - Toxic gas release (1984)**: 2,700 dead; 50,000 seriously affected; 1,000,000 others less seriously affected.
- **Buncefield, UK (2005):** 40 injuries; widespread damage.
- **Deepwater Horizon Oil Spill, Gulf of Mexico (2010)**: 11 dead; major oil spill and environmental damage.

RRC INTERNATIONAL

NEBOSH
International Technical Certificate in Oil and Gas Operational Safety
Unit IOG1

Sample Study Text

RRC International

27-37 St George's Road
London SW19 4DS
United Kingdom

T: +44 20 8944 3100

E: info@rrc.co.uk

W: www.rrc.co.uk

RRC INTERNATIONAL

nebosh Endorsed

RRC Sample Study Text

MANAGEMENT OF INTERNATIONAL OIL AND GAS OPERATIONAL SAFETY

A GUIDE TO THE NEBOSH INTERNATIONAL TECHNICAL CERTIFICATE IN OIL AND GAS OPERATIONAL SAFETY

Fourth Edition

ENDORSED BY NEBOSH

Learning from Incidents

KEY INFORMATION

- Investigating incidents is important, as is effective root-cause analysis and the recommendation of improvements, in order to make every effort to avoid future incidents.
- Lessons can be learnt from major incidents, especially with regard to management, and from cultural and technical (process) failures that lead to incidents occurring.
- Incidents can take many forms, including near-misses, accidents, dangerous occurrences and ill-health conditions.

Investigating Incidents

When an incident occurs in the workplace, it should be recorded and investigated. The main reason for this is that, having happened once, it may happen again; and when it happens again the outcome may be as bad as, or worse than, it was the first time. We must therefore attempt to understand exactly why the incident happened so that corrective actions can be taken to prevent a recurrence.

All incidents and near-misses in the workplace should be recorded and investigated.

Near-misses are an indicator of potential consequences - what might have been. Often, the only thing that separates a near- miss from an accident is luck - so regard each near-miss as a “free warning”.

All near-misses should be examined to determine the potential for serious harm. Where this potential exists, a thorough investigation should be carried out to prevent that harm from becoming actual. This is not to say that all incidents should be investigated in great depth and detail - that would be a waste of time and effort in many cases - but it is to say that all incidents should be examined for the potential for serious harm so a decision can be made as to whether more detailed investigation is required. This idea is sometimes formalised into an organisation’s incident investigation procedure.

The objective of any such investigation is to determine why the organisation’s policies and procedures failed. Consequently the incident investigation process is an important part of the health and safety management system. As it is management who ultimately make the decisions and allocate resources, it is vitally important that they are actively involved at every step of the investigation process, including making sure that any recommendations are fully implemented and closed out.

TOPIC FOCUS

Reasons for carrying out an incident investigation:

- **To identify the immediate and root causes of the incident** - incidents are usually caused by unsafe acts and unsafe conditions in the workplace, but these often arise from underlying, or root causes.
- **To identify corrective actions that will prevent a recurrence** - the main reason for investigating.
- **To record the facts of the incident** - people do not have perfect memories and investigation records document the factual evidence for the future.
- **For legal reasons** - incident investigations can be an implicit legal duty imposed on the employer.
- **For claims management** - if a claim for compensation is lodged against the employer the insurance company will want to examine the incident investigation report to help determine liability.
- **For staff morale** - non-investigation of incidents has a detrimental effect on morale and safety culture because workers will assume that the organisation does not value their safety.
- **For disciplinary purposes** - although blaming workers for incidents has a negative effect on safety culture, there are occasions when an organisation has to discipline a worker because their behaviour has fallen short of the acceptable standard.
- **For data-gathering purposes** - incident statistics can be used to identify trends and patterns; this relies on the collection of good-quality data.

