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# *Module 18*

# INVESTIGATING AND REPORTING INCIDENTS

## OBJECTIVES:

After completing this module you will be able to:

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| CRO | 18.1 | State two basic purposes of NPP performance reporting. | ⇔ *Page 2* |
| | 18.2 | Given the name of any of the NPP performance reports mandated by regulatory document R-99, briefly describe the content of the report. | ⇔ *Page 2* |
| | 18.3 | Describe the SS's responsibility with respect to station performance reporting, and name two types of reports produced by the SS. | ⇔ *Page 4* |
| | 18.4 | State the generic circumstances requiring the SS to make an immediate verbal report to the Operations Manager, and thence to the AECB. Give the rationale for this reporting requirement. | ⇔ *Page 4* |
| CRO | 18.5 | State and briefly discuss three advantages of properly investigating and reporting abnormal operating events. | ⇔ *Page 4* |
| | 18.6 | Briefly describe the following techniques for investigating abnormal operating events, and give at least one advantage of each: | |
| CRO | | a) Root cause analysis | ⇔ *Page 5* |
| | | b) Barrier analysis | ⇔ *Page 6* |
| | | c) Human performance enhancement system (HPES) | ⇔ *Page 8* |
| | | d) Change analysis | ⇔ *Page 8* |
| | | e) Event and causal factor charting | ⇔ *Page 9* |

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18.7 Briefly describe the *Operating Experience* program in the following jurisdictions, and discuss the advantages of these programs to nuclear safety:

*Page 10* ⇔ a) CANDU Owners Group

*Page 11* ⇔ b) The Utility Corporate office

*Page 11* ⇔ c) The station.

# PLANT PERFORMANCE REPORTING

The station Operating License can be revoked or suspended at any time, and its continuance depends on providing the AECB with continual assurance that the station is operating in accordance with all of the License's terms and conditions. Performance reporting provides that assurance, and is itself a condition of the License.

*Obj. 18.1* ⇔ Station performance reporting accomplishes two basic purposes:

1. It permits the Regulator to assess the quality of nuclear safety management, and to ensure that the Utility takes appropriate corrective action in the event of unfavourable trends in nuclear safety performance. It assures the AECB that the station is operating in accordance with all of the License's terms and conditions, and that safety analysis assumptions regarding system and staff performance remain valid.

2. It provides *Operating Experience* feedback to Designers and other sites, so that system design and operation can be improved.

*Obj. 18.2* ⇔

## R-99 Reporting Requirements

R-99, which became effective January 1, 1995, requires Utilities operating NPPs to submit various types of reports to the AECB. In each case, R-99 prescribes the time frame within which the reports must be made. The following gives a rough idea of the R-99 reporting requirements, without reproducing all the details:

a) ***Event Reports***. A prescribed list of abnormal events must be reported both orally and in writing to the AECB, including license violations, acute radioactive and chemical environmental releases, serious process failures, reactor trips, degradation of a special safety system or pressure boundary, heavy water spills, security incidents, labour relations incidents, radiation alerts and emergencies, and the discovery of unforeseen nuclear safety problems via either *operating experience* or revised safety analyses.

b) ***Quarterly report***. This report provides an overview of station performance for the previous quarter, per established performance measures for the respective key effectiveness areas. Performance is rated against established performance targets, and trended from quarter to quarter. Thus corrective action can be taken in the event of a deteriorating performance trend.

The Quarterly Report is derived from documents such as Significant Event Reports (SERs), logs, test results, shift summaries, and work reports. It describes changes to staffing, equipment and procedures that might affect plant safety. It also reports abnormal operating events, routine effluent emissions, in-plant radiological surveys, worker dose, emergency response drills, and so on.

c) ***Safety Report updates***. Such updates feature design and procedural changes and revised safety analysis results.

d) ***Annual Radiological environmental monitoring report***. This report summarizes the results of the off-site radiological environmental monitoring program.

e) ***Annual research and development report***. This report describes research and development programs which are planned or in progress to resolve identified safety issues.

f) ***Periodic inspection reports***. These reports describe the results of inspections mandated by CSA Standards N285.4 and N285.5—eg, pressure tube inspections.

g) ***Annual reliability report***. This is a report on the reliability of each special safety system and any other safety-related systems which have specific reliability requirements described in the licensing documents. It describes for each safety system the testing program results, impairments, and predicted reliability. In the event of an unacceptable trend in a system's reliability, the report provides an assessment of the trend, and describes planned corrective actions.

h) ***Fissionable and fertile substances reports***. This report describes the inventory and transfer of fissionable and fertile substances—eg, new and irradiated fuel.

