Integrated Decision-making Process for PSA Applications
Spanish Experience

Lecturer
Lesson IV 3.2_11.8

Workshop Information
IAEA Workshop

City, Country
XX - XX Month, Year
Contents

- Overview
- IDP definition
- PSA applications with IDP. Spanish experience
  - RI-IST
  - RI-ISI
  - AOT extension
  - Maintenance Rule
- The GADE panel in Cofrentes NPP
- Conclusions
Overview

- Integrated Decision-making Process (IDP) plays a key role in the new trends of Risk-informed regulation.
- The use of a ID Panel is basic to the process
- IDP has been proven in Licensing Basis changes request and approval
- The pioneer PSA applications and Maintenance Rule Implementation recognised the need of a “blend” between deterministic and probabilistic approaches
IDP Definition

- NUMARC 93-01 (Maintenance Rule Guidelines) suggested the use of PSA insights by a panel of individuals experienced in PSA, Operations and Maintenance

- EPRI’s “PSA Applications Guide” (1995) presented a Decisions Criteria chapter that was not yet a formal process
IDP Definition

- NRC staff to the ACRS (1996) stated the key elements of an Integrated Decision Making Process:
  - Decision supported by both deterministic & probabilistic assessments
  - Conflicts among conclusions must be explained and resolved
  - Current rules and regulations are to be complied with
  - Performance feedback and monitoring are essential elements of the process
IDP Definition

- Risk findings must support the conclusions by:
  - Numerical criteria for risk impact (Regions map)
  - Qualitative arguments if application is not able to be quantified
  - Robustness demonstrated through sensitivity studies and importance measures

- NUREG-1602 introduces “Risk-informed decision-making”
IDP Definition

  - Current regulations meeting
  - Defence-in-depth is maintained
  - Small increases in risk
  - Safety margins are maintained
  - Performance-based implementation & monitoring strategies
IDP Principles

- Defence-in-depth is maintained
- Current Regulations meeting
- INTEGRATED DECISION MAKING
- Safety margins are maintained
- Performance based implementation & monitoring strategies
- Small increases in risk

INTEGRATED DECISION MAKING
IDP Definition

- The four elements approach
  - Define the proposed change
  - Perform engineering analysis
    - Traditional analysis
    - PSA analysis
  - Define implementation and monitoring program
  - Submit proposed change
The four elements IDP approach

1. Define change
2. Perform engineering analysis
3. Traditional analysis
4. PSA
5. Perform engineering analysis
6. Submit proposed change
IDP Definition

- SRP Chapter 19: “The acceptability of proposed changes should be evaluated by the licensee in an integrated fashion that ensures that all principles are met”
  - “One important element of integrated decision making can be the use of an “expert panel”. Such a panel is not a necessary component …but when used, the key principles and associated decision criteria still apply…”

- In Spain, a guideline has been issued for PSA applications as a consensus among CSN and industry
  - IDP is there recommended for PSA applications
Spanish PSA Applications with IDP Examples

- In-service testing
- In-service inspection
- DG AOT extension
- Maintenance Rule implementation
Risk-informed IST

- Objective: Optimisation of test intervals for pumps and valves under IST programme, informed by risk and based on performance

- IDP principles:
  - Current regulations: All the regulations are met, excepted for those regarding the test time intervals
  - Defence-in-depth: The seven attributes are assessed
Defence-in-depth philosophy

- Prevention-mitigation balance is preserved
- No excessive reliance on programmed activities to compensate for plant weaknesses
- System redundancy, independence and diversity are preserved
- Defence against common cause failures: preservation and avoiding new mechanisms
- Independence of barriers not degraded
- Defence against human errors
- The intent of design criteria is maintained
Risk-informed IST

- IDP principles (cont’d):
  - Risk assessment:
    - PSA Scope, level of detail & quality proved.
    - Three categories (HSS, PSS, LSS) based on F-V and RAW measures.
    - Qualitative assessment to compensate quantitative assessment limitations.
    - Sensitivity analysis.
Risk-informed IST

- IDP principles (cont’d):
  - Safety margins:
    - test methods and acceptance criteria are not modified
    - all safety functions evaluated
    - comparison with other programmes
    - compensatory measures when required
    - progressive implementation
Risk-informed IST

- IDP principles (cont’d):
  - Implementation, monitoring & corrective actions:
    - Historical performance review.
    - Programme proposal: overall risk evaluation.
    - Progressive implementation.
    - Compensatory measures adopted for PSS.
    - Performance monitoring & corrective actions procedure.
Risk-informed IST

- Experts panel role
  - Comment and confirm categorisation process.
  - Review sensitivity studies
  - Review historical performance data
  - Confirm consistency with Maintenance Rule results
  - Define new test strategies for LSS and PSS components
  - Review the final overall risk study
  - Define an augmented programme for HSS non-ASME XI
  - Define a transient RI-IST programme
  - Review the Final Report issue
Risk-informed ISI

- **Objective:** Optimise inspection intervals for piping under In-service Inspection programme (Class 1, 2 & 3 ASME XI)

- A Spanish RI-ISI Guideline developed with two pilot applications (PWR & BWR)
Risk-informed ISI

- IDP elements:
  - **Risk assessment**: Failure probabilities are estimated with probabilistic structural mechanic methods.