Types of Incident

- Near-miss - an unplanned event that had the potential to cause injury, ill health, loss or damage but did not, in fact, do so (a worker was narrowly missed by oil spurting from a burst pipeline).
- Accident - an unplanned, unwanted event, which leads to injury, damage or loss.
  - Injury accident - where an unplanned, unwanted event leads to some sort of personal injury (e.g. a cut hand).
  - Damage-only accident - where the unplanned, unwanted event leads to equipment or property damage, or loss of materials, etc. (e.g. a wall is knocked down by a vehicle).
- Dangerous occurrence - a specified event that has been reported to the relevant authority by statute law (e.g. a major gas release).
- Ill health - a disease or medical condition that is directly attributable to work (e.g. dermatitis from exposure to oils and greases).

It is important to remember the importance of investigating all of the above types of incident, not just those we expect to lead to fatalities, or major injury.

Basic Investigation Procedures

There are some basic principles and procedures that can be used when investigating an incident:

Step 1: Gather factual information about the event.

Step 2: Analyse that information and draw conclusions about the immediate and root causes.

Step 3: Identify suitable corrective measures.

Step 4: Plan the remedial actions.

However, before the investigation can begin there are two important issues that have to be considered:

- **Safety of the scene** - is the area safe to approach? Is immediate action needed to eliminate danger even before casualties are attended to?
- **Casualty care** - any injured people will require first-aid treatment and possibly hospitalisation. This is a priority. The welfare of uninjured bystanders also has to be taken into account - they may be suffering shock.

Once the immediate dangers have been dealt with and casualties attended to, a decision should be made regarding the type and level of investigation that is needed. Should it be:

- A relatively simple investigation of an incident that caused only minor outcomes and did not have the potential for serious outcomes?
- A more in-depth and thorough investigation of an incident with serious outcomes or potential for serious outcomes?

The first type of investigation might be carried out by the line manager of the area; the second type often involves a team of investigators, which might include a safety specialist, senior managers, a technical specialist and perhaps a worker representative.

Offshore investigating teams may also include installation specialists from services such as drilling, well services, maintenance, process, and deck crews. In the most serious or major cases, an inspector from the national safety enforcing agency (for example, the Health and Safety Executive in the UK) may become involved and conduct or lead an investigation.

Step 1: Gathering Information

- Secure the scene as soon as possible to prevent it being altered.
- Collect witnesses' details quickly, before they start to move away. In some cases, it may help to remove witnesses from the scene and ask them to wait in a separate area. If there are many witnesses it may be better to separate them from each other to prevent collusion or contamination of their testimony.
- Collect factual information from the scene and record it. This might be done by means of:
  - Photographs.
  - Sketches.
  - Measurements.
  - Videos.
  - Written descriptions of factors such as wind speed, temperature, etc.
  - Taking physical evidence.

  The investigator should come prepared with the appropriate equipment to record this information.

The investigator should collect factual information from the scene and record it

- Once the scene has been thoroughly examined, move on to the second source of information: witnesses.

  Witnesses often provide crucial evidence about what occurred before, during and after incidents. They should be interviewed carefully to make sure that good-quality evidence is gathered.

  Once witnesses have been interviewed, move on to the third source of information: documentation. Various documents may be examined during an incident investigation, such as:
  - Company policy.
  - Risk assessments.
  - Training records.
  - Safe systems of work.
  - Permits-to-work.
  - Maintenance records.
  - Disciplinary records.
  - Internal accident report forms.
  - Log-book entries.
  - Computer printouts relevant to the situation.

TOPIC FOCUS

Good witness-interview technique requires that the interviewer should:

- Hold the interview in a quiet room or area free from distractions and interruptions.
- Introduce themselves and try to establish rapport with the witness using appropriate verbal and body language.
- Explain the purpose of the interview (perhaps emphasising that the interview is not about blaming people).
- Use open questions, such as those beginning with What? Why? Where? When? Who? How? etc. that do not put words into the witnesses' mouths and do not allow them to answer with a "yes" or "no".
- Keep an open mind.
- Take notes so that the facts being discussed are not forgotten.
- Ask the witness to write and sign a statement to create a record of their testimony. Thank the witness for their help.

Step 2: Analysing Information

The purpose here is to draw conclusions about the immediate and root causes of the incident.

