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SNSA Surveillance over the Ageing Effects and Suitability for Long Term Operation at the Krško NPP

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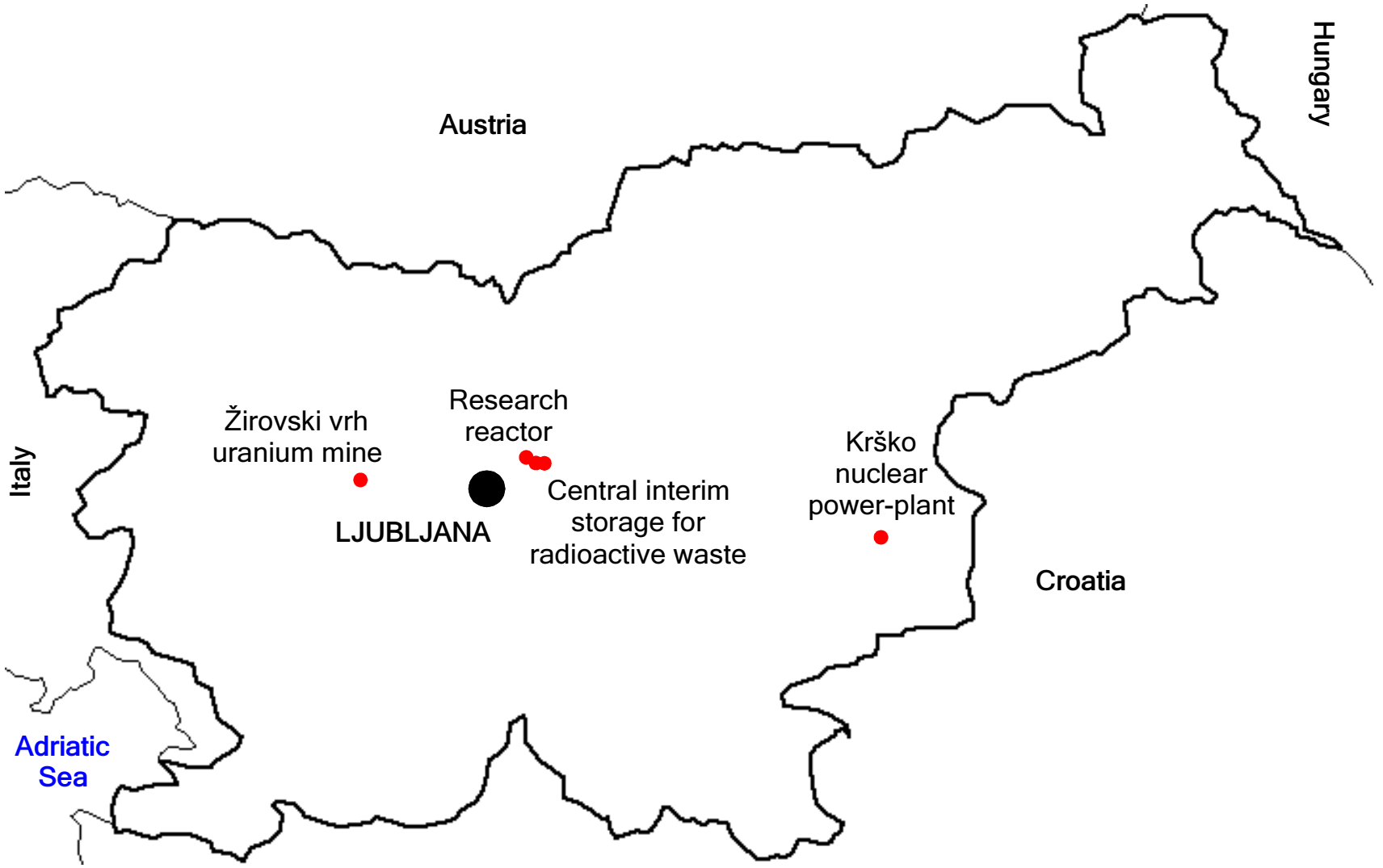
Nuclear installations in Slovenia



Krško Nuclear Power Plant

- Westinghouse PWR
- 2 loop
- 2000 MWth
- 696 MWe
- Commercial operation since 1983
- 40% of Slovenian electricity production