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*Obj. 18.3* ⇔

## Shift Supervisor's Role in Performance Reporting

The Shift Supervisor (SS) is responsible for ensuring that routine reports required of shift staff, such as logs and work reports, are completed to an acceptable standard. These reports provide important information for performance analysis, and for the preparation by Technical Support staff of formal reports to the AECB. The SS personally completes the Shift Summary Report and SERs.

*Obj. 18.4* ⇔

The SS is responsible for recognizing and filing SERs on events and operating conditions which do not comply with the OP&P or Reactor Operating License. High profile events such as radiation emergencies, level 1 safety system impairments, and License violations warrant immediate verbal reports to the Operations Manager, and via the Operations Manager, to the AECB. Such incidents merit immediate *defense in depth* review, because of the elevated nuclear safety risks involved. The immediate verbal reports are followed up by written reports.

# INVESTIGATING AND REPORTING INCIDENTS

*Obj. 18.5* ⇔

The advantages of rigorously investigating and reporting on abnormal operating events include the following :

1. Using proper investigative techniques, skilled investigators can find the root cause(s) of an incident, so that effective corrective action can be taken to prevent recurrence. Thus nuclear safety is improved at the affected site.

2. The lessons learned from the investigation can be published for the good of the nuclear power industry as a whole, so that others can benefit without having to experience the painful consequences of similar incidents. Thus nuclear safety is improved globally.

3. On the basis of the reports, the Regulator can assess independently the impact of abnormal incidents on public safety, and ensure that the Utility takes appropriate corrective actions to prevent recurrence.

4. Rigorous investigation, full and frank disclosure of the findings, and proper corrective action follow-up pay off in increased public confidence in the integrity and safety of the nuclear power industry. To put it another way, these activities avoid the inevitable loss of public confidence which occurs when cover-ups come to light. Needless to say, the future of nuclear generation depends absolutely on maintaining public support.

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⇔ *Obj. 18.6 a)*

## Investigative Techniques—Root Cause Analysis

**Definition:** A ***root cause*** is one which, if eliminated, would prevent recurrence of an incident or problem.

**Definition:** A ***problem*** is a current performance of people or equipment, that is producing unsatisfactory results.

The purpose of a root cause investigation is to identify what needs to be fixed to prevent repeat incidents. It is a *fact* finding, not a *fault* finding process.

Normally, root cause investigations and follow-up are done by staff within the responsible work groups. For example, System Engineers monitor and correct equipment, maintenance and operational problems on their systems. Work group Supervisors monitor and correct performance problems within their work groups.

However, in the case of some serious incidents, root cause investigations are conducted by persons external to the responsible work group, and even to the station. For example, severe personnel injuries and radiation overexposures are investigated by the Health and Safety Division. Even in such special cases, persons from the affected work groups may be asked to participate.

A person who discovers a problem that is not within his own jurisdiction, should identify the problem to the responsible work group for resolution.

The classical approach to root cause determination and corrective action follow-up consists of five steps:

1. Define the problem
2. Determine the root causes from analysis of the facts turned up by careful investigation
3. Identify the corrective actions required to remove the root causes
4. Implement the corrective actions
5. Follow-up to ensure the problem is resolved.

The following investigative techniques will be discussed briefly in this module. These are not the only techniques but they are the most widely used.

- ***Barrier Analysis***
- ***Human Performance Enhancement System***
- ***Change Analysis***
- ***Event and Causal Factor Charting***

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*Obj. 18.6 b)* ⇔

## Barrier Analysis

**Definition:** A ***barrier*** is a physical, administrative or people-based safeguard used to detect, prevent, discourage, terminate, or to compensate for unsafe conditions, equipment failure, or inappropriate human action.

***Examples of physical (engineered) barriers:***

- access controlled area (barrier to radiation exposure)
- handrail around open hatchway (barrier to falling)
- plastic suit (barrier to bodily uptake of radioactive material)
- interlock (barrier to inadvertent defeat of safe operation)

***Examples of administrative barriers:***

- work protection Code (barrier to unsafe working environment)
- operating manual (barrier to unsafe operation)
- jumper record (barrier to unreviewed, unauthorized change)
- work plans (barrier to unsafe, unproductive work)

***Examples of people-based barriers (knowledge, skill, experience, and safety culture):***

- skills training to perform breaker potential checks (personnel training barrier to performing the checks unsafely and incorrectly)
- extensive experience on the job (a barrier to injuries and errors)
- good supervision (coaching and verification barrier to injuries and errors)

Barriers are put in place to ensure personnel, public and environmental safety. *Barrier Analysis* looks at the various barriers in place and asks why they were not effective in preventing the problem.