  - **Required info**:
  - Categorisation of segments into *more safety significant* and *less safety significant*, by applying risk importance measures and deterministic insights
Risk Categorisation

- Identification of an initiating event, or a basic event or group of events, modelled in PSA, with a failure with the same effects as the analysed segment.
- Calculation of the CCDP/CLERP with the component failed.
- Achievement of the CDF/LERF for each segment, using the CCDP/CLERP and the failure probabilities.
- Addition of all the segments contributions to obtain the CDF/CLERF due exclusively to pressure boundary failures.
- With these measures, is performed the initial piping segments classification.
  - High safety significant: Risk Reduction Worth > 1,005
  - Less safety significant: RRW < 1,001
  - Plant Expert Panel: 1,001 < RRW < 1,005
Failure Probability Assessment Required Information

- GENERAL INFORMATION.
  - Degradation mechanisms,
  - Material characteristics and
  - Design conditions.

- IN SERVICE INSPECTION INFORMATION.
  - Type of IS Inspection,
  - Type and quality of PSI,
  - Failures found,
  - Hydrostatic proof identification (if performed),
  - Radiographic inspections (if performed)…
Failure Probability Assessment Required Information

- **STRESS INFORMATION.**
  - Identification of thermal fatigue,
  - Vibration fatigue,
  - Residual stress level,
  - Normal operating pressure,
  - High and low cycle fatigue loads,
  - External loads…

- **SCC PARAMETERS.**
  - O_2 concentration,
  - Conductivity,
  - Material sensitivity…
Failure Probability Assessment Required

Information

- **SNUBBERS.**
  - Type of snubber,
  - Historical flaw data, and
  - Failure effects on the segment.

- **FLOW DATA.**
  - Minimum leak which disables the safety function
  - Minimum observable leak.
**Risk-informed ISI**

To select the new sample size, the pipe segments are categorized in a Segment Matrix

<table>
<thead>
<tr>
<th>HIGH FAILURE POTENTIAL</th>
<th>REGION 3</th>
<th>REGION 1A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inspection requirements established by the Plant</td>
<td>100% Inspection.</td>
</tr>
<tr>
<td>LOW FAILURE POTENTIAL</td>
<td>REGION 4</td>
<td>REGION 1B</td>
</tr>
<tr>
<td></td>
<td>Visual Exams and Pressure tests</td>
<td>Method Selection</td>
</tr>
<tr>
<td></td>
<td>LOW SAFETY SIGNIFICANT SEGMENTS</td>
<td>HIGH SAFETY SIGNIFICANT SEGMENTS</td>
</tr>
</tbody>
</table>
Risk-informed ISI

- Experts panel
  - Two different Panels for this specific application
  - Technical ISI Panel (only inspection, materials & engineering people): Decisions within the ISI field
  - Plant Experts Panel (inspection, operations, licensing, PSA,… people): Decision makers
Risk-informed ISI

- Experts panel role:
  - Assess failure mechanisms identified for each segment
  - Define /validate items of welding to be quantified
  - Validate PSA assumptions
  - Assess operating experience
  - Obtain a final categorisation
  - Select items of welding to be under the ISI programme scope
  - Defines the RI-ISI programme
  - Assess the overall risk impact
  - Final validation/approval
DG AOT Extension

- Objective: extend allowed outage time for DGs from 3 days to 14 days.

- IDP elements:
  - Risk assessment:
    - PSA Scope, level of detail & quality proved.
    - No ranking; comparison among current and future situation under given assumptions; simple and cumulative risk are compared to acceptance criteria.
    - Qualitative assessment to compensate quant. assessment limitations.
    - Sensitivity analysis.
DG AOT Extension

- Experts Panel not required for IDP
- Plant personnel interaction still required for IDP:
  - Maintenance practices
  - Historical logs interpretation
  - Test requirement fulfilment
  - Other
**Maintenance Rule**

- Implementation Experts Panel role:
  - Composition: Operations, maintenance, systems engineering, licensing, PSA, nuclear safety, QA.
  - Scope validation, proposed by engineering service
  - Determination of risk significant system function at every plant mode of operation
  - At power operation risk: the Panel completes the PSA input according to a structured analysis (Delphi method)
  - Determination of Performance Criteria, proposed by PSA
  - Supervises the whole process
Maintenance Rule

- Monitoring & updating panel:
  - Different people and functions: operations, PSA, licensing and all maintenance specialities
  - More focused on equipment trouble tracking and solving. Root cause analysis
  - PSA still involved in the process
Monitoring in Cofrentes NPP

- In Cofrentes NPP a “data” panel has been set up: GADE
- Function:
  - Assess plant events from all points of view and determines effect in each area: PSA, Maintenance Rule, DACNE (Spanish failure and unavailability data bank), IST and other.
  - Supply with inputs for updating & monitoring tasks
Monitoring in Cofrentes NPP

- Operations and Maintenance logs are periodically reviewed.
- Panel members are common to MR Panel
- GADE work is under a specific plant procedure
Conclusions

- IDP is a cornerstone for PSA applications success
- IDP is to be under procedure as any plant process, including Experts Panel meetings
- In the future, IDP could imply a huge responsibility for Expert Panel members.
- Management involvement and full support is required
- IDP is also basic for future Risk-Informed Regulation