SNSA

- Six Divisions, 47 employees
  - Division of Nuclear Safety, Inspection, Division of Radiation Safety and Materials, Division of Analysis and Consulting, Office of International Cooperation
- Functions
  - inspection and licensing processes in the area of radiation and nuclear safety,
  - development of regulatory infrastructure,
  - review and assessment,
  - analyses of operational events and experience,
  - preparation of reports on nuclear safety…
- First priority
  - supervision over nuclear safety at the Krško NPP

Periodic Safety Review

- The Krško modernization project in 2000 → need for conducting a PSR
- First PSR started in 2001 with objectives:
  - confirmation that the plant is as safe as originally intended
  - determination of any SSC that could limit the life of the NPP
  - plant comparison against modern safety standards to identify where the improvements would be beneficial at justifiable costs
- First PSR approved in 2005
  - plant is as safe as it was originally intended
  - no SSCs, which could limit the plant life in the next ten years
  - no major safety issues revealed
  - number of recommendations to enhance safety were identified
  - PSR's Action Plan developed with 124 actions in 13 areas

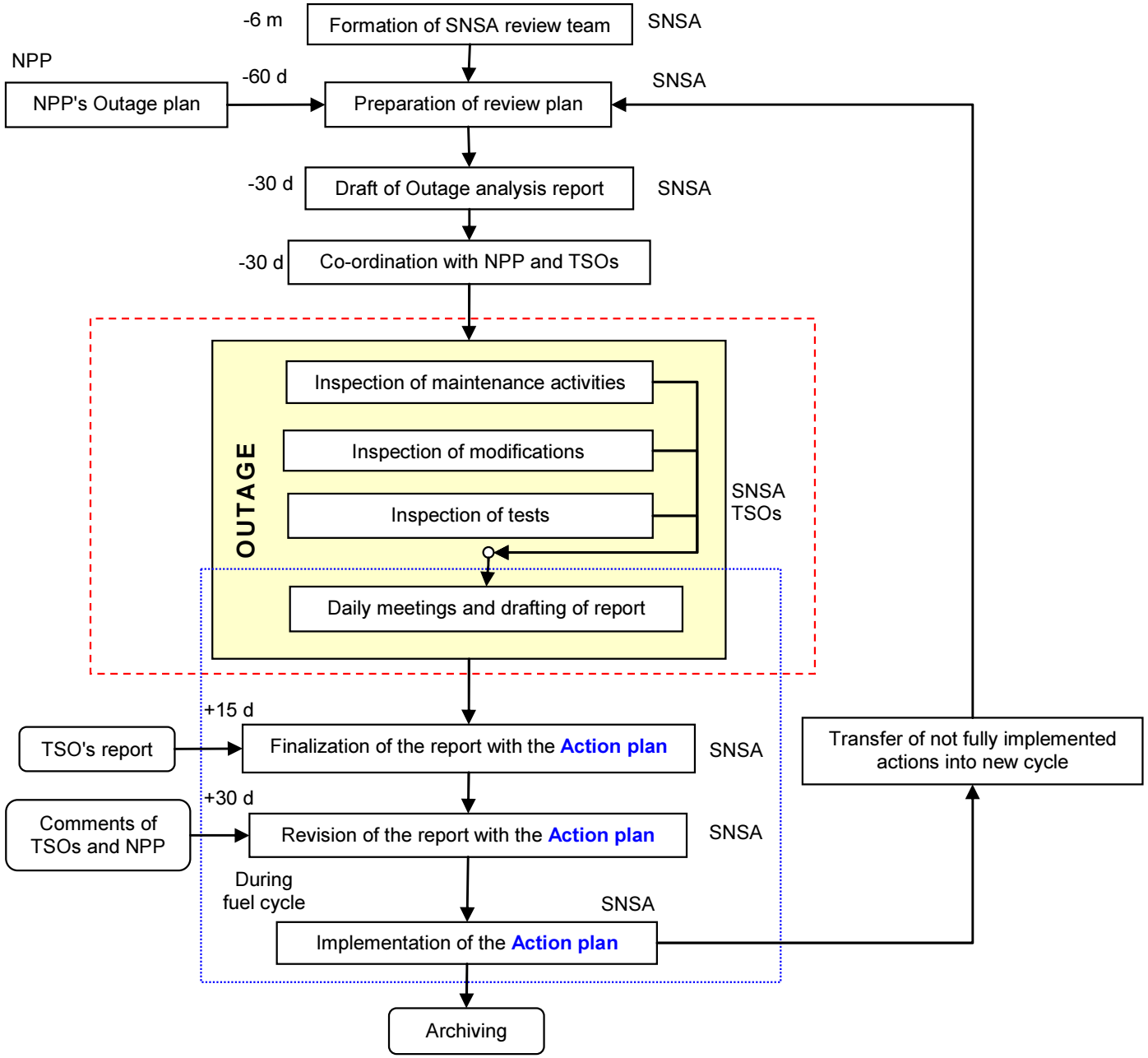
Periodic Safety Review

- According to new Slovenian nuclear legislation (2002) PSR obligatory for all nuclear installations
- Approved PSR report condition for renewing the operation license for the next ten year period
- Second PSR must be submitted to the SNSA by the end of 2013
- PSR programme described in "Regulation on Assurance of Operational Safety of Nuclear and Radiation Facilities"
- For regulatory body PSR provides good insight into suitability of plant for long term operation
  - Ageing Management, Equipment Qualification, Maintenance, Testing, Equipment Inspection, Modifications, etc. are elements of PSR.

SNSA's inspections

- Regular inspections: *operation*, *maintenance*, *testing and inspection*, *training*, *radiological monitoring*, *emergency preparedness*
- Maintenance, testing and equipment inspection:
  - supervision of on-line maintenance
  - presence at surveillance testing, review of tests results
  - review of in-service inspection reports
  - supervision of spare parts suitability in storehouse
- Additional inspections by SNSA's experts from Nuclear Safety Division during outages:
  - performance of plant modifications