Immediate causes are the obvious causes that gave rise to the event itself. These will be the things that occurred at the time and place of the accident. For example, a worker slips on a patch of oil spilt on the floor, injuring his back as he falls backwards and hits the ground. The immediate cause of the back injury is hitting the ground, but there are many contributors to this cause. It is common to think of these in terms of unsafe acts and unsafe conditions. So here, for example, we might have the slippery oil (unsafe condition), and the worker walking through it (unsafe act).

Underlying or root causes are the things that lie behind the immediate causes. Often, root causes will be failures in the management system, such as:

- Failure to adequately supervise workers.
- Failure to provide appropriate PPE.
- Failure to provide adequate training.
- Lack of maintenance.
- Inadequate checking or inspections.
- Failure to carry out proper risk assessments.

Accidents that happen in workplaces usually have at least one immediate cause and one underlying or root cause, often more. The root cause gives rise to the immediate cause, which, in turn, gives rise to the accident (rather like a row of dominoes falling; in fact, this idea is often referred to as the Domino Theory of accident causation).

If that one root cause is identified and dealt with, then the accident should not happen again. For example, if a worker twists their ankle in a pothole in the pavement then the obvious solution is to fill the pothole in. That deals with the immediate cause. It would also be worth asking how long the pothole had been there. If it had been there for a long time, why was it not spotted sooner? And if it had been spotted, why had it been left unrepaired with no interim measure being taken to protect people?

These questions might identify an underlying cause such as inadequate inspection and maintenance, or failure to put interim measures in place while waiting for maintenance work to be carried out. Any such root cause needs to be dealt with if similar accidents are to be prevented in future.

In contrast to this single-cause idea, some workplace accidents are complex and have multiple causes: there are several immediate causes for the accident and each of these has one or more underlying or root cause. This idea is usually referred to as Multi-Causation Theory.

EXAMPLE 1 (ONSHORE)

A WORKER MIGHT BE STRUCK BY A LOAD BEING CARRIED BY A FORKLIFT TRUCK.

Immediate causes for such an accident might be:

- Failure to secure the load on the pallet.
- Poor road positioning of the truck close to a pedestrian exit.
- Aggressive braking by the truck driver.
- An inattentive pedestrian stepping out in front of the truck.

On investigation, each of these immediate causes might have their own separate root causes, such as:

- No training for the driver, who is new to the workplace, has not worked with this type of load before and is unaware of the load-securing technique required.
- Lack of segregation of pedestrian and traffic routes; no barriers and no markings to separate the two.
- Lack of proper driver induction into their new workplace, so they are unaware of the layout and position of pedestrian exits, etc.
- Poor maintenance of the truck.
- No refresher training for existing staff, meaning that experienced staff have become complacent.

If there are multiple causes for the accident then it is important that each of these causes is identified during the investigation; otherwise, incomplete remedial action will be taken and similar accidents may happen in the future.

EXAMPLE 2 (ONSHORE/OFFSHORE)

A WORKER SLIPS ON A PATCH OF SPILT OIL.

Immediate causes:

- The slip hazard (unsafe condition).
- The worker walking through the oil (unsafe act).

With such a slip, the root causes might be a poorly maintained machine that has leaked oil onto the floor, and a poorly inspected and maintained workshop (where the oil leak was) with broken light fittings and inadequate lighting levels. Here, the worker might be blameless on the basis that, given those conditions, the incident was bound to happen eventually.

EXAMPLE 3 (OFFSHORE)

A LIFTING SLING BREAKS ON THE DRILLING DECK.

Immediate causes:

- A damaged and worn sling (unsafe condition).
- A worker using the sling in poor condition (unsafe act).

With this offshore scenario, the root causes again fall to poorly maintained equipment, with a less than adequate inspection and sling replacement system, together, perhaps, with inadequate storage of lifting equipment, possibly exposing it to a harsh environment, being dropped on the deck, not hung up, etc. In this case, there is some responsibility on the worker not to use a sling that is in poor condition. The fact that they did use it could be a result of lack of training in care and use of lifting equipment.

Consequences could have been many, including dropping equipment over the side into the sea, striking a worker (or workers) on the drilling rig beneath the sling, damage to plant on the drilling deck, etc.