No barrier is foolproof—physical barriers can be removed inadvertently or can fail if their design limits are exceeded; administrative barriers can contain errors or become obsolete; skill and knowledge based barriers can be forgotten, undermined by carelessness or cynicism, or not recognized as applicable to the problem. Therefore, consistent with the *defense in depth* philosophy of nuclear safety, multiple protective barriers are used.

The greater the consequences of barrier failure, the greater the required number and effectiveness of barriers. *Operating experience* shows that engineered barriers

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are the most effective, whereas people-based barriers are the least effective. If the event or situation to be prevented is catastrophic, then several barriers should be in place, including some engineered barriers if possible.

*Barrier Analysis* can be used for any problem, but it has its strengths and weaknesses. One weakness is that it is sometimes difficult to identify the actual barriers which were in place, and to identify 'missing' barriers which should have existed but did not.

*Barrier Analysis* is particularly useful for identifying procedural or training problems, when a problem has occurred during execution of an operating or maintenance procedure. Each step can be scrutinized to identify conditions which affect performance, and what safeguards could prevent errors or injuries.

One advantage of *Barrier Analysis* is that it is intuitive, easy to use and widely practiced. Most people easily grasp the concept of degraded or defective barriers. Another advantage is the suitability of the *Barrier Analysis* technique for proactive application. When work is planned, one can assess the barriers in place and decide whether they should be strengthened or supplemented with new ones.

One further advantage of *Barrier Analysis* is that it can help to clarify where the responsibility for problem resolution rests.

Example: Investigation of a pump failure showed that the pump and motor had not been properly aligned after an earlier rebuild. The Maintainers had never received training on new alignment tools, and through inappropriate use of those tools, had misaligned the pump set. The missing training barrier was identified to the appropriate work group Supervisor for resolution.

*Barrier Analysis* can be used alone, or in conjunction with other methods. It is especially effective when combined with the *Event and Causal Factor Charting* technique. *Barrier Analysis* consists of the following steps:

1. Identify the problem
2. Determine which barriers (physical, administrative, or people-based) are in place to prevent the problem
3. Determine how the barriers failed,
4. Determine why the barriers failed.

By determining how and why the barriers failed, the root causes of the problem will be found.

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*Obj. 18.6 c)* ⇔

## Human Performance Enhancement System (HPES)

HPES methodology is an effective root cause determination technique when inappropriate human action is an obvious factor in the problem. Except in the case of deliberate sabotage or willful negligence, the emphasis is on finding out exactly how and why the inappropriate action occurred, not on who did it. This approach can uncover subtle root causes of poor human performance, so that effective corrective actions can be prescribed. Since the causes of non consequential events (near misses) are the same as the causes of consequential events, the former should also be investigated rigorously.

The goal of the HPES is to improve nuclear safety by improving human performance reliability, by correcting the root causes of human performance problems. Human error cannot be eliminated, but it can be managed.

Examples of typical corrective actions:

- implement personnel error reduction strategies, such as self checking and independent verification
- retrain staff
- reassign individuals to different jobs better suited to their aptitudes
- implement a better alarm system or automated response
- install an interlock
- provide a clearer or simpler procedure
- introduce colour coding

*Obj. 18.6 d)* ⇔

## Change Analysis

*Change Analysis* is a root cause determination technique which starts by asking questions such as, "What is different about this situation from others where the problem did not exist? If an activity succeeded in the past, what change may account for the present lack of success? If equipment is performing unsatisfactorily, and similar equipment has performed successfully elsewhere, what change is there in the present, problematic application (or in the equipment)?"

*Change Analysis* is effective and easy to use when:

- a history of success, or ongoing success in similar applications, contrasts with the current problem
- changes may have contributed to the situation

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It should be considered also when the causes of the problem are obscure, or where to start the investigation is unclear.

Drawbacks to the *Change Analysis* technique include the following:

- It is practically impossible to identify all the changes involved in a situation
- The effect of gradual changes is often difficult to separate from other effects
- The synergistic effect of combinations of changes may not be recognized, especially changes made over an extended period of time.

The steps to the *Change Analysis* technique are as follows:

1. Identify the problem.

2. Identify the changes since the last successful operation, or relative to ongoing successful operations elsewhere.

3. Isolate the change or combination of changes which is responsible for the problem.

Such change(s) are the root cause of the problem.

## Event and Causal Factor Charting

⇔ *Obj. 18.6 e)*

An *Event and Causal Factor Chart* is a flow chart showing the chronological sequence of events which led up to a problem, together with environmental conditions and causal factors influencing each event.