  - maintenance and equipment inspection
  - surveillance testing

Supervision of plant's outages and fuel cycles



Supervision of plant's outages and fuel cycles

- Main task to be supervised during 2007 outage

Plant modifications	• Replacement of moisture separator reheaters • Replacement of low pressure feedwater heaters • Replacement of reactor coolant pump motor • Replacement of chilled water system chillers • Repairing of turbine cross-under piping
Maintenance and equipment inspection	• Inspection of spent fuel integrity • SG sludge lancing • Revision of turbine driven auxiliary feedwater pump • Inspection of secondary pipelines • Revision of main generator
Surveillance testing	• Auxiliary feedwater full flow test • Containment integrated leak rate test • Safety injection full flow test
Outage activities related to plant programmes	• Control and limiting of corrosion at the Krško NPP • Steam generators programme • Reactivity Management Programme • Fuel Integrity Programme
Plant pre-outage activities and outage phases	• Refuelling • Planning of outage activities, risk and safety evaluation during shutdown

Review and assessment

- Review of design modifications
- Review and assessment of new plants documents
  - Environmental Qualification Programme (EQ)
  - Ageing Management Programme (AMP)
  - Maintenance Rule Programme (MR)
  - Corrosion/Erosion Monitoring Programme
- Findings discussed with plant managers, most of findings taken into account by plant's specialists
- New Slovenian regulations will include additional requirements on *ageing management*, *environmental qualification*, *maintenance*, *testing*...

Monitoring the condition of important plant SSCs

Database for monitoring the condition of the plant SSC:

- Functions
  - monitoring of transients important for fatigue from TS and USAR
  - monitoring of the status of safety important plant SSCs
- Based on data from surveillance testing, inspections and maintenance, received from the NPP
- Included limited number of safety important SSCs

SNSA's procedure for supervision of ageing processes

  - criteria for incorporation of new components into database
  - criteria to rank components by their importance for safety
  - determination of parameters to monitor level of degradation
- In case of poor results SNSA should start actions to help solving problem at the NPP

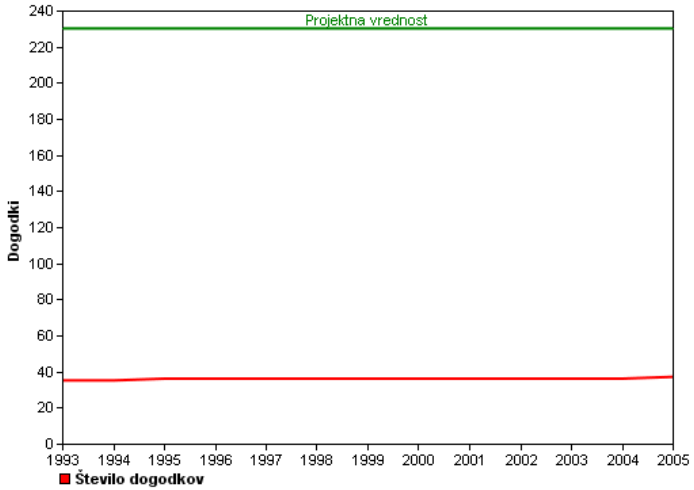
Monitoring the condition of important plant SSCs