Step 3: Identify Suitable Control Measures

Once the immediate and underlying causes of the accident are known, appropriate control measures can be identified. It is important that the correct control measures are established, otherwise time, money and effort will be wasted on inadequate and unnecessary measures that will not prevent similar occurrences in the future.

Control measures must be identified to remedy both the immediate and underlying causes. Immediate causes are usually easy to identify - if there is a spill of oil on the floor, clean it up; if the guard is missing from the machine, reattach it.

Underlying causes can be harder to determine because they reflect failure of the management system, but it is essential that the correct control measures to remedy the failure of the management system are identified because this will help prevent similar accidents occurring in similar circumstances across the entire organisation:

- Clean up the oil leaking out of the vehicle in the distribution depot but fail to deal with the underlying cause (lack of inspection and maintenance) and more leaks will occur which, in turn, will lead to more pedestrian slips (and perhaps, more alarming, vehicle skids).
- Clean up the oil leaking out of the vehicle and deal with the underlying cause (by introducing a proper inspection and maintenance system) and there is a good chance that most oil leaks will be prevented in the future for all vehicles in the fleet at all locations.

Perhaps the most important questions to ask when identifying control measures are:

- If this action is taken, will it prevent this same accident from happening in exactly the same way at this location?
- If this action is taken, will it prevent other similar types of accident from happening in similar locations in the future?

If the answer to both of these questions is "no", then you need to identify other control measures.

Step 4: Plan The Remedial Actions

An accident investigation should lead to corrective action being taken, in just the same way as a workplace inspection will.

Remedial actions can be presented in an action plan:

Recommended action	Priority	Timescale	Responsible person
Introduce induction training for all new drivers	Medium	1 month	Warehouse manager
Introduce new inspection and maintenance system	High	1 week	Maintenance manager

When the action plan is being prepared, appropriate immediate and interim control measures must be given suitable priorities and timescales. Unsafe conditions must not be allowed to persist in the workplace. Dangerous practices and high-risk activities must be dealt with immediately. This means that immediate action must be taken to remedy such circumstances when they are discovered. Machinery and equipment may have to be taken out of action, certain work activities suspended, and locations evacuated. These responses cannot be left until the investigation has been completed. They will have to be implemented immediately to ensure safety while the investigation is in progress.

There may be interim control measures that can be introduced in the short to medium term to allow work to proceed while longer-term solutions are pending. For example:

- Hearing protection might be introduced as a short-term control measure until the maintenance of a piece of machinery that is producing excessive noise has been completed.
- A perimeter guard might be fitted around an overheating machine that would ordinarily be protected with a fixed enclosed guard while new cooling units are sourced and delivered.

Underlying causes will often demand significant time, money and effort to remedy. It is essential, therefore, that the remedial actions that will have the greatest impact are prioritised and timetabled first. There may be actions that have to be taken (to address a management weakness, or to achieve legal compliance) that will not be as effective in preventing future accidents. These actions should still be taken, but with a lower priority.

Cost Of Remedial Actions

It is worth bearing in mind that there is always an element of cost involved when taking remedial action. Remember that there will not only be immediate costs, but also ongoing costs.

An example of this would be the simple matter of providing personal protective equipment. If a task required respiratory protection to be worn, in the form of half-masks with replaceable filters, the initial cost would be for the masks and filters themselves, face-fit tests for users of the masks, storage facilities such as boxes, cases or cupboards, and the ongoing requirements for regular formal inspections of the masks by the users. Also ongoing would be the cost of replacing the filters and, eventually, the masks.

Where slings were not being cared for on an offshore installation, the remedial costs could be a supply of new slings, training for all users of lifting equipment, the introduction of a formal inspection, examination and testing programme, and new storage facilities away from harsh conditions. Ongoing costs would be regular supervision, maintenance of the storage facility, the regular inspection, examination and testing programme and occasional replacement of slings.

Importance Of Learning From Major Incidents

It is vital that lessons are learned from all major incidents, as management, cultural and technical failures (i.e. process failures) must be understood so that incidents can be prevented from happening again.