*Event and Causal Factor Charting* is an effective root cause determination technique when the problem results from a sequence of actions by individuals and equipment. It is particularly useful when understanding the environmental factors is key to diagnosing the root causes of the problem.

This technique offers many advantages. It organizes all the information related to a problem chronologically, and shows cause and effect relationships. As the chart is developed, some of the less obvious contributing causes of the event may be revealed. The chart is particularly useful for complex event sequences, and is more effective than a long narrative description in describing the problem and its root causes to others.

A generic Event and Casual Factor Chart for a hypothetical incident is shown in Figure 18.1

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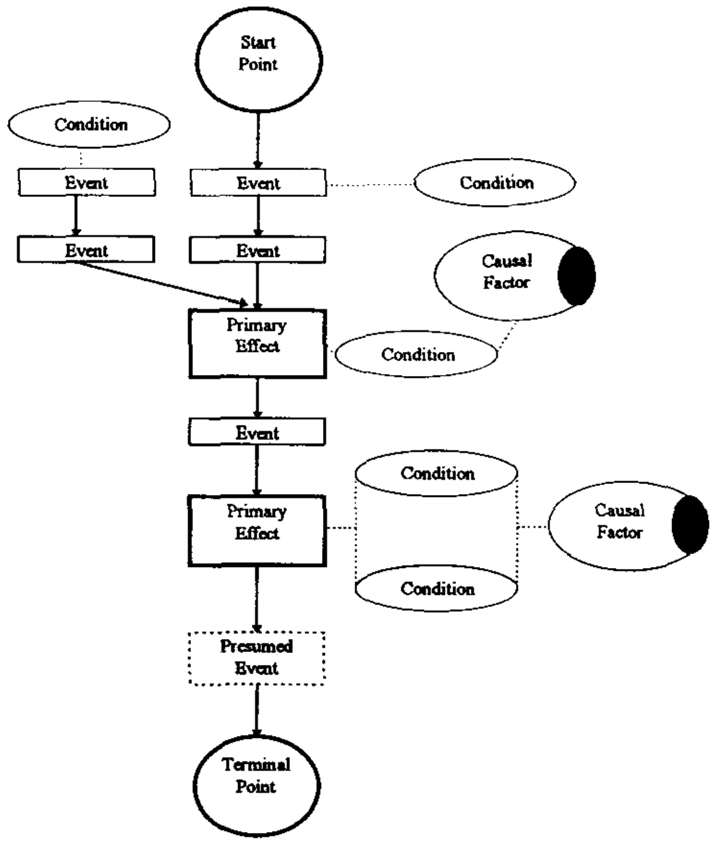


**Figure 18.1: Generic Event and Causal Factors Chart**

# OPERATING EXPERIENCE PROGRAMS

*Obj. 18.7 a)* ⇔

## CANDU Owners Group (COG)

The COG operates an electronic reporting network linking CANDU operating Utilities. Reports of significant events at any one CANDU site are distributed to other CANDU sites so that they can all take advantage of any lessons learned.

The COG network is linked to other networks, and provides an exchange of *operating experience* between CANDU operators and other NPP operators world-wide.

Any network subscriber can broadcast a request for information from other NPPs—eg, as to what measures they use to minimize a specified risk. This is a proactive sharing of *operating experience*, whereas sharing lessons learned from

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abnormal incidents is clearly a reactive (after the fact) application of *operating experience*.

⇔ *Obj. 18.7 b)*

## Corporate office

The corporate office typically maintains an *Operating experience* (OE) group which analyzes significant event reports from both CANDU plants and other NPPs, with a view to identifying the potential application of lessons learned on the Corporation's nuclear generating stations. This group liaises with both external and internal NPP operators to facilitate lesson transfer.

The Corporate *OE* group monitors and reports on Corporate wide nuclear safety performance against performance targets reflecting Corporate key results areas in nuclear safety.

⇔ *Obj. 18.7 c)*

## The Station

Each CANDU site maintains an *Operating experience* Unit, typically inside the Nuclear Safety organization. This site *OE* Unit performs the following functions:

- scrutinizes *OE* reports on the electronic network for relevance to the site, and distributes such reports to the appropriate site contacts
- Broadcasts selected site SERs to the network
- Liaises with Corporate *OE* group
- Acts as the Contact for external and site-generated requests for information, and for distributing replies
- Monitors and reports on station nuclear safety performance, so that site Management can take corrective action in the event of a deteriorating performance trend. Nuclear safety performance is typically reported using measures and targets reflecting the key effectiveness areas of Module 2.
- Produces training packages for delivery to site staff, highlighting lessons learned from internal and external incidents.

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# *ASSIGNMENT*

1. Carefully prepare detailed answers to the Module 18 learning objectives.

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