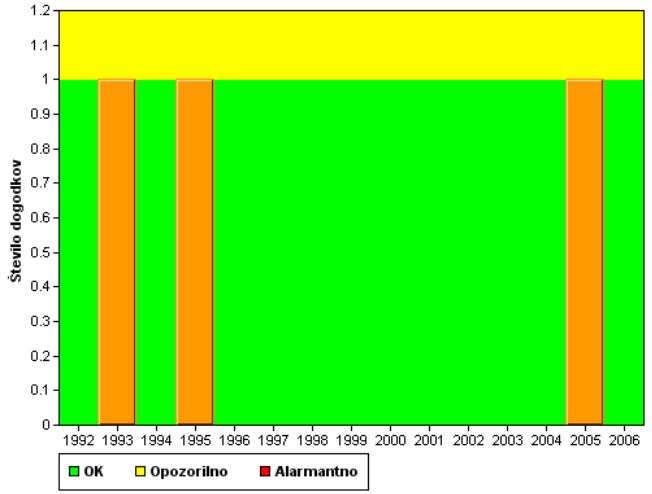
- Transients, included into database

Component	Project number of cycles	Cyclic or Transient Limit	Design Cycle or Transient
Primary coolant system	200	Heatup cycles at $\leq$ 55.6°C/h	Heatup cycle T_{avg} from $\leq$ 93.3°C to $\geq$ 287.8°C
	200	Cooldown cycles at $\leq$ 55.6°C/h	Cooldown cycle T_{avg} from $\geq$ 287.8°C $\leq$ to 93.3°C
	200	Pressurizer cooldown cycles at $\leq$ 111.1°C/h	Pressurizer cooldown cycle temp. from $\geq$ 343.3°C to $\leq$ 93.3°C
	80	Loss of load cycles, without immediate turbine or reactor trip	$\geq$ 15% to 0% of rated thermal power (RTP)
	40	Loss of offsite A.C. electrical power	Loss of offsite A.C. electrical ESF Electrical System.
	80	Loss of flow in one reactor coolant loop	Loss of one reactor coolant pump
	400	Reactor trip cycles	100% to 0% of RTP
	10	Auxiliary spray actuation cycles	Spray water temperature differential $\geq$ 177.8°C
	10	Hydrostatic pressure tests	Pressurized to $\geq$ 218.4 kp/cm^2
	200	Leak tests	Pressurized to $\geq$ 174.7 kp/cm^2
Secondary coolant system	1	Large steam line break	Break with a 1300 cm^2 throat area
	10	Hydrostatic pressure tests	Pressurized to $\geq$ 94.9 kp/cm^2

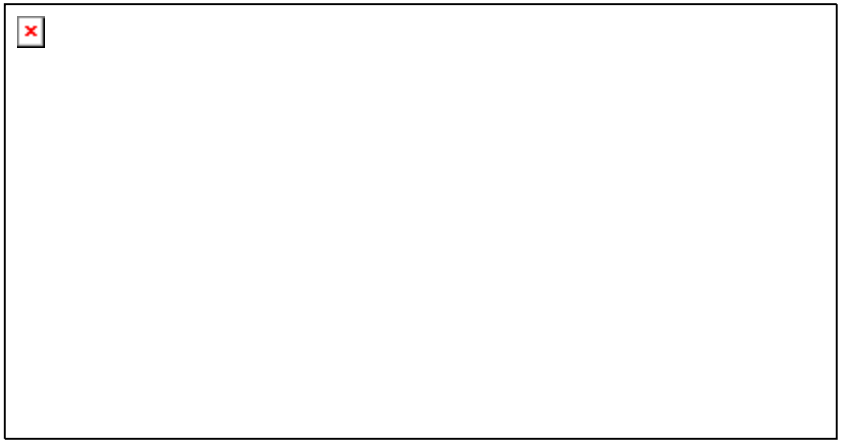
Monitoring the condition of important plant SSCs