There is much to be learned from investigations carried out into internal incidents, but the outcomes of other incidents also provide important information. An old saying in health and safety is: "There is no such thing as an accident - only a management failure." But remember that this statement is not laying the blame for incidents on managers. Instead, it suggests that health and safety was managed poorly overall by having inadequate safety systems in place.

For instance, an action as simple as misplacing a permit-to-work certificate was just one of the root causes of the Piper Alpha incident in the North Sea. There are other parallels that can be drawn from Piper Alpha, too, in management, cultural and technical failures that contributed to the loss of the oil rig and 167 lives.

The Piper Alpha Disaster

On the morning of 6 July 1988, as part of a maintenance programme, a gas-pump pressure safety valve was removed from the processing area and, as the work could not be completed that day, a blanking plate was fitted over the end of the pipe where the pump had been removed. That evening, another pump failed. Without the engineers knowing (possibly owing to the loss of a permit-to-work certificate) the safety valve was still off the process, and when they tried to start it the escaping gas exploded, penetrating the firewalls. Gas and oil pipes suffered in the heat and provided further fuel to the growing fire.

Although there was an automatic deluge sprinkler system in place, which could pump hundreds of tons of sea water onto a fire, it was switched off because divers had been in the water, and it could only operate manually. It was not switched back on to automatic, and when it was needed it did not operate.

Twenty minutes after the initial explosion, large-diameter gas pipes (up to 900mm) weakened and burst, releasing gas at two thousand pounds per square-inch pressure, increasing the size of the fire.

A rescue boat arrived, but could not deploy its equipment quickly as it shut down when turned on, so this did not provide assistance quickly enough.

Many workers took refuge in the accommodation block but the coming and going and opening of doors allowed smoke in. The accommodation block was not smoke-proofed. By this time no one could get to the lifeboats, so many workers went to the extremities of the rig and jumped into the sea. Sixty-two people survived by taking this action. The accommodation block slipped into the sea, and a major part of the platform followed it.

The other 167 people on the rig lost their lives in the disaster. The whole incident occurred in just 22 minutes, the after-effects continuing into the night.

MORE...

You can find out more about the Piper Alpha disaster by referring to:

The Public Enquiry into the Piper Alpha Disaster, Cullen, The Honourable Lord, The Stationery Office, 1990, ISBN 9780101131025

A Lesson Learned

This incident was instrumental in bringing about the introduction of the **Offshore Installations (Safety Case) Regulations 2005** in the UK (see later), and the regulatory control of offshore installations was taken over by the Health and Safety Executive (HSE) in 1991.

Some of the problems highlighted and lessons learned from the Piper Alpha disaster include:

- **Permit-to-Work Systems** - (paperwork systems used in high risk situations to control activities by closely monitoring the work carried out). The Piper Alpha systems had been relaxed, allowing less formal systems to operate, particularly relating to control of permits and communication at the shift hand-over. Proper adherence to the formal system and close control at the shift hand-over would have retained the hand- over permit and prevented the pump without the safety valve ever being started, so averting the disaster. Following Piper Alpha, the introduction of a permit co-ordinator and facilities for permitry were instigated. Control-room competencies were also subject to review.
- **Safety Management** - vital in any industry, but more so in high-risk industries such as this, it was shown (in Lord Cullen's report on the disaster) to be lacking. It was described as "superficial". Not all managers had adequate qualifications, and they tolerated poor practices and did not appear to audit systems properly. The delays in decision- making allowed oil production to continue from other connected platforms while the fire raged on Piper Alpha.
- **Design** - when the original oil exploration rig was adapted for gas processing, no changes were made to the firewalls. The original ones were capable of withstanding fire, but were not built to withstand an explosion, and they were breached in the gas explosions.

