NOTES & REFERENCES

Module 15

IMPAIRMENTS

OBJECTIVES:

After completing this module you will be able to:

CRO 15.1 Define what is meant by an *impairment* of a safety related system. ⇔ *Page 1*

CRO 15.2 Briefly describe the three impairment levels of Special Safety Systems (SSSs) in terms of system effectiveness, and the likely effect on nuclear safety if a coincident worst case process failure were to occur. ⇔ *Page 2*

CRO 15.3 State the consequences if no action is taken in the event of a SSS impairment. ⇔ *Page 3*

CRO 15.4 Give four general actions taken to reduce risk in the event of a SSS impairment, and give the rationale for each. ⇔ *Page 3*

IMPAIRMENTS OF SAFETY RELATED SYSTEMS

This module deals mainly with impairments of special safety systems (SSSs), but the concept of impairments applies to safety related systems generally.

Definition: An *impairment* of a safety related system is a failure such that the system would operate with reduced redundancy or margin of safety, or would fail to meet its design intent. ⇔ *Obj. 15.1*

Impairments of various degrees of severity can occur on systems of various importance to nuclear safety. Operating staff must respond to an impairment in a manner consistent with its potential nuclear safety consequences, and with the unit conditions prevailing at the time of the fault. In responding to an impairment, the following questions are relevant:

NOTES & REFERENCES

* In this context, "operating instructions" may be the Abnormal Incidents Manual (AIM), the Impairments Manual (IM), or the Operating Manual (OM), depending on the station, the system, and the nature of the impairment.

1. How serious is the effect on nuclear safety? Is this impairment classified in operating instructions*)?
2. What must be done to control the overall risk? Do operating instructions*) provide guidance? For example, can the impairment level be reduced or eliminated by placing equipment in its safe state?
3. How long will it take to effect repairs?
4. How long can unit operation continue, given the estimated repair times?

Special Safety System Impairments

Obj. 15.2 ⇔

SSS Impairments are classified in increasing order of severity as level 3, 2 and 1. *Abnormal Incidents Manual/Impairments Manual (AIM/IM)* procedures specify the actions required to restore an acceptable level of risk for each SSS impairment level. SSS design varies from station to station, and each station tabulates the impairment levels assigned to various specific equipment failures in its own *AIM/IM* procedures. But the nuclear safety impact of the respective impairment levels is essentially the same at all stations, and is described below.

Level 3 Impairment

The level of redundancy or margin of safety designed into the SSS is reduced, but the system is still fully capable of meeting design intent. No increase in radioactive, environmental releases is anticipated, even for worst case process failures. However, the probability of a level 2 or 1 impairment is increased for the duration of the level 3 impairment.

Examples: - One shut-off rod fails to drop on test, all other rods available.
- One SDS channel unavailable on one trip parameter

Level 2 Impairment

System effectiveness is reduced to the extent that it would provide some, but not complete, protection for a worst case process failure. In event of a worst case process failure, greater than normal environmental, radioactive releases could be expected. However, the system would still provide adequate protection for (more probable) events of lesser severity. A level 2 impairment represents a moderate increase in risk to public safety.

NOTES & REFERENCES

Examples: - ECI is capable of providing some, but not full design flow
- Failure of several*) shutoff rods to drop sufficiently fast

* For minimum number of 'slow' rods resulting in a level 2 impairment, consult station documentation

Level 1 Impairment

SSS effectiveness is impaired to the extent that it would provide inadequate protection. A worst case process failure could cause environmental, radioactive releases much greater than (more than 10 times) normal. A level 1 impairment represents a large increase in nuclear safety risk.

Examples: - ECI is incapable of providing any flow.
- Both door seals deflated on same air lock
- Two of three SDS channels unavailable on a trip parameter

Response to Special Safety System Impairments

If no action is taken in response to a SSS impairment, the unit would continue operating with **elevated nuclear safety risk, resulting in an OP&P violation.**

⇔ *Obj. 15.3*

Discussed below are four actions designed to reduce the nuclear safety risk when a SSS is impaired, together with the rationale for each action:

⇔ *Obj. 15.4*

1. ***Reduce Likelihood of Process Upsets:*** Reducing the likelihood of a process upset also reduces the likelihood of the safety system's being called to respond while impaired. Precautions to reduce the likelihood of process upsets typically include:

   - Suspending fueling operations after completing the channel in progress
   - Terminating any test in progress at the next safe point, and suspending any further testing
   - Suspending O&M activities with the potential to cause process upset
   - Suspending discretionary power maneuvers.

2. ***Initiate Repairs:*** As a preliminary stratagem, it may be possible to reduce the effect of the impairment by putting equipment into a safe state without upsetting the unit. For example, a SSS channel may be placed in the trip condition while repairs are completed on that channel. Such action not only reduces the nuclear safety risk, but may also buy time to effect repairs, as the grace period for continued operation is longer for less serious impairments.

NOTES & REFERENCES

If the estimated repair time is within the specified grace period for continued operation, then repairs are initiated immediately with the unit at power. Otherwise, the reactor is put into a state where the impaired system is not required.

The rationale for specifying a grace period prior to mandatory unit shutdown is that the probability of a serious process failure's occurring during the grace period is very low, whereas the shutdown procedure itself incurs a risk of upset due to human error or equipment failure. Consistent with the definition of risk as product of event frequency times consequences, the more serious the impairment, the shorter the specified grace period.

3. ***Make Notifications:*** Designated Utility and AECB officials must be notified that the unit is operating at an elevated risk, and informed of any shutdown plans. Those notified can then respond appropriately—eg, by arranging for alternative generation, giving advice or approvals, summoning help, or issuing verbal instructions.

4. ***Shut down reactor, Cool down and Depressurize HT system:*** When an impairment cannot be removed within the specified grace period, the unit is shut down and cooled down in a controlled manner. The risk of a process failure which would require SSS action is much reduced with the HT system cold and depressurized. The GSS may also be mandated by the pertinent *AIM/IM* procedures, certainly in the case of a SDS impairment.

SUMMARY OF THE KEY CONCEPTS

- A safety related system is *impaired* when it would operate with reduced redundancy or margin of safety, or would fail to meet its design intent.

- A level 3 impairment reduces a SSS's redundancy or margin of safety, but does not reduce its effectiveness, even for a worst case process failure.

- A level 2 impairment reduces SSS effectiveness to the extent that it would fail to meet design intent. However, system operation would still provide significant benefit. Should a worst case process failure occur, greater than normal environmental, radioactive releases are possible. A moderate increase in nuclear safety risk results.

- A level 1 impairment is such that the SSS would provide inadequate protection. Since a worst case process failure could result in an environmental, radioactive release much greater than normal, there is considerably increased nuclear safety risk.

NOTES & REFERENCES

- If no action is taken in the event of a SSS impairment, the station continues operating at elevated risk levels, resulting in an OP&P violation.
- Four actions to reduce risk when a SSS is impaired:
  - — reduce likelihood of process upsets
  - — initiate repairs
  - — make notifications
  - — shut down reactor, cool down and depressurize HT system

ASSIGNMENT

1. Carefully prepare detailed answers to the Module 15 learning objectives.
2. State the potential consequences of a level 2 SSS impairment, and briefly explain when and why it would be permissible to operate for a period of time during a level 2 impairment before a shutdown is required.
3. Give the precautions which might be taken to reduce the likelihood of a process upset in the event of a SDS impairment with the reactor at power.
4. Upon discovering a level 1 impairment of a single reactor shutdown system, the CRO would take certain actions related to nuclear safety. Give the actions, and an overview of the objectives of these actions.

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