- Cumulative and annual number of transients "Rx trip from 90-100% without cooldown"



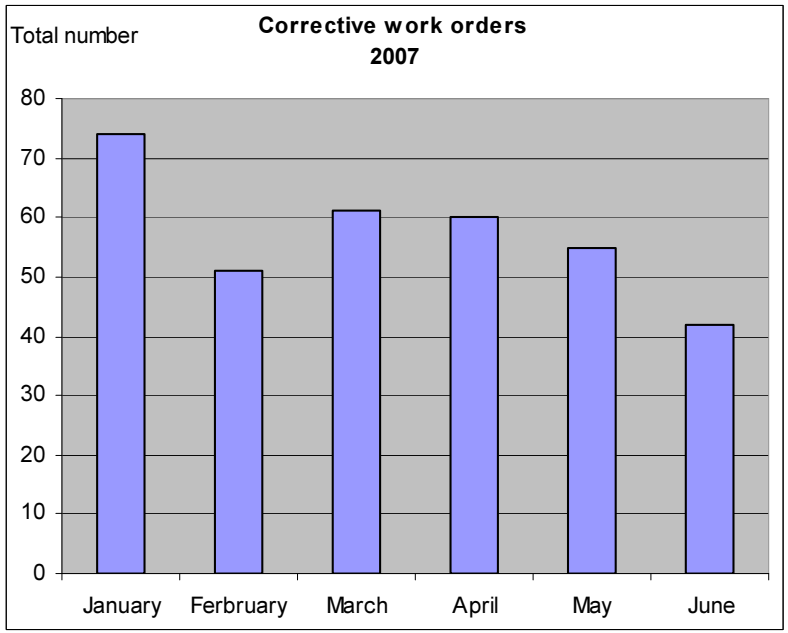


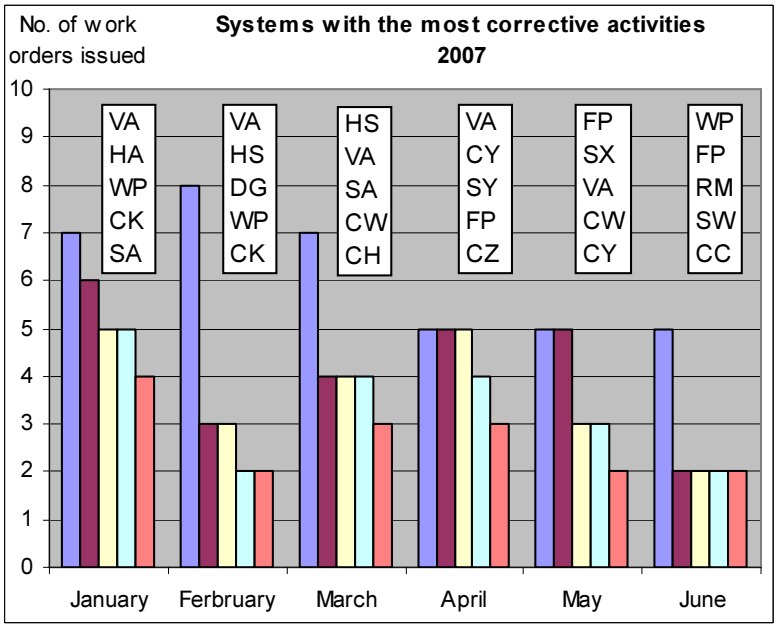
- Monitoring of thickness of pipeline segment from the Extraction Steam System



Tracking of plant's work orders

- List of corrective work orders submitted to the SNSA
- Safety performance indicators for corrective work orders
  - number of work orders issued per month
  - systems with more frequent failures
  - efficiency of corrective activities, performed by screening the identical activities of the same equipment within last 12 months.





Conclusions

- Period of operation license for the Krško NPP based on successful 10 years Periodic Safety Review
- First PSR at Krško NPP confirmed that plant is as safe as originally intended and no SSCs could limit plant life in next ten years
- In addition to PSR the SNSA is trying to implement additional activities to determine plant's suitability for future operation
- Software for monitoring of the condition of important SSCs and database for tracking of plant's work orders can provide direct information to regulatory body on equipment status
- In case of undesirable trend or increased number of corrective work orders SNSA actions should be started