  Closely tied in with design was the number and size of pipelines on and attached to the platform, which helped feed the fire.
- **Maintenance Systems** - closely associated with the permit- to-work system:
  - Proper maintenance procedures would have prevented the pump being started without the safety valve.
  - Closer control of the deluge system would have controlled its switching off while divers were in the water, and switching on when the area was clear.
  - Closer attention to audit and inspection reports would have meant that corroded sprinkler pipes and heads were repaired or replaced.
- **Safety Training** - some workers who ignored what they were taught survived by not entering the accommodation block, which eventually failed and sank into the sea. But, in general, training in emergency procedures on and off the platform was lacking. In particular, management leadership was especially inadequate in dealing with such emergencies.
- **Safety Audits** - as in all areas of offshore operations, audits are many and complex. The audits in Occidental Petroleum's North Sea field were in place and carried out on a regular basis, but they were not carried out satisfactorily. They identified few problems, possibly even overlooking issues such as corroding sprinkler deluge pipework. Some issues highlighted in audits were just ignored.

In the UK HSE publication HSG48, *Reducing Error and Influencing Behaviour*, the human contribution and other causes of the Piper Alpha disaster are summarised as:

"Formal inquiry found a number of technical and organisational failures. Maintenance error that eventually led to the leak was the result of inexperience, poor maintenance procedures and poor learning by the organisation. There was a breakdown in communications and the permit-to-work system at shift changeover and safety procedures were not practised sufficiently."

Source: HSG48 Reducing Error and Influencing Behaviour (2nd ed.), HSE, 1999 (www.hse.gov.uk/pubns/books/hsg48.htm)`

Toxic Gas Release, Bhopal, December 1984

The Bhopal incident changed the way that the chemical industry organises and manages the storage of chemical stocks, safety standards and safety procedures.

On 3/4 December 1984 a chemical release occurred at the Union Carbide India Ltd. plant in Bhopal, India, causing a massive toxic gas cloud. The process at the plant involved using methyl isocyanate (MIC), an extremely toxic chemical, to make Sevin, a pesticide. About 1,700 to 2,700 (possibly more) people were killed, 50,000 people were seriously affected, and 1,000,000 people were affected in some way by the chemical release. It was one of the worst industrial accidents in history.

The accident occurred when about 120 to 240 gallons of water were allowed to contaminate an MIC storage tank. The MIC hydrolysed, causing heat and pressure, which, in turn, caused the tank rupture disc to burst.

Equipment designed to handle an MIC release included a recirculating caustic soda scrubber tower and a flare system designed to moderate flows from process vents, but not to handle runaway reactions from storage. The design was based on the assumption that full cooling would be provided by the refrigeration system; at the time of the release the refrigeration had been turned off and the flare tower was shut down for repairs. A system of pressurised sprinklers that was supposed to form a water curtain over the escaping gas was deficient, as water pressure was too low for water to reach the height of the escaping gas.

Causes Of The Accident

There were conflicting stories of how water got into the tank, including operator error, contamination and even sabotage.

The root cause of the accident appeared to be a management system that did not respond adequately to the potential hazards of MIC. There was probably a greater inventory of MIC than was needed. The main process expertise was in the United States and local management did not appear to have understood the process or the consequences of changes made, including plant design, maintenance and operations, back-up systems and community responsibility.

Buncefield, December 2005

The incident at Buncefield oil storage depot at Hemel Hempstead, Hertfordshire, England, happened during the night of 11 December 2005. A major fire occurred, caused by a series of explosions. At least one of the initial explosions was of massive proportions and fire engulfed a large proportion of the site. More than 40 people were injured but there were no fatalities. Significant damage occurred to both commercial and residential properties in the vicinity, and a large area around the site was evacuated on the advice of the emergency services. The fire burned for several days, destroying most of the site and emitting large clouds of black smoke into the atmosphere.

The cause of the incident was the formation of a flammable mixture of petrol (gasoline) or similar spirit, and air that ignited, leading to the explosion and fire.

The filling of a tank (912) with petrol proceeded, and between 19.00 and 03.00 the tank became full and started to overflow. Evidence suggests that the protection system, which should have automatically closed valves to prevent any more filling did not operate. From 05.20 pumping continued, causing fuel to cascade down the sides of the tank and through the air, leading to the rapid formation of a rich fuel/air mixture around the tank.

At 05.38 CCTV footage showed a vapour cloud of around 1m deep, which had increased to 2m deep by 05.46. By 05.50 the vapour cloud began flowing off site, and at 06.01 the first explosion occurred, followed by further explosions and a large fire that engulfed more than 20 large storage tanks. The ignition point might have been a generator house and pump house in the vicinity.

Evidence suggests that a high-level switch, which should have detected that the tank was full and shut off the supply, failed to operate. The switch failure should have triggered an alarm, but that, too, appears to have failed.

The UK Health Protection Agency and Major Incident Investigation Board provided advice to prevent incidents such as this in the future. The primary need was for safety measures to be in place to prevent fuel from exiting the tanks in which it is stored. Added safety measures were needed for when fuel does escape, mainly to prevent it forming a flammable vapour and to stop pollutants poisoning the environment.

Deepwater Horizon Oil Spill, 2010

The Deepwater Horizon oil spill in the Gulf of Mexico near the Mississippi River Delta in the United States of America shows that lessons take some time to learn.

The Deepwater Horizon was a nine-year-old semi-submersible mobile offshore drilling platform, built by Hyundai Heavy Industries of Korea, owned by Transocean and operated under lease by British Petroleum (BP) from March 2008 (to September 2013).

In April 2010, drilling was in progress on an exploratory well at a water depth of approximately 5,000 feet (1,500m) in the Macondo Prospect in the Mississippi Canyon Block, about 41 miles off the Louisiana coast. The installation of production casing was under way, and when completed the well would have been tested for integrity and a cement plug put in place, reserving the well for future use.

On 20 April, high-pressure methane from the well escaped all the way up the drill column and expanded over the platform, igniting and causing an explosion, engulfing the platform in fire. The majority of workers from the platform escaped in lifeboats, but 11 were never found and are presumed to have been killed in the explosion (there were two later oil-related deaths, too).

The platform burned for around 36 hours, and then sank on 22 April. The oil leak was discovered later that day, when a floating oil slick spread where the rig had stood.

On 15 July the wellhead was capped, but not until it had released about 4.9 million barrels (205 million gallons) of crude oil. On 19 September the wellhead was finally sealed off. It has been estimated that around 53,000 barrels a day were escaping just before the wellhead was capped. The US Government announced that it was the 'worst environmental disaster the US has faced'.

The toxicity of the petroleum, oxygen depletion and the oil dispersant Corexit that was used at the location are thought to be the major causes of environmental damage.

Later investigations and witness testimony suggested that in a number of cases leading to the events of 20 April, BP appeared to have chosen riskier procedures, possibly in order to save both time and money, and sometimes against the advice given by their own workers and contractors on the project. The cementing procedure was questioned, and it was suggested that the blowout preventer failed to fully engage, and there may have been problems with both the hydraulics and the controls. Another issue was that protective drilling mud was displaced with seawater just hours before the explosion occurred.

In the US Government Commission findings BP was accused of being responsible for nine faults, including:

- Failure to use a diagnostic tool to test the strength of the cement.
- Ignoring the pressure test that had failed.
- Not plugging the pipe with cement.

(BP was not directly blamed for any of these events.)

The Commission's findings were that what was missing, and therefore needed, were:

- Better management of decision-making processes.
- Better communication between the company and its contractors.
- Effective training of key engineering and rig personnel.

NEBOSH
International Technical Certificate in Oil and Gas Operational Safety Unit IOG1

Full List of Study Text Contents

RRC International

27-37 St George's Road
London SW19 4DS
United Kingdom

T: +44 20 8944 3100

E: info@rrc.co.uk

W: www.rrc.co.uk

INTRODUCTION

ELEMENT 1: HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT IN CONTEXT

Contents

ELEMENT 2: HYDROCARBON PROCESS SAFETY 1

ELEMENT 3: HYDROCARBON PROCESS SAFETY 2

ELEMENT 4: FIRE PROTECTION AND EMERGENCY RESPONSE

ELEMENT 5: LOGISTICS AND TRANSPORT OPERATIONS

FINAL REMINDERS

SUGGESTED ANSWERS TO STUDY QUESTIONS